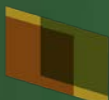# New Faculty Guide to Competing for Research Funding

What all new faculty need to know about finding funding and writing research proposals

Second Edition
Updated 2022

By Mike Cronan and Lucy Deckard

New Faculty Guide to
Competing for Research Funding

*What all new faculty need to know about finding funding
and writing research proposals*

BY MIKE CRONAN AND LUCY DECKARD

*Strategies to help new faculty get off to a successful
start in identifying and competing for grants to support
their research*

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About the Authors

This book was published by *Academic Research Funding Strategies, LLC*, a consulting firm that specializes in helping faculty and universities compete more successfully for research funding. We also publish a monthly newsletter, *Research Development & Grant Writing News*, which addresses in greater depth the subjects touched on in this book. The newsletter also includes information on recently-announced funding opportunities, strategic changes at the agencies, and other time-limited information and grant writing resources. For more information about the newsletter and how to subscribe, please see our website.

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Introduction

The following sections cover the central questions most often raised by new faculty starting a university research career. While federal agencies, foundations, and other funders of research differ significantly in their research mission and objectives, in agency culture and protocols, and in guidelines for submitting unsolicited proposals, the core knowledge base and writing expertise you need to acquire comprise a ***suite of broadly applicable strategies*** that lead to success in grant writing, regardless of academic discipline or research agency.

For example, regardless of whether you are submitting a proposal to the Defense Advanced Research Projects Agency (DARPA) or the National Endowment for the Humanities (NEH), your core competitive strategies will be similar:

- You must make a compelling case for the significance of your research, including its impact on the field and the value added benefits it brings to the agency's mission.
- You must understand the mission and culture of the agency sufficiently to explain how your research fits within the context (e.g., goals, objectives, outcomes, etc.) of the agency's research priorities as defined in the funding opportunity, as well as where your research fits in the context of the research field nationally and its impact.
- You must write a research narrative that fully responds to the program guidelines.
- You must understand how your proposal will be reviewed.
- You must describe for reviewers:
    - what you will do,
    - how you will do it;
    - why it is important to do it,
    - the significance and impact of your research on the field and agency mission,
    - why you are the right person to do the research,
    - why you have the capacity, expertise, and experience to perform the research, and
    - that you have the institutional infrastructure to support your efforts when required.

These, and other topics addressed here, offer strategies for success, although they will be made more robust and nuanced by the specifics you come to understand about the funder, your discipline, and detailed requirements unique to particular agencies or their programs.

Developing a Strategic Plan for Funding Your Research

New faculty members face a tremendous number of demands on their time. In addition to learning your way around campus, setting up your office, getting to know your colleagues, and preparing to teach, set aside some time to develop a strategic plan for what you will do over the next few years to position yourself to secure funding for your research. Creating a plan to guide you will make finding and competing for funding less overwhelming and will help you use your time more efficiently. Moreover, developing a long-term research funding timeline that maps your research capacities and interests to funding opportunities that you expect to become available over the next few years will enable you to develop a more coordinated and better planned research agenda. After all, your goal is not just to win one grant, but to win a series of grants over time that help to support your line of scholarship as you progress in your academic career. In fact, many of the things you'll need to do to plan your research proposals can be accomplished in parallel with your other activities. For example, when you meet with your Department Chair, ask about departmental expectations regarding funding, and as you meet your departmental colleagues, keep an eye out for potential grant mentors and collaborators and grant opportunities.

Below is a list of steps you need to take as part of developing your strategic plan. Subsequent chapters will explore many of these topics in more detail.

- **Develop your research agenda**: What research topics do you plan to pursue over the next five years? (You probably had to do this as part of your search for a faculty position, but you should revisit your plan periodically as your field evolves and as you determine the strengths of your institution and identify potential collaborators.)
- **Develop your education agenda**: What are your interests related to education in your discipline? (This is particularly important if you plan to pursue funding from NSF.)
- **Determine the expectations for research funding in your department**: How is funding counted in the promotion and tenure process in your department? Are you expected to win external funding early in your career, or are publications more important? When should you start pursuing external funding? Are certain types of grants or funders more highly valued than others?
- **Find research grant mentors**: These may be well-funded faculty in your department, colleagues from other departments, former dissertation advisors, staff in your research development office, or colleagues from other institutions.
- **Find out who is likely to fund your research, and get to know those funders**: Just as you need to network within your research community, you also need to get to know and understand your funding community – understand the mission, culture, and procedures of agencies and foundations likely to fund your research,

and get to know the program officers, reviewers, and researchers who are well-funded in your research area.

- **Develop a process for identifying specific funding opportunities that you may want to pursue now or in the future**: Many grant programs are recurring and have relatively predictable due dates. Others, particularly those in highly active areas, may appear suddenly. Creating a process for identifying opportunities early will give you time to plan which opportunities to pursue and avoid last-minute proposals.
- **Identify potential collaborators if appropriate**: If you're in a field that encourages collaboration, then collaborating with other researchers can help you expand your research and compete more successfully for grant funding. It's important, however, to determine how your department and institution view collaboration and how joint projects and publications will be credited during the promotion and tenure review.
- **Identify research development resources at your institution**: Most universities have research offices, and many have research development offices that provide a range of services that may include websites with updated funding opportunity lists, proposal workshops for new faculty, personal consultations, and even assistance with editing your proposal. Sponsored Projects (or similarly named) offices will often help you with your budget and with routing, uploading, and submitting your proposal. Seek out the resources available at your institution and the procedures required to use them.
- **Do your homework and determine what you must to do to be competitive**: Writing a proposal takes a lot of time and effort, so you'll want to make sure your proposal is as competitive as possible. Do you need more preliminary data? Have you read all of the relevant literature? Do you understand the program to which you're applying? Have you talked to the Program Officer? Have you talked to other researchers who have been funded through that program, or at the agency? Develop your proposal-writing skills. If your institution offers proposal-writing workshops, take advantage of them. Ask your funding mentors to show you examples of successful and unsuccessful proposals. Many agencies post abstracts of funded projects specific to the program area on the agency website, e.g., NSF, NIH, NEH. Go online and review these abstracts to get a sense of the common denominators of a successful proposal.
- **Schedule your proposal writing**: What grant do you plan to submit first and when is it due? What grant will you submit after that? How long will it take to produce the proposal? When should you start working on that first grant? Put those dates on your calendar, and set aside time for proposal writing. If you wait for your calendar to be clear, it will never happen!
- **Plan to be declined, and learn from your reviews**: It's a fact of life for anyone who submits proposals that they will be declined more often than they'll be funded. Successful researchers learn from their reviews and continue to submit

proposals. Build into your plan the expectation that you will need to revise and resubmit your proposal before it is funded. Persistence is the "coin of the realm" in successful grant writing!

We'll discuss these steps in more detail in the rest of this book. We'll also give an overview of the actual writing process and the sections that appear in a typical research proposal. Our intention is to give you a high-level overview of the process for finding and competing for research funding without overwhelming you.

For more information on grantsmanship, we have included an Appendix that provides more discussion of a number of topics related to writing successful proposal. Other resources, including our monthly newsletter, *Research Development and Grant Writing News*, and agency- and discipline-specific books on funding, explore these subjects in considerably more detail, discussing particular programs and agencies.

Developing Your Research Agenda

As you search for research funding, it's important to have a clear vision of where you want to go with your research. Having a clear, focused idea of your research direction will enable you to select the grants that will help you develop a clear line of scholarship. Publications arising from that line of scholarship will, in turn, help you establish the credentials that proposal reviewers seek.

Establishing Long-Range Research Goals

Your research proposals will be more compelling if you can place the proposed research project in the context of your larger research agenda. What do you want to accomplish in this field over the next ten years? What big questions do you want to answer, challenges do you want to meet, or need do you want to address? How will a particular project (which may be two-, three-, or five-years long) help you advance toward those long-term goals? Funders look for significance and impact, so tying a proposed two-year project (in which only a limited number of experiments can be accomplished) to your larger goals will allow you to make a stronger argument for the impact of your research.

Creating a long-range research plan will also help you make strategic decisions about pursuing some funding opportunities over others. While it's important to be flexible and move with the changes in your field, you'll want to avoid the trap of letting funding dictate your research. Jumping from topic to topic based on funding opportunities that happen to be available can result in a disjointed research record, and such proposals tend not to be successful anyway. Creating a well-thought-out, long-term research agenda will position you to use research funding as a tool to help accomplish your goals rather than as a wild card dictating those goals.

Questions to Consider

The detailed steps to follow in developing a research agenda vary considerably by discipline, but take these considerations into account as you develop your research agenda :

- Is your research agenda sufficiently separated from that of your graduate advisor so that you will be able to establish an independent career?
- Is your research agenda in an area that you are passionate about and would enthusiastically spend the next few years working on?
- Do you have a strong publication record that will support your chosen research area, or do you have a plan to establish a strong record soon? If the area is very new, will your previous publications demonstrate your qualifications to pursue this research area?
- Is your research agenda in an exciting, vigorous, high-impact area of scholarship (rather than in an already well-researched area in which progress is now incremental)?

- Is your research agenda in an area that is currently funded, or likely to be funded in the near future, by agencies or foundations? (You can find this out by exploring funder websites, strategic plans and roadmaps, as we'll discuss later in this book.)

This is not an argument for planning your future research based solely on any of these considerations. The importance of any one of the questions described above varies depending on discipline. For example, you may be passionate about an area of poorly funded scholarship, but if you have a strategy for conducting that research without external funding, and if your department values publications over funding, that could be a good choice for you. However, it is wise for any early career researcher to know the answers to the above questions before deciding on a particular research agenda.

Moving to a New Research Area

At this point in your career, you may have two or three research interests that move in somewhat different directions: continuation of the research that you did for your dissertation or postdoc, a relatively newer and more innovative offshoot of that research, and perhaps some research on a different but related topic that you plan to conduct in collaboration with other faculty. You'll typically have the strongest track record in terms of data and publications in the research related to your dissertation topic. On the other hand, the newer research directions may be more exciting and innovative. Many researchers maintain more than one track of research and pursue funding in each.

In the case of the newer research area, you'll want to start developing a track record in that area by generating preliminary data and publishing your findings. If you feel well qualified to conduct research on a topic, but an aspect of the research lies somewhat outside your expertise (an increasingly common occurrence as disciplinary lines become blurred in new areas of research), recruit a collaborator who can contribute that expertise. If you are faculty at a Predominantly Undergraduate Institution, and you identify an NSF-funded potential collaborator, you can participate in a [Faculty Opportunity Award Supplement](), whereby NSF provides funding enabling you to work with that faculty member during the summer. If the field is very new and you cannot find a collaborator, look for connections between the new research area and your prior research, and build on those connections. Reviewers look closely at your publications, so you'll need to make a convincing case that some of your prior publications, even if they are in a somewhat different field, are germane to the current research topic. And, of course, you'll want to publish in the area as soon as possible.

Developing Your Education Agenda

New faculty are generally not surprised that they need to develop a long-term research agenda; however, it can be a surprise that they should also develop an education agenda. (This is much more than the teaching philosophy you may have developed as part of your application for a faculty position, although they may have some elements in common.) The National Science Foundation (NSF) and, increasingly, other federal funding agencies want to know how your project will improve the education of students at various levels (not just graduate students), increase the diversity of graduates (particularly those in the STEM disciplines) and benefit society as a whole. These components are subsets of a global classification called "Broader Impacts" at NSF.

Establishing a long-term education agenda that fits your interests can make those Broader Impacts components stronger and the projects, once funded, more rewarding. Also, as you progress to larger grants, establishing a record of success in Broader Impacts can give you a competitive advantage. If you dream of someday being the Principal Investigator (PI) on a large NSF center-level proposal, perhaps a Science and Technology Center or an Engineering Research Center, keep in mind that strong Broader Impacts can be a factor in winning those large center-level grants. Moreover, in the more immediate future, a well-developed STEM education and outreach component is critical to winning an NSF CAREER award.

In addition, NSF and other federal agencies fund team or institutional projects specifically for STEM education improvement of various kinds, often related to workforce development in disciplinary areas of interest to the agency. For example, NOAA and NASA fund educational activities related to ocean sciences and space sciences, respectively, that prepare students for careers at those agencies. As a new faculty member, you may participate in this kind of proposal as a team member, but more senior faculty typically serve as PIs.

In the rest of this chapter, we'll focus on NSF since they generally have the most stringent criteria for education and outreach components in research proposals.

Selecting Issues to Address

When developing your education agenda, first consider those issues related to education and outreach in your field that interest you and are logical within the context of your proposed research. Is there an educational issue or need that you feel strongly about? Perhaps you are a scientist and have a child in elementary school and would like to help improve the quality of science instruction in elementary school. Perhaps you want to encourage more women to pursue careers in physics. It could be that you want to help improve understanding of your subject in the community. Maybe you've been teaching a sophomore class in your field and have noticed that the students aren't grasping an important concept. Perhaps you've learned about a new educational

approach or tool that you think could significantly improve learning in a course you teach. Any of these issues could inspire a variety of educational activities appropriate for an NSF grant.

Next, consider the needs and mission of your institution. Does your university serve a large number of minority students, students who are the first in their families to attend college, students from rural areas, working students, military veterans, or another special demographic? What are your institution's future priorities and plans? Perhaps they have identified e-learning as a big priority, or they are pushing to become a Tier One institution and increase their research activity, or perhaps they've identified increasing diversity of the student body as a major concern. Think about what educational needs you could address in support of these priorities.   Always keep in mind that you must make clear to reviewers why what you propose makes sense in the context of your proposed research and within the context of your mission.

Researching the Issue

Next, read the educational literature to find out what others have done in this area and how successful those efforts have been. Three helpful resources include the [NSF MSPnet](#) for K-12 STEM education, [NSF STEM Central](#) for undergraduate STEM education, and the [Education Resources Information Center](#) (ERIC), which is a searchable database of education research articles. If, for example, your goal is to encourage more girls to pursue careers in physics, you might search in ERIC for articles discussing the factors that affect girls' interest in science, and then look at MSPnet to see what projects NSF has already funded with a similar goal. In addition, your discipline may have an education journal that can provide helpful information on what has worked; for example, the [American Society for Engineering Education](#) has a peer-reviewed journal, conferences, and resources on their website.

If you find some interesting approaches, it's fine to propose to implement those approaches at your campus. NSF doesn't expect their PIs to reinvent the wheel; implementing approaches that have been successful elsewhere and assessing the results will contribute to the body of knowledge in education. Remember, also, that NSF doesn't want you to "reinvent the flat tire" by proposing approaches that haven't worked in the past. Since NSF has been funding education and outreach activities for many years (and has seen the results), there is often a consensus within NSF about what approaches are ineffective. (For example, proposing to recruit underrepresented minority students into an activity such as a research experience by passing out flyers and brochures is very likely to meet with high skeptical reviewer comments because this approach has consistently proven to be ineffective in past funded projects.) This is another reason that you need to do background research and talk to your colleagues to find out what approaches are generally seen as effective.

Leverage Existing Resources and Activities

Look for available campus resources on which you can draw. If your education topic relates to an institution-wide priority (for example, increasing diversity of engineering students, improving e-learning, providing more opportunities for students to become

globally engaged, or improving students' communication skills), you should be able to locate ongoing activities to which you can connect. There may also be experts with whom you can collaborate. Even if your chosen topic is not a campus-wide priority (for example, you might be concerned with a discipline-specific issue such as deficiencies in how a particular scientific concept in your field is taught), there may be experts in education, psychology, or other departments, or in a university office such as a Center for Teaching Excellence or a Writing Center who might be able to advise you. Talk to colleagues, but be aware that, particularly if you're at a large institution, they may not be aware of resources outside of your college. A university's research office and its website can also lead you to education and outreach resources across your campus.

Building a Track Record

Just as reviewers will scrutinize your track record in research to assess your expertise, they will look at your education and outreach track record. It's one thing to say that you plan to implement an innovative teaching approach; it's another to say that you have already implemented that approach on a pilot basis, discuss the results, and offer supporting metrics as evidence of success. Of course, as a new faculty member, you have limited time and resources, but there are often small tasks you can take on that support your education agenda and will help you to develop a track record. If one of your priorities is to recruit more minority students into science, volunteering to judge a science fair in a local school district with high minority enrollment would not require a large time commitment but would help you build relationships with the schools and provide experience that you can mention in your proposals. If you have an idea for a new teaching approach, try it out in one of your classes and note the results.

   You can also build a track record by participating in education projects that might be funded (or are being proposed) in your department, such as NSF Research Experiences for Undergraduates ([REU](#)), Improving Undergraduate STEM Education ([IUSE](#)). At this point in your career, you shouldn't take on a project role that entails administrative responsibilities (such as PI of an REU), but you should consider acting as a research mentor for an REU, which will not require a lot of time in meetings and will provide valuable experience that you can mention in your next proposal.

Research Affinity Groups

Given the increase in federal agency funding for projects of all sizes that are multidisciplinary, interdisciplinary, or, to use NSF's term, transdisciplinary in nature, new faculty should consider joining or forming institutional affinity groups, collaborations, and partnerships across university colleges, departments, and disciplines, as well as multi-institutional initiatives at the regional or national level. Often the start of this process may begin with exploratory meetings to identify, define, and characterize the potential scope, vision, uniqueness, possible team configurations, and funding potential from federal agencies that matches the research interests of a faculty affinity group, or possible subgroups.

Research affinity groups often function as a precursor to research partnerships and collaborations. Research partnerships and collaborations often have their origins in the pursuit of a specific open solicitation or anticipated solicitation on an annual grant cycle. By contrast, research affinity groups tend towards a more open-ended timeline that permits them to consider an array of possible funding opportunities across several agencies under an overarching research theme such as sustainability or health disparities.

This process of developing and configuring exploratory affinity groups can be challenging to junior and senior faculty alike. Often the research opportunities driving the need for affinity groups have very broad, overarching themes, such as sustainability, health disparities, climate, water, and energy, Big Data, antimicrobials, among many others. NSF and NIH often emerge as major funders in many of these overarching research areas, e.g., through cross-cutting programs or NIH's Common Fund, but these global research themes can also receive significant funding from many of the federal mission agencies as well, and sometimes in partnership with each other. For example, major federal agency investments in antimicrobial research come from NIH, CDC, NSF, FDA, USDA/NIFA.

Given these emerging developments, the need to establish research affinity groups is not new but increasingly common as federal research agencies address the so-called grand research challenges of all sorts, e.g., the 14 grand challenges of the 21st Century presented by the National Academies. While the processes and protocols for forming research affinity groups may already be fairly common across many disciplines, the disciplinary boundaries are being dramatically expanded by federal agency funding that recognizes the importance of such affinity groups to solving complex scientific challenges, particularly those with societal dimensions. An affinity group can be started and led by an experienced principal investigator working with a few colleagues and a shared vision, or, increasingly, *it can be initiated by a group of new and more junior faculty who find intense intellectual excitement in transdisciplinary research*. Regardless how it begins, the group then evolves as an affinity group, with a better defined research vision and more fully developed goals, objectives, and operational

details to achieve the vision than would have been possible had they worked in disciplinary isolation.

The core of the research vision will be grounded in disciplines well supported at specific agencies of interest, often engineering and the sciences. But the affinity group for such overarching research themes as those listed above must also include disciplines that complement the core research in such areas as education, societal benefits and impacts, public policy, and economics. In addition, researchers from the social and behavioral sciences or humanities would give significant value-added benefits to the core research by articulating its uses and benefits in terms of societal impacts. In many cases, the absence of these complementary disciplines will disqualify the proposal for funding. For example, NSF's INFEW program (Innovation at the Nexus of Food, Energy and Water) requires the research team to include PIs from three or more distinct NSF directorates. As a result of this dramatic increase in the number of research funding opportunities appearing under the umbrella of overarching research themes or grand challenges, new and more junior faculty not only have to master the craft of writing successful research proposals but also develop the leadership skills to form, develop, and move forward a research affinity group in a way that enhances the opportunities for funding success of all the members. Over the past two decades, this skill set has most often resided with senior faculty who successfully competed for research centers funded by NSF (see Profiles in Team Science), NIH, DoD, DHS, and NASA, among other agencies. However, many new and junior faculty may have no connection with senior faculty who successfully secured major center or center-level funding in research areas that required a transdisciplinary partnership approach.

On many campuses, the experience and expertise in the processes and protocols of establishing successful research affinity groups may also reside in research development and grant writing offices, typically at the university or college level, with a track record of assisting faculty on specific projects requiring the formation of research partnerships and collaborations. Regardless where that expertise resides, it is important that new and junior faculty benefit from it, either by linking successfully to senior faculty as mentors, or by seeking support of research office professionals experienced at working with faculty on developing affinity groups and the proposals resulting from such groups.

With this in mind, the first objective of a research affinity group is to define an overarching research vision or goal, e.g., sustainability of regional coastal ecosystems, that maps inclusively to group members and concurrently maps to one or more federal agency research funding areas, or agency mission areas. Depending on group dynamics and leadership, participation in exploratory meetings of potential research affinity groups requires at least a moderate tolerance of chaos, disorder, false starts, and confusion, preferably made more tolerable by an experience-based faith that good ideas can come out of what initially appears to be disorder. These early meetings are no place for biblical literalists or constitutional strict constructionists, or those with a preset idea about how an exploratory meeting should progress.

One caveat in this regard is to be both cautious and suspicious of those who offer what might be called "pedagogies of partnerships" or "canned protocols" for developing

research partnerships often disconnected from the research culture as well as disconnected experientially from the hard work of having actually developed a successful research partnership in the past. ***When it comes to developing research affinity groups or partnerships, keep in mind the old adage that "experience is the best teacher***." For new faculty, it may be helpful to find an experienced faculty mentor whose past funding success makes her an excellent guide into what may seem like a daunting task at first—forming a successful affinity group or partnership.

Senior faculty or research development offices can assist in this process in several ways. Perhaps most importantly, they can bring an institutional memory to the meeting of models, processes, and protocols that work and those that may not. This helps to ensure that the research affinity group does not reinvent the wheel, or, worse, reinvent the flat tire, as one NSF program officer observed. It is not uncommon for the initial meeting of an exploratory research affinity group to be an all-day affair, or even a weekend retreat. During this meeting, many opportunities will arise to offer observations that subtly redirect some of the more exuberant ideas disconnected from an agency mission or programmatic area of support. While the meeting will likely be called to develop a common research vision or goal as its overarching purpose, it still must be guided by information about possible funding scenarios that can breathe life into the group if it is to sustain itself over the long term.

One way to do this is by a ***judicious reverse engineering of potential funding opportunities***. There is a bargain to be made that balances the research interests of the group members with the availability of funding. Including someone informed about funding opportunities across some of the key research agencies can help this process immensely. Such a group member can ensure that ideas and action plans for implementing them are informed in a general way by funding prospects, particularly the prospects for these overarching research themes with opportunities across agencies. Unfortunately, the "***Field of Dreams***" analogy does not work for the development of research affinity groups—***if you build it they (funders) may not come***, especially if the group vision is established and framed in a way that does not resonate with one or more of a funding agency's mission or research priorities.

Newly forming research affinity groups also need to hear ***advice about what is and what is not a competitive proposal***. Participants must be reminded that research agencies do not fund ideas, no matter how good, that do not align with the mission objectives of the agency, or advance the state of the knowledge in some significant way. Some members of a newly formed research affinity group may be overly ambitious, or inexperienced in grant writing to the point that they confuse a research grant to NSF or another federal agency with applying for a MacArthur Foundation Fellowship, or so called "genius grant." Excitement and exuberance must be tempered by a realistic assessment of a group's capacities and the corresponding opportunities for funding. There are benefits to research affinity groups that sustain themselves on ideas alone, without external funding, but in most cases, various academic demands, particularly promotion and tenure for new faculty, will force a more realistic and grounded expectation of anticipated outcomes, i.e., funding.

Support for research affinity groups can be significantly enhanced by offering the appropriate information at the appropriate time with regard to ***contextualizing the group's research ideas*** to the mission, culture, and strategic investment plans of federal funding agencies, or programmatic areas within agencies. Some members of newly formed research affinity groups may not have more than a very cursory, at best, understanding of the research priorities of various federal agencies, and it is not uncommon that opinions of what will and will not fit the research mission are not grounded on any understanding of the mission and culture of the agency, or appreciation for what has been funded by the agency, or, more importantly, what characterizes successful principal investigators at the agency.

In some cases, research affinity groups may have ambitious expectations that the group will compete successfully for major awards or funding at the center level. Here, it is helpful to ***discuss a range of potential funding configurations***. For example, in most cases, research center awards and other large grants go to a research team with a configuration of funded grants approximating a de facto center and a successful history of research collaborations. It is helpful to disaggregate the constituent components of a center grant into discrete grants that the research affinity group may consider pursuing to build a track record of success before setting its sights on a major research award. These discrete grants may be developed by disciplinary subgroups within the affinity group, while remaining in harmony with the overall vision of the group. Faculty often overlook the option of configuring a research center as a collection of smaller grants funded in a piecewise fashion.

Moreover, these groups can often benefit from ***experience-based observations*** on the various processes, protocols, and sustaining practices related to communications, group dynamics, decision making, and leadership needed to advance an affinity group to successful competition for funding. It might be well to observe a caveat in directing the group's dynamics: exercise caution in recommending the use of "group process techniques" that many group members might find personally intrusive, ***or worse, a waste of time***. Rather than focusing on topical pedagogies of group dynamics outside the scope and charge of a research affinity group, consider ***focusing the group's attention on the research***. Success in funding a research team comes from the hard work of developing good ideas and crafting them into a compelling and competitive proposal.

Finally, in this process of supporting research affinity groups, a senior faculty mentor or an experienced research development professional can act as a referee or umpire at research affinity group development meetings. The referee need not pass judgment on the ideas but rather can offer advice ***when asked*** about whether development plans seem to be aligned with a potentially competitive idea based on a multitude of factors that come from repeated engagement and experience in research team development .

Finding Research Funding: an Overview

This topic area will be addressed by focusing on the following four subtopics related to finding funding for your research:

- Funding from Federal Agencies,
- Funding from Foundations,
- Funding in the Humanities, and
- Funding for Less Well-Supported Research Areas.

These subtopic areas share characteristics as the following definitions and discussion of common terms should clarify:

- There are two major research funding paths open to new faculty: one involves responding to an agency-published research *solicitation*, and the other involves following agency-specific guidelines for the submission of *unsolicited or investigator-initiated research proposals*. New faculty should explore and understand both of these funding mechanisms.
- Funding announcements, or solicitations, may be referred to differently by various agencies, including Request for Proposals (RFP), Funding Opportunity Announcement (FOA), Program Announcement (PA), or Broad Agency Announcement (BAA), among others*. We will refer to those here as the RFP*. RFPs contain the key information you will need to submit a proposal, and their role will be addressed in a subsequent section.
- Most university research is funded by federal agencies, but an important research role is also played by foundations, industry, state agencies, and private sources, among others.
- In the humanities and humanities-related social sciences, research funding for scholarly work often comes from libraries, collections, associations, museums, and related institutions, all addressed more fully below.

   While the universe of research and educational grant opportunities from federal, state, and local agencies, foundations, professional associations, and industry is very large, it shrinks quickly when you cull out the agencies, programs, and solicitations *without relevance to your research interests*. Once you define your disciplinary area of expertise and your research interests within that area, *your funding universe will become very small, very quickly*, perhaps amounting to only a few agencies, a few program areas within any particular agency, and a few solicitations within that program area. This also applies to foundations and the above-mentioned humanities funders.

   As a new faculty member, it is important that you learn how to identify research and educational funding opportunities immediately upon their announcement (e.g., by signing up for agency and program specific RSS feeds, email alerts, weekly funding aggregators, etc.). Most agency websites offer RSS feeds and email notifications to keep

you informed of funding opportunities and related information, e.g., agency webinars, grant writing resources, new agency research interests, etc. This will gain you valuable time for preparing your proposal. This added time may give you a decisive advantage in the competition for these awards. It allows you to assess the requirements for responding to a solicitation, to make a measured decision about whether or not to pursue it, and to undertake your response with sufficient time remaining for developing and writing a competitive submittal .

As a new faculty member, most funding opportunities that will fit your research expertise and interests will likely come from a few of the over 24 federal agencies that post upcoming solicitations to Grants.gov, or perhaps a few foundations that fund research specific to your discipline, e.g., social science, education, humanities. Your funding focus will likely remain on research grants specific to your discipline. However, in some disciplines, you may also explore educational grants, or hybrid grants that integrate research and educational objectives, something common at NSF, or technical workforce development grants in STEM disciplines (Science, Technology, Engineering and Mathematics) from federal mission agencies such as the Department of Energy (DOE), Department of Defense (DOD), National Oceanic and Atmospheric Administration (NOAA), etc.. These are the three most common grant categories (research, educational, hybrid research/educational) pursued by university faculty. Determining where your search for funding will begin is a function of your research goals and performance expectations, likely related to third-year review and promotion and tenure. Your objective is to map these criteria to possible sources of research support through published solicitations from federal funding agencies, or through familiarizing yourself with the process of submitting unsolicited proposals or investigator initiated proposals to federal agencies.

In the latter case above, keep in mind that significant funding opportunities for your research may also come from writing unsolicited proposals, a topic that will be addressed herein as a specific topic in a subsequent section. For example, roughly 50 percent of NSF and 80 percent of NIH research funding is awarded through the unsolicited proposal process, e.g., NIH Parent Announcements for unsolicited or investigator-initiated proposals or NSF Core Programs. Other funding opportunities may come from foundation funding, another topic addressed separately below.

When first identifying research funding, note the part of the research spectrum (basic, applied, applications, contract, etc.) that best defines your expertise, capacities, and interests. This will likely be significantly influenced by departmental expectations defined in the hiring process, as well as advice on research from an assigned or requested faculty mentor(s) or a department head or chair. ***Does the department favor certain types of grants over others?***

For example, departments frequently encourage new faculty in the technical disciplines to focus first on research grants rather than educational grants such as undergraduate research, curriculum development, or K-12 partnerships, whereas education, social, and behavioral sciences departments may have tenure expectations advanced by these educational grants, particularly in those areas where education is a

research area, e.g., cognition and student learning at NSF. Hybrid grants that integrate research and education vary significantly by agency, but a sufficient number of them will have a primary focus on research along with an educational component. So you can use multiple determining factors and criteria such as those mentioned above first to filter your search parameters for finding funding opportunities and second to narrow your search to funding opportunities that best fit your career expectations as a new faculty member.

Another important distinction to make when identifying potential federal funding agencies is *to note how and whether each agency restricts the definition of various general research areas to one that is unique to that agency's mission*. For example, several federal agencies support research in biochemistry, including NSF and NIH, but the NSF objectives are not (like those at NIH) conjoined to human diseases or medical outcomes. Moreover, many of the major umbrella research topic areas funded across many federal agencies, e.g., climate change, water, sustainability, energy, critical infrastructures, homeland security, materials, smart grid, big data, BRAIN initiative, antimicrobial research, etc., are often uniquely and tightly aligned with their research investment priorities as driven by one or more agency strategic plans or research roadmaps. Your capacity to note these distinctions is an important part of your overall funding strategy.

As an individual researcher, you have the most nuanced understanding of the particular research solicitations or unsolicited opportunities most relevant to your career objectives. Therefore, it is helpful to recognize that you can do the best job of identifying funding of possible interest to you by "packing your own funding chute." Develop your own search and organizational protocols for finding and categorizing research funding opportunities. This is very easily done.
The bottom line here is that finding funding opportunities is not a difficult task. All grants funded by federal agencies will be posted to Grants.gov, a site that also allows you to sign up for funding alert emails and RSS feeds. Some funding opportunities listed at Grants.gov will have links to three other sites: FedConnect , Federal Register, or FedBizOps where additional information on the funding opportunities will be posted. Federal agency websites duplicate the Grants.gov postings, e.g., at NSF, NIH, NEH, DoED, etc. Foundation websites, along with such humanities funders as libraries, museums, and special collections websites, are a source for non-federal agency research funding. A Google search for funding by disciplinary key work or disciplinary topic of interest is also another proven tool for finding funding opportunities.

Funding from Federal Agencies

All federal research agencies post new funding solicitations to Grants.gov. This site includes all information required for submittal of your proposal, including downloadable pdf files, agency URL links, due dates, funding amounts, etc. Grants.gov offers both RSS feeds and email alerts that notify you daily of new grant opportunities based on advanced search criteria you select when you subscribe to the alerts (e.g., agency or agencies, funding opportunity number, funding instrument type, eligibility, or subagency). For example, you can subscribe to the "modified opportunities alert" that notifies you of any modifications to open solicitations. ***This is particularly important for solicitations that stay open for an entire fiscal year or multiple fiscal years***, e.g., broad agency announcements (BAAs) from the defense agencies or other mission agencies that may change research priority areas during the open period prior to the publication of a superseding BAA, or make other modifications that impact how you write the project narrative. Finally, all of these electronic alerts can be saved in a folder to give you a chronological record of funding directions and recurring open periods on solicitations published annually. Importantly, at Grants.gov you can browse all funding opportunities by open/close dates, funding agency, research category, CFDA number, and eligibility, as well as search for grants by keywords. The CFDA, or **Catalog of Federal Domestic Assistance (CFDA), contains descriptions for 2,320 federal programs at 68 agency units, including formula grants and project grants, lists programs by funding agency, allows keyword searches, and serves as a complement Grants.gov.**

Ways to complement agency websites

In some cases, solicitations by federal agencies may also be published to FedConnect and Federal Register,. This will be ***in addition to and not a replacement*** for publication in Grants.gov. For example, the Department of Energy may publish the entire downloadable solicitation in FedConnect and the Department of Education will publish in the Federal Register, but in both cases a hot link to these sites will be provided in the Grants.gov announcement. DARPA and other agencies may post to FedBizOps, but this is also in addition to and not a replacement for the Grants.gov posting.

Moreover, most of the federal research agencies will also have agency-specific RSS and email alert systems for notification of funding opportunities posted to the agency website, e.g., NSF and NIH. In other cases, it is helpful to bookmark agency sites that continuously update funding information, e.g., EPA, DARPA, DOE, ONR, DoED, etc. This is particularly helpful for the federal mission agencies, e.g., DOD, EPA, NOAA, DARPA, etc., where large, multiple research program areas within a single agency function with significant autonomy. Also, remember that Google is your friend. A simple Google search on **"RSS feeds at 'agency name'"** or some modification of this search string specific to your research domain or program office within an agency will likely retrieve the information you need.

These agency websites are a robust complement to Grants.gov and an excellent source of funding information and related funding resources. Another advantage to subscribing to agency-specific electronic alerts is that you can also receive information such as agency reports, agency presentations, strategic plans and roadmaps, research alerts, and changing research investment priorities, etc. that can help clarify the agency's mission and culture, thereby aiding you to write a proposal that clearly describes the significance and impact of your research on the mission of the agency. *This is a key competitive factor in writing a successful proposal.*

It is important to anticipate the funding horizon for your research area of interest over the coming year so you can plan your proposals accordingly and with sufficient time to write a competitive proposal. This can be done by:

- Review agency website
- Identify annual (periodic) solicitations
- Learn solicitation due dates for upcoming year
- Learn the agency's unsolicited process
- Review foundation annual reports
- Talk to colleagues

The open period for a solicitation runs from the publication date to the due date. Some open dates are long and others are a "short fuse." Regardless, this is your core window of opportunity for funding success, i.e., it determines the time you have available to plan, develop and write a successful proposal. You will be able to write a more competitive grant by doing the "leg work" required to know the publication date of upcoming solicitations and thereby be able to jump start your grant success by make good use of all available time.

Who Funds What? A Quick Guide

This table provides a high-level guide to some of the U.S. federal agencies that fund academic research, along with links to funding opportunity pages. However, don't forget that you can use Grants.gov to search for all federal funding opportunities (non-research as well as research-related) by agency as well as by keyword.

Agency and Funding Links	What They Fund	Comments
Administration for Children and Families (ACF) **Grants & Funding**	Funds research to promote the economic and social well-being of families, children, individuals, and communities. Funds fellowships.	Most of the grants are implementation rather than research grants. Be sure to look for grants related to research.
Agency for Healthcare Research and Quality (AHRQ) **Funding & Grants**	Funds research to improve quality, safety, efficiency and effectiveness of health care.	Part of Department of Health and Human Services. Current funding priorities include health issues of minorities, health information technology, health care system redesign and more.
Agency for International Development (USAID) **Funding Opportunities**	Applied research and development to evaluate new products, tools, approaches and interventions focusing on health concerns in developing countries (includes behavioral research).	Collaborative Research Support Programs (CRSPS) partners with Land Grant Universities to strengthen agriculture in developing countries. Partnerships for Enhanced Engagement in Research (PEER) funds scientists and engineers in USAID partner countries for collaboration.
Centers for Disease Control (CDC) - **National Institute for Occupational Safety and Health**	NIOSH funds research to identify occupational populations at risk, develop methods for measuring exposures to hazards and detecting adverse health effects, determine the prevalence and incidence of occupational hazards, understand the etiology of occupational diseases and injuries, and reduce or eliminate exposures to hazards.	Part of Department of Health and Human Services. Procedures are similar to NIH
Congressionally Directed Medical Research Program (CDMRP) **Open Funding Opportunities** **Research Programs**	Funds disease-related research. Diseases of focus selected each year by Congress. Some, but not all, are related to military needs.	Includes grant categories for high-risk research and new investigators. Part of DoD, but culture and processes more like NIH. Panels include representatives of the patient community.

Agency and Funding Links	What They Fund	Comments
Department of Defense - **AFOSR Long-range BAA (investigator initiated)** - **ONR Funding Opportunities** - **ARO BAAs** - **DARPA Funding Opportunities** - **NSA Opportunities in Academia**	Fund basic and applied research related to the mission of each service. In addition to physics, materials, mathematics, computer science, etc., they may fund some life science and psychology (e.g., human cognitive and behavioral modeling). They also fund workforce and skill development.	Research offices are AFOSR (Air Force), ARO (Army), ONR (Navy), DARPA (high risk, high payoff research for all services), NSA (National Security Agency).
Department of Education **IES** **OPE** **Grants Overview**	Research on education from pre-school through higher education, adult education	Main research programs of interest to faculty funded through Institute for Education Science (IES) and Office of Postsecondary Education (OPE).
Department of Energy – **Advanced Research Projects Agency – Energy (ARPA-E)** **Funding Opportunities** **Funding Portal**	Research on overcoming specific techical barriers around a specific energy area.	Modeled on DARPA, so looking for innovative, high-risk, high-reward ideas.
Department of Energy – Office of Science	Funds basic research related to energy, including advanced computing, biological and environmental research, basic energy sciences, high energy physics, nuclear physics, and more.	Offer new investigator-type grants in the various program areas. Oversees the DOE National Labs. Collaboration with National Lab researchers is often a big plus.
Department of Energy – **National Energy Technology Laboratory (NETL)**	Funds or oversees research related to energy, fossil energy, including solid state lighting, smart grid, electric vehicles, clean coal, and other technologies	Mostly interested in more applied research.
Department of Energy - **Energy Efficiency and Renewable Energy (EERE)**	Funds research related to clean energy technologies, including solar, wind, water, biomass, geothermal, and hydrogen & fuel cells. M	Mostly interested in more applied research. Ultimate commercialization is often a big priority. Funds a lot of industry research.
Department of Homeland Security (DHS) **Grants**		
Department of the Interior - **Bureau of Indian Affairs** - **Bureau of Land Management**	Each of these bureaus funds projects specific to their missions. Overall agency goals focused on resource protection, resource use, recreation, and serving communities.	You can find funding opportunities in Grants.gov (use the agency filter)

Agency and Funding Links	What They Fund	Comments
- **Bureau of Ocean Energy Management, Regulation and Enforcement** - **Bureau of Reclamation** - **National Park Service** - **Office of Surface Mining, Reclamation and Enforcement** - **U.S. Fish and Wildlife Service** - **U.S. Geological Survey**		
Department of Justice - **National Institute of Justice (NIJ) Funding Opportunities**	Funds physical and social science research, development and evaluation projects about criminal justice. Also funds fellowships.	NIJ is the DoJ's research arm. NIJ Challenge Program
Department of State - **Fulbright Program** - **Bureau of Educational & Cultural Affairs**	Most grants fund cultural exchanges, fellowships	Funds opportunities for students and faculty to conduct research or teach abroad.
Department of Transportation **Grants** **Office of Research**	Funds research to bring advanced technologies to the transportation system. Funds university transportation centers.	
Economic Development Agency (**EDA)** **Funding Opportunities** **University Centers**	Funds projects to stimulate job creation, economic development, and innovation (institutional projects)	Part of Department of Commerce. Funds collaborations between university and industry (entrepreneurship and small business development)
Environmental Protection Agency (EPA) **Research Grants**	Funds research to improve EPA's scientific basis for making decisions on environmental issues	STAR grants, fellowships, research, small business grants
Housing and Urban Development (HUD) - **Office of University Partnerships**	Funds some research on housing and urban issues and policy analysis. Mainly funds dissertation research.	Most grants are not research-related, but they do fund some research out of the Office of Policy Development and Research (PD&R)
Institute for Museum and Library Services (**IMLS)** **Grants**	Fund activities including professional development, conservation, collections management, informal learning, community engagement, and more.	
Intelligence Advanced Research Projects Agency (I-ARPA) - **Research Programs**		

Agency and Funding Links	What They Fund	Comments
National Aeronautics and Space Administration (NASA) [NSPIRES Funding Opportunities](#)	Funds research related to NASA's space mission (also funds some STEM education programs)	Description of programs released annually in large [ROSES](#) solicitation.
National Endowment for the Arts (NEA) [Grants](#) [Grants for research](#)	Funds fellowships and projects in the arts (including theater, arts education, dance, literature, folk arts, music and more)	Much of their funding goes to local arts organizations. Matching/cost share typically required.
National Endowment for the Humanities (NEH) [Grants](#)	Funds fellowships, humanities initiatives, collections and education in the humanities	Funds scholarship and research, not creative projects such as novels.
National Institutes of Health (NIH) [Funding Opportunities](#) [Parent Announcements (investigator initiated)](#)	Basic and applied research related to human health, including social science research. Fellowships, instrumentation, training grants.	Part of Department of Health and Human Services. Research must have implications for enhancement of health, lengthening life, or reduction of the burdens of illness and disability.
National Institute for Standards and Technology (NIST) [Funding Opportunities](#)	Funds research related to materials, manufacturing, information technology, measurement and standards. Also supports curriculum development.	Part of Department of Commerce. Most of research is intramural, but they do funds some extramural research, particularly in collaboration with NIST researchers.
National Oceanic and Atmospheric Administration (NOAA) [Research](#)	Fund research on the structure and behavior of the ocean, atmosphere, and related ecosystems. Also fund education and scholarships related to their mission.	Part of the Department of Commerce (To find funding opps, go to Grants.gov and search on Dept. of Commerce – not NOAA). Much funding funneled through [Sea Grant](#) programs (geographically organized).
National Science Foundation (NSF) [Funding Opportunities](#)	Research in science, mathematics, computer science, engineering, social and behavioral science, and STEM education. STEM education initiatives. Fellowships, instrumentation.	Largest funder of academic research. Tend to fund basic research. Will not fund human disease-related research if it would fit at NIH. Does not fund research in the humanities or arts.
Nuclear Regulatory Commission (NRC) [Grant Opportunities](#)	Funds education, minority serving institutions, research on nuclear materials safety and other nuclear-related issues.	

Agency and Funding Links	What They Fund	Comments
Substance Abuse and Mental Health Services Administration (SAMSA) **Grants**	Implementation grants for mental health and substance abuse services.	Part of Department of Health and Human Services.
U.S. Department of Agriculture (USDA) **National Institute of Food and Agriculture** (NIFA) **Agriculture and Food Research Initiative** (AFRI)	Funds a wide range of food and agriculture research, including biotechnology, genomics, pest management, biofuels, childhood obesity and more. Funds fellowships.	Most research funding through AFRI (NIFA's largest research grant program). Also teams with other agencies (NSF, DoD) for some grant programs.

Funding from Foundations

Funding from foundations typically represents a much smaller part of a university research portfolio than does funding from federal agencies. Foundation funding is most often of interest to a much smaller subset of faculty, often in the humanities, social and behavioral sciences, and education. In most cases, the application process differs significantly from those directed to federal agency solicitations. Some colleges, e.g., education, and some disciplines, e.g., social and behavioral sciences, may locate more opportunities in foundation funding specific to their research domain of interest, e.g., [Spencer Foundation](), than other colleges and disciplinary departments, particularly those in the STEM disciplines that are well funded at federal research agencies. Regardless, in most cases, foundation funding will be at significantly lower levels than funding from federal agencies. Moreover, foundations have specific protocols for seeking research and education funding, in some cases including published solicitations with defined eligibility guidelines specific to preselected university applicants, or ongoing programs in specific disciplines. For example, the [Camille and Henry Dreyfus Foundation]() funds chemical sciences and chemical engineering.,

It is particularly important when seeking foundation funding to understand the mission and agenda of the foundation. For example, the [Russell Sage Foundation]() and the [Social Science Research Council]() are devoted to research in the social sciences, whereas the [Howard Hughes Medical Institute]() funds biomedical research grants for individuals and science education grants for institutions. The [W. M. Keck Foundation]() focuses on science, engineering, and medical research and undergraduate education. The Robert Wood Johnson Foundation funds grants in seven program areas related to health and health care. However, many smaller foundations will often restrict eligibility based on mission and agenda-specific factors. Geographic restrictions on eligible applicants, for example, is one of the more common restrictions for this funding group.

Finding funding from foundations is always tightly linked with becoming knowledgeable about a foundation's mission and agenda. This can be accomplished in several ways, including exploring the foundation website, reading the foundation's annual report on funded projects, reading publications of disciplinary colleagues and scholars whose research has been funded by the foundation, talking to colleagues who have been funded by the foundation or may have served as a reviewer for the foundation, and exploring links at the [Foundation Center (now Candid)](). *It is always helpful to talk to a program officer at a foundation to get a deeper and more nuanced understanding of its mission-specific agenda and application process.* Foundations can range from the very large ([Gates](), [Ford](), [Rockefeller]()) to the very small. Understanding the mission and agenda of small foundations can sometimes be more challenging, but one good starting point is the [990 Finder]() at the Foundation Center (Candid) website. The 990-PF is the information return U.S. private foundations file with the Internal Revenue Service. This public document provides fiscal data for the

foundation, names of trustees and officers, application information, and a complete grants list.

   Below is a table of some of the largest foundations that fund academic research and a short description of what they currently fund. Remember, however, that the priorities and topics of interest of these foundations often change, so be sure to check the foundation websites at the links below to check their current funding priorities. (This list is not meant to be comprehensive but may help you get started on your funding search.)

Private Foundations that Fund Academic Research: A Quick Guide

There are many private foundations that fund a variety of projects, but only a portion of those foundations fund academic research. Below is a table of some of the largest foundations that fund academic research and a short description of what they currently fund. Remember, however, that the priorities and topics of interest of these foundations often change, so be sure to check the foundation websites at the links below to check their current funding priorities. (This list is not meant to be comprehensive but may help you get started on your funding search.) For more information on foundations, see the Foundation Center (renamed Candid).

Funding Agency and Funding Links	What They Currently Fund	Comments
Alfred P. Sloan Foundation	Funds research in: STEM (including economic and behavioral science), STEM higher education, Data and computational research, Public Understanding of Science, Tech and Economics, and other select issues.	Public Understanding of Science, Technology & Economics includes funding for books, TV, films, etc. Also funds research fellowships for early-career scientists and scholars. Tips for writing a successful grant proposal to Sloan here.
Andrew W. Mellon Foundation	Funds scholarship in the humanities in place, arts and cultural heritage, and public knowledge	Also funds Mellon Mays Undergraduate Fellowships, dissertation, postdoc and early career faculty grants focusing on the humanities to support diversity, HBCUs and tribal colleges, and higher education in the US.
Arthur Vining Davis Foundations	Philanthropy to "religious, charitable, scientific, literary and educational purposes within the United States and its territories."	Current areas of support are Private Higher Education, Public Educational Media, Interfaith Leadership and Religious Literacy, Environmental Engagement, and Palliative Care.
Beckman Foundation	Funds basic research in chemistry, biochemistry and medicine. Includes Beckman Young Investigators, Beckman Scholars, Beckman Postdoctoral Fellows.	Invitations to apply to Beckman Scholars sent to a relatively large number of major universities and scholars. Must be at an invited institution to be eligible.
Bill and Melinda Gates Foundation	Projects to improve: global health and development (especially preventing disease in children and empowering	Grand Challenges opportunities announced here. Awarded grants database here. FAQs here. While much of the funding is focused

Funding Agency and Funding Links	What They Currently Fund	Comments
	women and girls), and education of underprivileged US students. Also fund special projects in Washington state.	on interventions, they do fund basic research (especially related to disease prevention).
Burroughs Wellcome Fund	Supports basic research to advance biomedical sciences. Fund career awards for medical scientists, career award at the scientific interface, postdoctoral diversity enrichment grants, investigators in pathogenesis of infectious disease, and research in regulatory science .	Also fund a number of other scientific and educational activities, including at the K-12 level. Special emphasis on North Carolina.
Camille & Henry Dreyfus Foundation	Focused on funding chemical sciences. Funds machine learning in the chemical sciences and engineering, teacher-scholar awards, awards for encouraging women, and others.	
Dana Foundation	Supports programs in science, health and education, including clinical neuroscience research and neuroscience and society.	Funded grants search here.
David & Lucile Packard Foundation	Projects to improve the lives of children, families and communities, and restore and protect the environment. Current program areas are: Climate, Children, Families & Communities, Reproductive Health, Ocean, Land Conservation in the North American West, and local grants for projects in northern California and Pueblo, Colorado.	Fund "use-inspired" research as well as communication of science to decision-makers. Also fund Packard Fellowships Science and Engineering for early-career researchers (nominated by presidents of 50 invited institutions). Grants database here. FAQs here. Not all programs accept unsolicited proposals. Check each program page for info.
Ewing Marion Kauffman	Supports research on entrepreneurship and entrepreneurship education and the intersection of technology, public policy, and the economics of education.	Most external funding for intervention and support projects in education, entrepreneurship and rather than research. Supports entrepreneurship.org. Special focus on Kansas City.
Ford Foundation	Funds projects that challenge inequality, including civil	You can find current grant opportunities here. Information

Funding Agency and Funding Links	What They Currently Fund	Comments
	engagement and government, free expression and creativity, disability inclusion, future of work(ers), gender, racial, and ethnic justice, international cooperation and global governance, natural resources and climate change, and technology and society. Funds large fellowship programs for underrepresented grad students who aspire to careers in academia. Also funds films and new media projects	on Ford Diversity Fellowships (predoctoral, dissertation and postdoctoral) can be found here.
Henry Luce Foundation	Projects in American Art, Asia, Women in STEM, Indigenous Knowledge, Luce Scholars, Public Policy, and Religion and Theology.	Awards grants to undergraduates, graduate fellowships and professorships for women in STEM through the Clare Boothe Luce program).
Howard Hughes Medical Institute	Projects to advance biomedical research and science education. Includes HHMI Investigator Program and Faculty Scholars Program	Check eligible institutions list before applying.
John Templeton Foundation	Funds programs on Science and the Big Questions, Character Virtue Development, Genetics, and Individual Freedom & Free Markets, and Exceptional Cognitive Talent and Genius.	Includes research on philosophy and theology. Especially interested in bold ideas that cross disciplinary boundaries to engage the Big Questions. Funded grants here.
McKnight Foundation	Neuroscience research, Arts & Culture, International, Midwest Climate & Energy, Vibrant & Equitable Communities. Special emphasis on Minneapolis area.	Grants database here. Funding FAQ here.
Robert Wood Johnson Foundation	Projects to improve health and health care of Americans.	Awarded grants here. FAQs here. Emphasis on public health, life style factors, communication, etc. rather than pharmaceutical therapies.
Russell Sage Foundation	Funds projects to strengthen the methods, data, and theoretical core of the social sciences as a	Current priorities include Future of Work; Race, Ethnicity, and Immigration; Social, Political and

Funding Agency and Funding Links	What They Currently Fund	Comments
	means of improving social policies.	Economic Inequality; Immigration and Immigrant Integration; Pipeline Grants, Behavioral Science and Decision Making in Context, and Dissertation Research Grants
Spencer Foundation	Research on education and improvement of its practice. Includes Research Grants, Training Grants, and Field Building Grants	Fund dissertation and postdoc fellowships
W.K. Kellogg Foundation	Projects to promote Thriving Children, Working Families, and Equitable Communities. Focus on early childhood (prenatal to age 8), within the context of their families and community. Committed to racial equity and community & civic engagement. Special interest in Michigan,	Applications accepted throughout the year; no set deadlines. Most grants that include research combine interventions with research. Mississippi, New Mexico, New Orleans, Chiapas and the Yucatan in Mexico, and Central and South Haiti. Awarded grants database here. Submission tips.
W. M. Keck Foundation	Supports research in science, engineering and medical research. Funds a Research Program, and Southern California Program.	Encourages high-risk, potentially transformative projects from early career and senior investigators. FAQ here. Funded grant abstracts for the Research Program are here.
Wenner-Gren Foundation	Supports anthropology and anthropologists worldwide. Funds Grants and Fellowships, Research Grants, Conference and Workshop Grants, Disseration Fieldwork Grants and more.	Application Guide, hosts virtual Proposal Workshops
William and Flora Hewlett Foundation	Projects to help people build measurably better lives, including improving education, addressing cyber challenges , economy and society , effective philanthropy, protecting the environment, addressing gender equity and governance, and supporting performing arts	Interactive tool to explore awarded grants. Most of their funding goes to non-research focused grants and support. Letters of inquiry accepted only for certain programs (see program pages).

Funding Agency and Funding Links	What They Currently Fund	Comments
	in California Special emphasis on California and the Bay Area.	
William T. Grant Foundation	Funds research focused on reducing inequality and improving the use of research evidence in decisions that affect young people in the US.	Current focus areas include Reducing Inequality; and Improving the Use of Research Evidence.

Funding in the Humanities

Research funding of interest to university faculty in the humanities is most often focused on **scholarly research**. In most cases, funding for scholarly research differs from the research funding sought by faculty in the technical disciplines and the social and behavioral sciences. It differs as well from the funding sought by institutions with a humanities mission focus, such as museums or other cultural institutions, and programs that seek funding to promote the humanities to a wide public audience or advance it through teacher training. Funding from the National Endowment for the Humanities (NEH) or the U.S. Department of Education (DoED), for example, often has this objective. Moreover, depending on the institution, the research interests of faculty in the humanities may not be as well understood, and hence not as well promoted or supported by university research offices more familiar with supporting faculty research in the technical disciplines.

Funding for scholarly research in the humanities is distributed widely across a vast number of museums, libraries, collections, centers, archives, associations, endowed programs, and institutes, to name only a few sources. Moreover, compared to the technical disciplines, the dollar amounts for scholarly research in the humanities are small and often do not allow for charging indirect costs. In many cases, depending on institutional protocols, funding to faculty in the humanities goes directly to the faculty member rather than the institution.   How this works on your campus is something to discuss with your sponsored projects office or similar research support office, often under the office of vice president for research.

The largest federal funder of the humanities is NEH, but supporting faculty scholarly research is only one part of how that agency supports the humanities. Other federal agencies fund humanities-related activities, **as opposed to scholarly research**, including U.S. Department of Education, Institute of Museum and Library Services, Department of State (Bureau of Educational and Cultural Affairs), and the Department of Interior Heritage Programs.   The Department of State funds scholarly research through the Fulbright Program.

There are several good starting places for finding funding for scholarly work in the humanities, including the American Academy of Arts & Sciences website. Many universities and humanities centers at universities have excellent web sites that offer exhaustive listings of opportunities for research funding in the humanities. For example, the following websites provide a good starting point that will quickly become a cascade of opportunities as you follow embedded links: Fellowship and Grant Opportunities for Faculty Humanities and Social Sciences, University of Kansas, Northwestern University, Duke University, University of Florida, Boston University, Vanderbilt University, among many others.

There are many online resources to help new faculty learn how to write successful grants in the humanities once a funding sources has been identified. One of the best

sites is NEH which publishes online as downloadable pdf files numerous examples of successful applications to most NEH programs along with the five review criteria used by NEH to evaluate proposals. While these five criteria are specific to NEH, you will find them to be generic as well to funding from foundations, libraries, collections, etc.: (1) The intellectual significance of the proposed project, including its value to humanities scholars, general audiences, or both. (2) The quality or promise of quality of the applicant's work as an interpreter of the humanities. (3) The quality of the conception, definition, organization, and description of the project and the applicant's clarity of expression. (4) The feasibility of the proposed plan of work, including, when appropriate, the soundness of the dissemination and access plans. (5) The likelihood that the applicant will complete the project. Moreover, keep in mind that an excellent way to develop your grant writing skills in the humanities, or any other discipline for that matter, is to serves a reviewer for the funding agency. At NEH, you can register to be a reviewer [here](.).

Other sites helpful to writing humanities proposals include:
- [How to Get a Grant from NEH](.)
- [Writing Proposals for ACLS Fellowship Competitions](.)
- [How to Write Effective Proposals in Humanities](.), Susan Stanford Friedman, Department of English, University of Wisconsin-Madison
- [Ten Myths About Fulbright](.)
- [National Humanities Center](.)
- [Signposting and Front-Loading](.), by James Mulholland, Assistant Professor of English at Wheaton College in Massachusetts.

Helpful books:
- Peter Burke. History and Social Theory. 2nd. Ed. Ithaca: Cornell U P. 1993.
- Raphael Folsom. How to Get Grant Money in the Humanities and Social Sciences. New Haven: Yale U P. 2019.
- Michele Lamont. How Professors Think: Inside the Curious World of Academic Judgment. Cambridge: Harvard U P. 2009.
- Barbara L. E. Walker & Holly E. Unruh. Funding Your Research in the Humanities and Social Sciences: a Practical Guide to Grant and Fellowship Proposals. New York: Routledge. 2018.

Funding Less Well-Supported Research Areas

Locating funding for your research can be a frustrating search if your discipline or research topic area is not well supported, or not supported at all, by any federal agency. Most federal agencies fund either basic research or mission-driven research specific to that agency. Given this predetermined funding landscape, and the mission-specific opportunities it offers in terms of funding solicitations, it is not uncommon for some faculty to come to the challenging realization that their research interests and expertise do not map to any open funding solicitations at any of the federal agencies. However, they are still faced with institutional expectations for research along their academic career path, particularly at third-year review and in the tenure and promotion process. Fortunately, many avenues in addition to federal agency solicitations lead to funding for your research interests. For example, consider the following as some possible routes to follow for funding success.

Explore Research Collaborations

As a synthesis of research capacities, collaborations hold the potential for research funding opportunities that might not otherwise be funded as discrete topic areas by individual researchers on single-PI grants. However, true research partnerships regardless of size come about from taking the time to establish the groundwork for collaboration through networking at conferences, working with and engaging mentors and colleagues, publishing jointly, and making a keen assessment of the "value-added" characteristics that research collaborations bring to any given initiative. Moreover, collaborations require creative and integrative thinking about the synergy that occurs at the intersection of your research with the research of potential partners. So take the time to create your own personalized "partnership roadmap," including identifying the possible benefits your research expertise might bring to that of your colleagues, on your campus or on other campuses.

Find a Place for Your Research on Large Proposals

Many center-level proposals require multiple research strands, increasingly of an interdisciplinary or transdisciplinary nature. In some cases, these proposals may require transdisciplinary programmatic components outside the core technical or scientific domains that enable the center to meet the goals and objectives of the funding agency. For example, topics such as public outreach and societal benefits, or ethics, public policy, communications, public or stakeholder surveys, workforce planning, community and cultural impacts, evaluation and assessment, and the like, may be required by the sponsor to complement the technical research core of the center. This is common, for example, on center and center-level grants from NSF. Regardless, in many cases, center-level proposals require the inclusion of programmatic components that represent unique and highly specialized research expertise from faculty in other

disciplines in order to fully respond to the agency research objectives and thus be competitive for funding.

Research deans and department heads in various colleges and university-level professional staff in various VPR offices can serve as a possible source of information about the types of center-level proposals being developed or planned on your campus, or in partnership with other universities. Talk to research office professionals on your campus to see if there are planned or ongoing major grant proposals being developed that require disciplinary expertise outside of the core technical areas that might benefit from you involvement.

Review Websites of Researchers in Your Disciplinary Area to Find Funding References

University websites exist for almost every conceivable disciplinary area and research topic with a home at an academic institution. These range from comprehensive websites of centers and institutes to websites by interdisciplinary and affinity groups, to the personal websites of individual faculty. Surfing the websites of faculty whose research is in your topic area can have great benefit in terms of a deeper and more nuanced understanding of possible ways you can find funding for your research, or funding partnerships. In some cases, websites of research groups in an area that mirrors your own research domain may identify sources of research funding by project area, agency, foundation, and industry.

Review Journal Articles for References to Funding

Journals and publications in your academic field and specialty area may include authors' acknowledgements of support from a funding agency or agencies that made the research possible. Look to those acknowledgements as a potential funding source for your own research.

Find Funding from Business and Industry

Identify business, industry, or consulting firms that provide client services that would benefit from your research expertise or specific research topic area (remember Google is your friend here). Perhaps you will identify a consulting firm that advises township clients on wetlands or ecosystem restoration processes or policies required as part of plans for growing communities and annexing former rural areas. As in all examples here, the key is to know how to describe your research, identify a potential funder that would benefit from your research, and pursue discussions that focus on the added value your research brings to their particular enterprise.

Find Foundation Funding

Funding from foundations holds many advantages for those whose research topic areas and expertise do not map well to federal agency funding. It is typically the first alternative option researchers think of when they are unable to find federal agency

funding. The process of seeking foundation funding resembles that of seeking federal funding in several key respects. Your primary goal is to map your research and programmatic interests, capacities, and ideas to the research and programmatic interests and mission of the foundation. ***Therefore, be sure to research and understand the mission, culture, and investment agenda of the foundation, and learn the role of the program officer at the foundation during the application and review process***. Importantly, opportunities for funding at foundations exist at many scales, ***including national, regional, state, and local foundations.*** Foundations will have domains of interest and a mission agenda driving their investments. Your job is to explore those mission and agenda domains in your search for foundations that fund programmatic areas to which you bring competitive expertise and ***offer an idea of interest to the foundation.*** Do not overlook small regional or state foundations in your search.

Find Funding from NGOs, Associations, and Professional Groups

Another avenue to explore begins with mapping your research interests, expertise, and particularly an idea you have to the agenda of local, regional, or national associations and professional groups, special interest groups, nongovernmental organizations, advocacy groups, community groups, and the like. The goal is to find an organization with a mission and agenda that could benefit from your research. This may seem like a very open-ended challenge made more troublesome by the vagueness of a starting point. However, the stepwise process is generic to any research funding search: (1) define your research, (2) map it to the interests, mission, and agenda of a possible funder; and (3) start discussions or meet with the potential funder to explore how your research expertise can bring value-added benefits to its mission.

Municipal, County, and State Governments

Municipal, township, county, and state government agencies and offices often have mission or operational objectives that can benefit from research, particularly applied or applications-based research, that can help that agency better serve the public. Keep in mind that successful public-serving agencies must function as problem solvers, ***and good research is one ingredient of successful problem solving in a host of areas.*** For example, councils of government at both the regional and local levels along the coastal Gulf of Mexico may have an interest in the disaster preparedness protocols established by an assistant professor of political science as part of her doctoral dissertation. Similarly, coastal communities along Lake Michigan may need surveys and analysis of the impact of wind farms on coastal ecosystems and flyways that attract tourists to the area. While these examples abound, the ***key task for you is to creatively envision the role your research could potentially play in helping government agencies serve the public by helping the agency to better solve problems***.

Community Partnerships

Many community organizations have mission objectives that could potentially benefit from a research perspective, particularly in the applied and applications-based social and behavioral sciences and community health. Community organizations often have agendas specific to local or regional needs, and may have a focus on a range of issues, including health disparities, educational attainment, environmental issues, healthy communities, domestic violence, and the like. Learn about local and regional community organizations to discover how your research interests and expertise may contribute to the ability of a specific organization to offer better services.

What to Do When You Need Equipment

New faculty who conduct laboratory research often find that they need expensive equipment that is not available at their university. This is particularly an issue at Predominantly Undergraduate Institutions (PUIs), which usually don't have the same level of research infrastructure as research-intensive institutions. If you find yourself in this situation, you can use several strategies to address this challenge.

   If the equipment you need is not very expensive (e.g., $50K or less), and it is clearly required to conduct a proposed project, you may be able request funding for the instrument as part of the project budget. Discuss this possibility with the program officer before submitting the proposal.

   If the equipment is needed by a number of faculty at your institution or at other institutions in your region, you should consider teaming to submit a proposal for an instrumentation grant. There are a number of such grants, the most widely known of which is the NSF Major Research Instrumentation (MRI) program. These grants fund research instruments up to $4 million and generally require multiple users, preferably from multiple departments and institutions. Many of these grants (particularly those for under $100K) have been awarded to PUIs, so if you have the right elements in place, you can be competitive for these grants. Other grants that fund instrumentation are listed at the end of this chapter.

    NSF also funds shared-use instrumentation for faculty at PUIs through the Research in Undergraduate Institutions (RUI) program. To be competitive for most of these grants, the instrument should have multiple users, many of which have strong research records (and in some cases, such as the NIH Shared Instrumentation grants, explicit requirements concern the source of funding for the instrument users' research).

   If you are the only researcher in your institution who will need the instrument in question and you'll need the instrument on an intermittent basis, you should consider looking to other universities that have the instrument and determine whether they would be willing to allow you access. This may not be as difficult as it might first appear. It's quite possible that the instrument was purchased on a grant such as the MRI, and as part of the proposal the PI committed to sharing access to the instrument. If this is the case, their proposal included a management plan, which probably described procedures for allowing outside researchers use of the instrument (usually for a reasonable use fee to cover consumables and technician time), and they may have committed to encourage use by faculty from PUIs and minority-serving institutions. You can search for such an instrument by looking through NSF's awards for MRIs as well as by networking with fellow researchers.

   A related strategy for PUI faculty is to find a colleague with access to the desired instrument who has a current NSF research grant. Propose a collaboration in which they submit a proposal for a Research Opportunity Award (ROA) supplement to their original NSF research grant. These FOA supplements fund faculty from PUIs to visit the NSF-

funded researchers' lab, usually during the summer, to conduct research. Not only can the ROA grant help you gain access to the needed instrument for a summer but it can also help you develop a collaboration that can continue beyond the life of the original grant. Also keep in mind that data generated using your collaborator's instrument can be used as part of an MRI proposal if you later decide to pursue a grant to fund an instrument at your institution.

    If you need more regular access to the instrument, traveling to someone else's lab may not be practical. In that case, you might investigate whether it's possible to get a used instrument as a donation or at a reduced price. If the instrument you need is frequently used in industry labs, you may find a company that is planning to upgrade to a newer instrument and would be happy to take the tax write-off by donating their used instrument to a university. Often, connections can be made with these companies through research colleagues or through alumni who work at the company. (If you decide to pursue this approach, be sure to check with your university's development office to determine the procedures you need to follow when requesting such a donation.) Used instruments might also be available for sale through the vendor or other venues (you can even find some instruments on e-bay, although caution would be advisable). Note also that DOE has a program that makes used equipment from their labs available to schools and universities [(LEDP)](#).

    You should keep in mind, however, that the cost of purchasing a lab instrument is only one portion of the expense involved. You also have to find a place to put it that meets space, power, water, and other requirements. In addition, significant operation costs (e.g. consumable materials such as liquid nitrogen) as well as maintenance expenses often apply. This is why it's important to enlist the support of your department head and possibly your dean. Make your case to them that having this instrument will benefit not only your research, but the institution and its mission. Will you involve students in your research? Will you incorporate the instrument or the data generated by the instrument in the curriculum? Will having the instrument help position you to publish and compete for research funding? All of these things will strengthen your case and perhaps convince your department head and dean to commit funds and space to support the instrument you need.

Grants that Fund Instrumentation

(Note that not all of these programs stage competitions every year. Program activity can vary markedly depending on agency funding priorities. If it's not clear when the next competition will be held, contact the funding agency to find out.)

Program: [Major Research Instrumentation Award (MRI)](#)
Funding Agency: National Science Foundation (NSF)

Program: [Midscale Research Infrastructure](#)
Funding Agency: NSF Directorate of Biological Sciences

Program: [Earth Sciences: Instrumentation and Facilities (EAR/IF)](#)

Funding Agency: NSF Directorate for Geo-sciences, Division of Earth Sciences

Program: [Chemistry Research Instrumentation and Facilities](#) (CRIF)
Funding Agency: NSF Directorate for MPS, Division of Chemistry

Program: [Archaeometry Awards](#)
Funding Agency: NSF Directorate of Social, Behavioral and Economic Sciences, Archaeology

Program: [Astronomical Sciences Advanced Technologies and Instrumentation (ATI)](#)
Funding Agency: NSF MPS Directorate, Division of Astronomical Sciences

Program: [Shared Instrumentation Grant (SIG)](#)
Funding Agency: NIH

Program: [Defense University Research Instrumentation Program (DURIP)](#)
Funding Agency: DoD agencies

Program: [High End Instrumentation Grant](#)
Funding Agency: NIH

Program: [National Institute of Food and Agriculture Equipment Grants](#)
Funding Agency: USDA Agriculture and Food Research Initiative

Program: [Energy-related Laboratory Equipment (LEDP) Program](#)
Funding Agency: DOE

The Role of the RFP

The RFP is an invitation by a funding agency to submit proposals on research topics **of interest** to the agency. It contains the key information you will need to develop and write a competitive proposal, e.g., submission process, agency research goals and objectives, referenced documents, review criteria, eligibility, budget requirements, etc. To be competitive, your proposal must respond **fully** to an agency's submission process, program objectives, review criteria, budget guidelines, and other requirements specific to the program. It is important to read the RFP carefully and in its entirety, including review criteria and all referenced documents. Writing a competitive proposal requires that you understand the RFP for what it is--*an expression of agency interest in a specifically defined research area.* The RFP is almost never a perfect mirror of your research interests. From the funding agency's perspective, the RFP is a **non-negotiable listing of research performance expectations** reflecting the agency's mission, goals, objectives, and investment priorities that **you must meet** to be funded. The RFP is *not meant as a menu or smorgasbord inviting you to* address some topics and review criteria but not others. A flawed understanding of the requirements of the RFP, or the agency guidelines defining the unsolicited proposal process and the role they play in structuring a competitive research narrative is one of the more common reasons proposals are poorly reviewed and declined by funding agencies.

The competitiveness of your proposal will depend on how well you understand the RFP as a very detailed expression of an agency's interest in a specific research topic area. Once you clearly understand the agency's objectives, the next step is to map your expertise to the RFP to determine whether or not you should respond to the solicitation. If your interests and expertise do not map tightly to an RFP, it is wise not to submit and wait for a more appropriate solicitation.   Invest your time, resources, and energy wisely—they are your most valuable assets and they must not be squandered.   Having a good idea is a necessary **but not a sufficient condition** for successful funding. Funding agencies are seeking exciting ideas clearly stated that *make a compelling case that your expertise will advance the research priorities of the sponsor* .

The RFP needs to be closely analyzed and understood as an integrated whole. This includes understanding the agency's research objectives, desired outcomes or deliverables, the way in which those research objectives will be reviewed, and any referenced strategic plans or research roadmaps that define the research context in more detail.   RFPs are written documents, and, like all written documents, they are not always perfectly clear. Any uncertainties you have regarding the meaning or intent of any portion of the RFP need to be resolved early in the proposal process to ensure your proposal research narrative fully responds to the guidelines. You can often resolve uncertainties through repeated, closer readings of the RFP, discussions with colleagues who have been funded by the agency in similar research areas, or by contacting the program officer directly. The latter is often the best option. Never hesitant to contact a

program officer for clarifications. Timidity is NEVER rewarded in the competitive proposal process! Ambiguities are ALWAYS punished!

The same general principles will apply in terms of following agency guidelines for the submission of unsolicited proposals.

Unsolicited or Investigator-Initiated Proposals

As we discussed in the previous chapters, funding agencies regularly issue solicitations for proposals. Because these solicitations tend to be highly visible – they are posted on Grants.gov, announced on various websites, and many university grants offices distribute them – researchers who are new to the grants process may think that the only way to compete for funding is to respond to these solicitations. However, for many funding agencies, responding to solicitations is not the only (and often not the best) way to win grant funding. Many agencies, including NSF, NIH, DoD, DOE, DoED and DARPA, fund research through "unsolicited" or "investigator-initiated" proposals.

   To understand how unsolicited proposals work, it's helpful to understand how funding mechanisms evolved at the basic research agencies, taking NSF as an example. NSF was originally given the broad mandate to fund the best research ideas in science, math and technology. It was set up along disciplinary lines mirroring the structure of universities, with Directorates corresponding to the colleges within a university, Divisions within each Directorate corresponding to university departments, and Programs within each Division. These NSF Programs (often called "Core Programs") were set up to fund a broad range of research fitting within the "Program Description." (For information on how to use the NSF website to identify the core program that best fits your research, see the videos posted here.)   Below is an example Program Description for NSF's **"Condensed Mater Physics" program** (which resides in the **Division of Materials Research**, which is part of the **Math and Physical Sciences Directorate**).

"he Condensed Matter Physics program supports experimental, as well as combined experiment and theory projects investigating the fundamental physics behind phenomena exhibited by condensed matter systems. Representative research areas in such systems include: 1) phenomena at the nano- to macro-scale including: transport, magnetic, and optical phenomena; classical and quantum phase transitions; localization; electronic, magnetic, and lattice structure or excitations; superconductivity; and nonlinear dynamics. 2) low-temperature physics: quantum fluids and solids; 1D & 2D electron systems. 3) physics of soft matter: partially ordered fluids, liquid crystals, gels, foams and emulsions, granular and colloid physics, rheology and jamming. 4) mesoscale systems and macromolecular assemblies: self-organization and active matter, physics of biological materials, intrinsically heterogeneous materials and complex interactions across different length scales, and 5) understanding the fundamental physics of new states of matter as well as the physical behavior of condensed matter under extreme conditions e.g., low temperatures, high pressures, and high magnetic fields. Questions of current interest that span these research areas are: How and why do complex macroscopic phenomena emerge from simple interacting microscopic constituents? What are the rules and principles controlling collective motion, self-organization and self-assembly of matter? What new physics occurs far from equilibrium and how? What

is the physics behind the behavior of matter confined to the nanoscale in one or more dimensions? What is the physics of spin systems and quantum states of matter that could lead to their coherent manipulation and control?"

As you can see, this program accepts proposals based on investigators' ideas, as long as they fit under the broad program description. It does not offer a detailed solicitation or explicit guidance on acceptable proposal topics beyond the program description, hence, the term "unsolicited" or "investigator-initiated" proposals.

Initially, almost all proposals to NSF and NIH were unsolicited proposals. However, over the years the agency found that they wanted to encourage proposals on specific topics of interest to the agency – often because they saw great potential in a new area (for example, nanotechnology) or because the agency had specific objectives it wanted to meet (for example, encouraging more undergraduates to pursue majors in science). In order to encourage more proposals in these high-priority areas and to provide more guidance to researchers, NSF began issuing solicitations. You can find an example of a solicitation [here](#). The solicitation is obviously much more prescriptive, and it also tends to come to the attention of more people because it is officially "released." Probably for this reason, unsolicited proposals to NSF often have higher success rates than proposals written in response to solicitations (although success rates vary markedly depending on funding available and the number of applicants). In fact, over half of the research grants funded by NSF and NIH are unsolicited.

Not all agencies accept unsolicited proposals, and those that do have a variety of mechanisms for providing guidance to researchers on the types of unsolicited proposal they want to see. Below is a list of some agencies that accept unsolicited proposals and useful links for finding out more about how to submit them. If you would like to find out whether an agency not listed below accepts unsolicited proposals and the mechanisms involved, in addition to exploring the agency's website, a Google search on "how to submit an unsolicited proposal to <NAME OF AGENCY OR PROGRAM>" is often a useful tactic. (Some private foundations also accept unsolicited proposals, but their processes can be quite different from those used by government agencies.)

Some Agencies that Accept Unsolicited (Investigator-Initiated) Proposals

Agency: National Science Foundation
Mechanism: Proposals submitted to disciplinary core programs
Due Dates: Most core programs have due dates, target dates, or proposal windows that come around once or twice each year (although some core programs accept proposals at any time). This information is posted on the core program webpage.
Proposal Guidance: Program Descriptions on the core program webpage describe the general areas of interest. The proposal format (page limits, margins, etc.) is dictated by NSF's [Grant Proposal Guide](#).

Useful NSF Resources:
 NSF's website is full of extremely helpful information.
We have posted videos on how to find and analyze core programs using the NSF website.

Agency: National Institutes of Health
Mechanism: Investigator-initiated proposals are submitted in response to "Parent Announcements," but must address a topic of interest to an NIH Institute or Center.
Proposal Guidance: Follow the instructions in the NIH Application Guide.

Useful NIH Resources:
You can search active Program Announcements here.
You can find a lot of NIH grants resources here.
You can identify a Program Officer who might be interested in your research topic by consulting the database of funded projects here.

Agency: Department of Defense
Mechanism: Each service that funds research releases what they call a "long range" or "blanket" Broad Agency Announcement (BAAs). These Long Range BAAs, which may be released only once every few years and are often close to 100 pages long, describe the various research interests of the service. If a researcher is interested in submitting a proposal related to one of these topics, she should contact the Program Officer to explore her interest in the proposed project before going further (more on this in the next article).
Proposal Guidance: See the BAA.

Useful DoD Resources:
Army Research Office Long Range BAA
Air Force Office of Scientific Research Long Range BAA
Office of Naval Research Long Range BAA for Science and Technology

Other Agencies

Department of Education Institute of Education Sciences (IES)
The Institute of Education Sciences accepts investigator initiated applications for research, evaluation, statistics, and knowledge utilization projects that would make significant contributions to the mission of the Institute. More information here.

Department of Energy
The National Energy Technology Laboratory (NETL), Pittsburgh Office, has operational responsibility for the DOE Unsolicited Proposal (USP) Program. More information here. Investigator-initiated proposals to DOE's Office of Science should be submitted under

their [blanket FOA](#), typically issued annually. (Search for "FY20xx Continuouation fo Solicitation for the Office of Science Financial Assistance Program".)

Defense Advanced Research Agency (DARPA)
Each of the technical offices within DARPA has a link on its [website](#) to an "office-wide BAA" that describes the kinds of research for which they will accept proposals. (As with any DoD funding opportunity, be sure to check with the Program Officer to assess their interest in your project before submitting a proposal).

Understanding Funding Agency Mission & Culture

Funding agencies do not passively fund research projects that are disconnected from a long-term, well considered research agenda and research investment strategy. Basic research agencies (e.g., NSF, NIH) often see themselves as leaders in a national dialogue on research topics and directions, and as key players in defining and driving that national agenda for fundamental research. The federal mission agencies (e.g., DOE, DoD, DARPA, EPA, NASA, NOAA, etc.) fund research, either basic or applied, that falls within the scope of their mission objectives and brings value-added benefits to that mission. This can be a source of surprise, and even frustration, to applicants new to the research funding enterprise, who may believe that a good idea alone will merit funding, regardless whether it connects to a particular agency's mission and investment priorities. ***However, agencies fund only very good ideas that clearly advance their mission, vision, and strategic research plan.***

Therefore, the more knowledgeable you become about a funding agency's mission, strategic plans, research culture, investment priorities, and the rationale behind them, the better able you will be to write a more compelling and competitive proposal narrative. This agency-specific knowledge allows you to more convincingly describe how your proposed research is relevant to the research objectives spelled out in the solicitation, as well as place your research in the broader context of the agency's strategic research plan. ***How well you convince reviewers that your research will play a key role in advancing the agency's mission-critical objectives as listed in the solicitation, or in the guidelines for unsolicited submissions, will determine whether your proposal is funded.***

Having a good idea is a necessary but insufficient requirement for funding success. A good idea cannot stand alone, at least in the world of funded grants, without first being preceded by and intertwined with the mission objectives and investment priorities of the funding agency.   A good idea that does not offer value-added benefits and impact the agency mission or the field in a significant way will not be funded by a federal agency. In the world of writing research grants, the facts of life, so to speak, are simple: it is not about the research goals the applicant would like to address; rather, it is about the research goals the funding agency requires the applicant to identify in support of its mission. Too often, those new to grant writing do not fully appreciate how tightly constrained federal funding agencies are in what they fund and why they fund it, or the very high degree of fidelity required of any successful proposal to meet all the research goals and objectives defined in the solicitation. A meticulous reading of the solicitation, an explication of text, if you will, is often the first casualty of unbridled enthusiasm neither bounded nor tempered by the constraints imposed on the proposal process by agency guidelines.

Many research programs funded by federal agencies, and some private foundations, grow out of an evolving consensus among the national research community on the most promising future directions in specific research topic areas. These directions and priorities, in turn, are translated into funding opportunities at the agencies, or are incorporated into an agency's strategic plans and given an investment priority level within the agency. These reports may be published by the [National Academies Press](#), for example, or be posted to agency websites. (All National Academies reports are downloadable in pdf format for free.) In many cases, these reports and studies will be cited with a URL link in the solicitation or program guidelines. It is always wise to review these reports, particularly the executive summary, to become more knowledgeable and better informed on possible persuasive arguments you might advance in your research narrative. These reports can help you enhance the perceived significance of your research by clarifying for program officers and reviewers the value of your research to the agency mission.

Educational programs targeted at universities, e.g., curriculum reform or undergraduate research, are often developed through the same process. It is not uncommon, for example, for reports of the National Academies, the American Association for the Advancement of Science, or similar associations to significantly influence funding directions at one or more agencies, and for those reports to form the underpinnings of subsequent solicitations. Understanding the origins, underpinnings, and rationale behind funding solicitations will help you better frame your claims of research merit and thereby better position you to write a competitive proposal narrative.

Some agencies, such as the National Science Foundation and National Institutes of Health, are composed of directorates and divisions, or institutes and centers, and these, too, have defined missions, strategic plans, investment priorities, and cultures, at times almost acting as autonomous funding agencies in themselves. It may, therefore, also be necessary to understand the mission, culture, and priorities of the particular organizational unit to which you will be submitting your proposal.   Other agencies, e.g., DOE, NOAA, DoD, NASA, etc., may often have very dispersed mission areas with multiple research offices acting autonomously.   In these cases, it is important to familiarize yourself sufficiently with the agency and program websites in order to become very knowledgeable about the mission, culture, and research investment priorities of that part of the agency that most fits your research expertise and interests.

A successful proposal allows the funding agency to form a partnership with the submitting institution and principal investigator that will help carry out the agency's vision, mission, and strategic research goals. As the applicant, you must understand the nature of this partnership and the expectations of the funding agency, both during proposal development and throughout a funded project. ***Analysis of the funding agency helps you better understand several key elements common to every competitive proposal narrative:***

- Who is the audience (e.g., agency program officers and reviewers) and how are they best characterized in terms of the expertise they bring to the review

process?

- What is the best way to address that audience?
- What is a fundable idea and how does it support the agency's research investment priorities?
- How are claims of research uniqueness and innovation best supported in the proposal text and connected to the agency's research objectives?
- How do you best communicate your passion, excitement, commitment, and capacity to perform the proposed research to review panels and program officers?

Program Officers and When to Contact Them

The role of the Program Officer (sometimes called the Program Director or Technical Point of Contact) varies markedly among funding agencies. In some agencies, they dictate the priorities of their program and may have almost sole control over which proposals get funded. In other agencies, their role may be more administrative, and they may have very little influence on the funding decision. An important part of getting to know the funding agency to which you plan to apply is to determine the role of the Program Officer for that agency and the culture regarding relationships with the Program Officer. At the Department of Defense, for example, it's virtually impossible to get funded if you haven't talked to the Program Officer. At NSF, most Program Officers see themselves as mentors to new faculty and are happy to provide advice and guidance. At NIH, PIs are often funded without ever having talked to the Program Officer (although it's still a good idea to do so). In some private foundations, the Program Officers are so busy that they may discourage you from contacting them personally but may instead want you to write a letter of inquiry outlining your idea.

When to Contact the Program Officer

There are several reasons to contact the Program Officer: (1) there is a point of ambiguity in the solicitation that you need to clarify; (2) you need to determine whether your project is appropriate for the funding agency or program and perhaps solicit advice on how best to present your idea; or (3) you need to get to know the Program Officer and s/he needs to get to know you (this applies to some agencies and not others).

As noted in a previous chapter, timidity is never rewarded in the grants process, and ambiguities are always punished. For proposals that are a response to a solicitation (a.k.a. RFP, RFA, or Call for proposals), the clearly understood solicitation forms the foundation of the successful proposal. If you don't clearly understand the research expectations in a solicitation, or if you feel the solicitation is ambiguous on some details or requirements, which can occur, call the program officer for clarification before you start writing. When you email or call a program officer, be informed. Questions should be based on a repeated reading of the solicitation after which clarification is still needed or ambiguities remain. You cannot write a successful proposal narrative based on an ambiguous understanding of any portion of the RFP. If you don't clarify ambiguities in the RFP, they will metastasize to the research narrative and almost certainly result in a declined proposal.

For unsolicited (a.k.a. core or investigator-initiated) proposals, it's even more important that you talk to the Program Officer in order to determine if your project idea fits the needs and priorities of that program since you don't have the explicit guidance of a solicitation to follow.

Program officers usually are happy to respond to queries by potential applicants, especially questions that are thoughtful, clearly stated, and focused on the research topic (NSF often notes "call us early and often"). However, **do not ask the program**

officer to make speculative comments on the likelihood that your idea will be funded, or to engage in similarly inappropriate discussions. But **do call them to resolve any ambiguities you feel exist in the RFP**, or to develop a more nuanced understanding of the agency's intent and your potential fit to it. (One caveat is that the Department of Defense often forbids Program Officers from talking to potential applicants after the RFP or targeted BAA has been released. However, this is not always the case, and if you need clarification of a point in the RFP, an administrative contact may be able to answer your question.)

For many funding agencies, particularly NSF, it isn't always obvious which program within the agency your research fits, and submitting to the wrong program can doom a good proposal. While many useful resources on the NSF website can help you understand the research interests of each program, it's always a good idea to contact the Program Officer to discuss your research and the specific interests of the program. In addition, NSF Program Officers will often point you to particular solicitations and discuss any recent changes in the focus of their program. The same is true of many other funding agencies.

Getting to know the Program Officer and making sure they know you and your research can also be very important at many agencies. The Department of Defense and many of the mission agencies (such as NASA, NIST, and NOAA) see externally-funded researchers as collaborators helping them to meet the needs of their agency and program. For that reason, you need to develop an understanding of their needs and a relationship with the agency and program in order to be competitive for funding. As mentioned above, NSF Program Officers often see themselves as mentors to early-career researchers; they want you to submit a high-quality proposal and encourage PIs to contact them for information about what NSF is seeking and what you need to do to submit a competitive proposal.

How to Contact the Program Officer

Even when Program Officers encourage PIs to contact them, that doesn't mean the contact will go smoothly. Program Officers tend to be very busy and travel quite a bit. For that reason, it's usually a good idea to send an email with a short summary of your research idea and ask to schedule a phone conversation. Give the Program Officer at least a week to respond, and if you don't hear back, try again. Program Officers typically get a large number of emails each day, and yours may have gotten lost in the inbox. If, after several attempts, you don't hear anything, it could be that your Program Officer prefers to communicate by voice mail, so you might try leaving a phone message. If that doesn't work, look to see whether there is another point of contact for the program and try that.

Before you talk to the Program Officer, be sure to do your homework. At the top on Program Officers' list of pet peeves is PIs who call them up and expect the Program Officer to read the solicitation to them. As was mentioned above, read the solicitation or program description thoroughly. Also read any background material that was cited in the solicitation, and look in the funding database to see what other projects have been

funded by the program. When you talk to the Program Officer, ask open-ended questions and listen carefully. Take what the Program Officer has to say seriously, even if what she's telling you is not what you want to hear. For example, if the Program Officer says your research doesn't fit his program, it's much better to accept that fact and talk to him about other programs where it might fit or how your research project could be modified rather than spend time on a proposal that's unlikely to succeed.

In addition, many Program Officers attend conferences in their field. If you happen to be at such a conference, take the opportunity to introduce yourself to the Program Officer if you get the chance.

The PO's Role in the Review Process

The PO's role in the review process can vary from total autonomy at one extreme, to having no role at all at the other. Most funders seek input from external reviewers (for research grants, these are usually peer reviewers with research backgrounds in the field), but these peer reviews are often only advisory. The relative influence of the PO versus external reviews on the funding decision varies by funder and by program.

Small private foundations are most likely to give POs a high level of influence on funding decisions. The PO typically works very closely with the foundation leaders and is expected to ensure that the program supports the foundation's mission and current focus areas. Also, small private foundations don't need to answer to Congress, and questions of fairness or concerns about conflicts of interest are typically not big issues.

The Department of Defense (DoD) also gives its POs a lot of discretion in determining what projects to fund. POs are usually experts in the program research area and are charged with funding projects that will produce results that address DoD's specific needs in support of its mission.

Among DoD agencies, POs for the [Defense Advanced Research Projects Agency (DARPA)](#) are typically the most autonomous. DARPA POs are often leading experts in the topic of their program and are expected to work with the research community to drive breakthroughs. DARPA prioritizes fast "out-of-the-box" results, and DARPA POs have the discretion to select the most promising ideas, encourage teaming of specific researchers, and pull funding if results aren't coming as quickly as expected or if a more promising idea comes along. While proposals do undergo review by external experts, it is often the case that much of the decision has already been made by the DARPA PO during discussions with the proposing team about their proposed technology. However, the PO may have to compete within DARPA for funding. As a result, if your DARPA PO likes your idea, your relationship may be collaborative, as you help the PO to secure funds to support your project.

POs at the [Air Force](#) (also [here](#)), [Army](#) and [Navy](#) Research Offices don't have quite as much autonomy as DARPA POs but are similarly tasked with helping to find the research projects that help solve issues that are important to the missions and priorities of their services. In order to be competitive, you need to talk to your prospective PO about the specific needs of interest to their program and convince them that you can deliver.

POs at NSF are more in the middle of the autonomy spectrum. They choose reviewers and run review panels. They are experts in the field of their program and are expected to act like portfolio managers, investing in a range of projects that address various important topics within their program area. However, they will typically choose only from well-reviewed proposals. As a result, while proposals are not funded strictly in accordance with how they are ranked, it is rare for a poorly reviewed proposal to be funded.

At NIH, the review process for most proposals (except for responses to PARs and most RFAs) is conducted by the Center for Scientific Review, which is separate from the Institute or Center (IC) that funds the grants. The PO may not even be in the room when the proposal is reviewed, although they typically try to be. NIH funding decisions are typically tightly tied to the impact score and ranking assigned to them by the peer review panel. However, a proposal that gets a fundable score but does not address a topic of interest to the funding IC will not be funded. It also sometimes happens that a proposal that doesn't get a fundable score but addresses an area of high priority for the IC may still be funded. The PO provides internal input on how relevant your proposal is to the IC's priorities.

Similarly, at the National Endowment for the Humanities (NEH), POs provide recommendations on the well-reviewed applications. At the Department of Education Institute of Education Sciences (IES), POs have no role in evaluating proposals or making funding decisions.

Interacting with the PO

It's probably obvious that in cases where the PO has a lot of say in the review process and funding decision, it's a good idea to try to talk to the PO before writing your proposal. However, POs' responsiveness and receptivity to such discussions also vary among funders. Some foundation POs are overwhelmed with requests, and they may be unwilling to schedule individual discussions (although it's always a good idea to try). In contrast, some foundations, particularly those that have programs aimed at helping early career scholars, such as the Ford Foundation, are typically very responsive.

While it's critical to get to know your DoD PO, if you're responding to a targeted RFP or BAA (as opposed to submitting an unsolicited proposal to a long-range BAA), DoD rules typically don't allow POs to talk to applicants in order to prevent unfair transmission of information. For that reason, it's a good idea to have developed a relationship with the PO well before the RFP or targeted BAA is issued.

DARPA POs often achieve a "celebrity" status and are so well known and busy that it can be very difficult to connect with them. However, similar to getting a meeting with Taylor Swift, you may be able to make connections through their assistants or through others (such as potential collaborators) who already have relationships with them.

NSF strongly encourages PIs to contact POs to discuss their projects and the fit with the program. However, the level of engagement can vary significantly depending on the program as well as the personality of the PO. While most POs are happy to meet with you in person or schedule a phone conversation, POs in the Social and Economic

Sciences division are so overwhelmed with requests that they resist in-person meetings and may even request that you send a white paper describing your idea instead of scheduling a phone conversation. It's important to be sensitive to the PO's constraints and the different cultures within NSF.

Even in cases where the POs have little or no involvement in the proposal review process, they can be of tremendous help. In fact, in some cases that lack of involvement frees them up to provide much more specific advice and mentoring. POs at NEH and IES often consent to read and critique entire proposal drafts. (If you'd like to get this kind of feedback, be sure to talk to the PO about this well in advance of the deadline.) NIH POs will often review and critique drafts of your Specific Aims page. Even though these POs will not be the involved in reviewing your proposal, they know their program's priorities and can help you to avoid common mistakes, so this advice can be invaluable.

Conclusion

From the examples above, it should be apparent how a PI can put himself at a disadvantage if he doesn't understand the role of the PO and the expectations for engagement. When getting to know a funder, do some research to make sure you understand these aspects of the agency. Potential sources of information include colleagues familiar with the funder, your research office, information provided by the funder on its website, in webinars, or in other outreach materials, and the PO herself.

Writing for Reviewers

Specific review criteria and review processes differ from agency to agency, as well as by program within an agency, and by type of solicitation. **But the core, generic questions program officers and reviewers want answered can be simply stated**:

- What do you propose to do?
- Why it is it important—what is its significance?
- Why are you able to do it?
- How will you do it?
- How does it contribute to and advance the research mission interests of the agency, or the field?

These simple questions may be expressed in various ways by different agencies and programs, and more specific details will often be requested in the solicitation or program announcement (e.g., NSF has both overarching review criteria and program-specific review criteria), but ultimately most review criteria can be distilled down to some equivalent version of these simple questions. Your challenge when writing for reviewers is to answer these questions in a clear, convincing, and compelling way that is **easily accessible and understood by the reviewers**.

Solicitations may often contain a fairly long listing of review criteria specific to the program, but if you keep these core criteria in mind while writing your project narrative, you will better infuse your narrative with the key arguments, details, internal connections, and explanations all reviewers will look to in making their evaluation of your research, regardless of discipline, agency, or foundation.

Your proposal typically will be read by two basic types of reviewers: those who are expert, or at least knowledgeable, in your research domain, and the those who are not. The program officer will play a key role in this process as well, but that role will be **agency specific** (e.g., at NSF reviewer inputs are advisory to the program officer, whereas at NIH the percentile score is key to your success). Unless you are confident you know otherwise, when writing to reviewers, **write for the intelligent reader and not the expert**. Remember you are most likely writing to a **panel** of reviewers, **each of whom** will be selected for a needed expertise. This particularly the case as research solicitations become increasingly interdisciplinary. In all cases:

- You must craft a persuasive argument presenting the merit, significance, rigor, and relevance of your research that **makes the reviewers want to fund it**;
- You must convince reviewers you have the capacity to perform, and the institutional infrastructure to support your research;
- You must extend your argument to discuss the likely impact your research will have in advancing the field and creating new knowledge, both in your research area and possibly in other research fields as well; and

- When writing to federal mission agencies, you must demonstrate to the program managers and reviewers that your research advances the mission of the agency.

The author of a funded proposal has successfully accomplished the following basic goals of writing for or with reviewers in mind:
- Ensured the reviewers were intrigued and excited about the proposed research;
- Understood its significance;
- Understood that existing research enhances the likely success of the proposed effort;
- Understood how the proposed research will be accomplished; and
- Developed confidence in the researcher's capacity to perform.

The proposal review is the most important factor influencing the likelihood your proposal will be funded. More than one person typically will review your proposal – these may be personnel at the agency or foundation, peer reviewers from academia, other people from outside the funding agency, or a combination. Reviews may be conducted on an ad hoc basis or by a standing panel. Reviewers will evaluate the proposal based on review criteria, both explicit (stated in the solicitation or other agency documents) and implicit (commonly held but unstated expectations held by the reviewers). Understanding how the reviewers will evaluate your proposal is critical to learning how to write a winning proposal. This, by the way, is not a simple task. It is a learned skill and, once mastered, a very valuable one.

Writing for Reviewers—Generic Narrative Tips
- Sell your proposal to a good researcher but not an expert;
- Write to **all the reviewers** on the panel, as some review panels may not have an expert in your field, or panels may be blended for multidisciplinary initiatives;
- Keep in mind that proposals are not journal articles; proposals must be user friendly and offer reviewers a **compelling and memorable** narrative;
- Proposals are not mystery novels. Reveal the significance of your research quickly, not at the conclusion;
- Check carefully for sloppy errors in language, usage, grammar, and logic, which reviewers may assume will translate into sloppy errors in your research;
- Write a compelling project summary (or abstract) and narrative introduction:
  - This is where you must capture the interest of reviewers and win them over by making them intrigued enough to want to read your entire proposal closely and with interest;
  - Define the significance of the core ideas quickly, clearly, and concisely;
  - Describe the connectedness of the core ideas to specific research activities and outcomes, and advance your ideas with sufficient detail to make your research **memorable after the proposal has been read**.

Agency Review Criteria

Each funding agency develops review criteria and a review process that best serve the mission of the agency, as well as the requirement of each solicitation. In the case of unsolicited proposals, the review criteria will most often be addressed in the agency guidelines for submitting unsolicited proposals, or in other agency documents.   For example, BAAs from DoD agencies that are open for a year or more will typically have a section on the review process for unsolicited proposals as well as solicited proposals. Agencies usually post review criteria and review processes on agency websites and include them within program solicitations, submission guidelines, and other documents. Two of the major funders of university research, NSF and NIH, have developed elaborate and comprehensive information on their websites about the review criteria and process.

Agencies typically develop two general kinds of review criteria: first, overarching criteria that apply across the agency to every grant application, for example, intellectual merit and broader impacts at NSF; significance, approach, innovation, quality of investigators, environment, and overall impact at NIH; or, at defense research laboratories, scientific and technical merit and the contributions of the research to the agency mission. Depending on the agency, not all overarching review criteria are weighted equally in terms of importance; for example, some mission agencies may list them in descending order of relative importance.

The second type of review criteria apply specifically to the particular program and may be very detailed in terms of expected project objectives and outcomes. The overarching review criteria of any agency typically are clearly stated and well explicated over time. For example, the "broader impacts" criterion, one of two overarching review criteria at NSF, has been much written about and discussed with detailed examples on the NSF website, as well as at various NSF workshops.

Solicitation-specific review criteria, however, especially on new programs, may not have been as fully vetted for possible ambiguities, in which case it becomes ***important to discuss the criteria with a program officer***. If you are uncertain about the meaning of one or more review criteria, it is important to clarify the agency's intent with an agency program officer, or perhaps a colleague who has been well funded by the agency. In summary, it is important to identify these review criteria, understand exactly how the agency defines them, and determine the relative weight (if applicable) the agency assigns to each criterion.

The Review Process

The review process itself can vary significantly from one agency to the next and from one program to the next. It may be conducted in an ad hoc fashion or by panel. Reviewers may be experienced researchers and academics ("peer review"); the reviewers may be program officers or a group of technical managers and personnel from within the funding agency ("internal review"); or they may be a combine these two

groups. Furthermore, reviews may be written independently and emailed in, or reviews may be conducted by a panel of reviewers who convene at the funding agency ("panel review"). Reviewers may be experts in your field; they may be experts in related fields; or they may have little or no knowledge of your field. They may be a standing committee or the membership may change. A writer who knows the backgrounds of the people who will review his or her proposal and crafts the proposal with those reviewers in mind obviously will have a substantial advantage over a writer who blindly writes a proposal without knowing the kind of audience he or she is trying to convince.

A fundamental tenet in grant writing is to "know your audience." Knowing your audience is a critical factor in determining the competiveness of your proposal narrative. For example, will your proposal be reviewed only by technical experts in your field (typically called an "ad hoc review"), or, in the case interdisciplinary proposals, will your proposal be reviewed by an interdisciplinary review panel (panel review). How you craft the research narrative, in this instance, may differ somewhat by the type of review your proposal receives. As a general rule, for an ad hoc review your research description would assume expert, specialized knowledge in the field equivalent to your own, whereas for a panel review you may write the narrative to be understood by a scientifically literate reviewer but not an expert in the field. Notably in the latter case, as many funding solicitations become increasingly interdisciplinary in order to address increasingly complex scientific challenges, and hence the review panel is more interdisciplinary, it becomes more important for the author(s) of the research narrative to accurately know their audience and write a research narrative accessible to that interdisciplinary audience.

The most comprehensive information on the agency review process will come from visiting the agency website and talking with agency program officers as well as with colleagues who have served as reviewers for the agency, served as rotating program officers at the agency, or who have been well funded by the agency. Below are descriptions of procedures used by some of the major research funding agencies.

Finding Research Funding Mentors

One of the best ways to get a successful start in finding and competing for research funding is to draw on the knowledge of others who have been successful. Seek out faculty in your field who have succeeded at winning research funding. These may be colleagues in your department, your former advisor, or colleagues at other institutions.

First, offer to take them out to lunch if they'll allow you to pick their brain about funding. Most faculty are delighted to talk about their experiences and share their hard-won knowledge. Ask them: what agencies and programs fund our kind of research? What are their expectations in terms of publications, preliminary results, type of research, etc.? How does the funding agency operate (i.e., what is its culture, mission, investment priorities, and research strategic plan)? Have you been a reviewer for these agencies or served as a program officer? If so, are there common mistakes that you see in proposals that you've reviewed? How did you get your first few grants? What advice would you give a new faculty member who is pursuing his or her first grant? How should I interact with program officers? Ask whether the faculty member might be willing to let you see a successful proposal, including the reviews. Finally, ask them whether, in the future, they might be willing to read a draft of your proposal and give you feedback when you are ready to submit it for funding.

Keep in mind, however, that agencies and programs can vary significantly in their cultures and expectations, and that they also change over time. One PI's experience may be very different from another's, and advice that might have been valid for a program five years ago might no longer apply. For that reason, it's important to talk to a number of successful researchers to get a wide range of perspectives, particularly on recently funding grants.

Be aware, also, that the halls of academia are rife with myths about funding agencies, the most prolific sources of which are faculty who have been unsuccessful in winning grants. Most of these nuggets of conventional wisdom concern reasons why you or faculty from your institution cannot be successful in winning a grant. So when someone in your department explains that NSF only funds east and west coast universities, or that NSF reviewers really don't care about broader impacts, be sure to consider the source. How well do these people really know the agency? How currently active are they in pursuing research funding? The best sources of information about an agency are researchers who have been successful in winning funding from that agency, and if there isn't anyone in your department who fits that description, you'll need to reach out beyond your department or institution to find a mentor.

In some agencies, the Program Officer can be one of your most helpful funding mentors. This is particularly true for the Department of Defense, some of the mission agencies like USDA and NASA, and many programs within NSF. If you are doing research of interest to the Program Officer, she can often help steer you to the right solicitation, ask for an unsolicited proposal, and give you feedback on your ideas. Program Officers

want good quality research proposals that fit the goals of their program, so they are often motivated to provide guidance to help you prepare a better proposal. The extent to which a Program Officer will help you depends on the culture of the agency, the personality of the Program Officer, and how busy she or he is, so be sure to solicit advice from the Program Officer, but be careful not to overburden them with requests.

For example, most Program Officers don't have time to read your entire proposal draft before submission, so don't ask them to do so unless they volunteer to do it. However, they are often happy to read an executive summary and give you feedback on your research ideas and how well they fit the agency research agenda. Furthermore, NSF Program Officers will often invite you to serve as a reviewer, which is an invaluable way to learn how to write effective proposals. If your university has a Research Development Office, the staff in that office can also serve as excellent funding mentors. Their job is to keep up with the latest developments at funding agencies, and since they are involved in dozens of proposals each year, they often have much more experience than single PIs with particular funding programs. What's more, if they work across your college or university, they may be able to connect you with potential collaborators and other faculty experienced in a program or agency of interest.

Another important role of a research funding mentor is to read your draft proposals and give you feedback. Undertaking a useful critical review of a proposal takes a significant amount of time, so recruit mentors to review your proposal early and give them sufficient notice when the draft will be ready. It's often a good idea to approach a potential reader at least six weeks before your draft will be ready and ask whether they would be willing to review your draft, giving them the date when you expect to have it ready. When the draft is ready, give them several days to go through it. Line up several readers so that you'll get more than one opinion. Be sure to give each reviewer the solicitation to which you are responding. A key part of the review is the determination of how responsive your draft proposal is to the research goals and objectives of the funding opportunity. Remember that all proposals can be improved, and the best mentors are demanding readers who will read your proposal draft closely and return it with numerous comments, suggestions, and critiques. If a reviewer returns your proposal draft with a few generally positive comments and no significant critiques, it's safe to assume that they didn't read it carefully. A thoughtfully detailed negative review is more helpful than a generalized favorable review.

Finally, after you identify particular agencies and programs likely to fund your research, work to connect with the community of researchers funded by that agency. Talk to colleagues at conferences and ask where they have been funded. Look for faculty at your institution or in your field who have served as Program Officers at the agency. Connect with researchers in your area who regularly serve as reviewers for the agency and program. Don't discount the value of gossip. When you see these people at faculty meetings or conferences, ask them about any developments at the agency. Often, there will be buzz among the community about a solicitation that is expected but hasn't come out yet, a workshop that's being planned in preparation for a new area to be funded, or

news about a new Program Officer. Networking with the community of funded researchers can also be a good way to find collaborators for future proposals.

Working with Research Collaborators

Early-career researchers can be intimidated by the prospect of competing for funding with more senior researchers with long track records and extensive lists of publications. You may feel that you're facing the classic chicken-and-egg conundrum: how can you get funding without a track record, and how can you build a track record without funding? One way to get your foot in the funding door is to collaborate with a more established researcher as a co-PI on a grant. This approach can allow you to demonstrate your ability to conduct research, generate publications, and get to know program directors at the funding agency.

There are also a number of other good reasons to collaborate. Your project may call for knowledge, skills, or resources that you don't have – an increasingly common occurrence as research becomes more multidisciplinary. You may be invited to participate in a large, multi-PI proposal such as a center-level grant. Or the project may require the participation of more than one type of institution (for example, some programs encourage or require collaboration with industry, international universities, or minority serving institutions).

When considering a collaboration, first find out the current policy in your department for assigning credit for jointly-funded projects and joint publications. In most departments, promotion and tenure policies have been updated to avoid punishing researchers for collaborating, but that is not always the case. Also, find out the procedures for collaborating with researchers outside your department, college, or institution, if applicable. There can sometimes be issues related to how the indirect cost (the "overhead") is shared among multiple departments or colleges, so it's best to bring this up with your Department Head or Chair early so that those issues can be resolved before your proposal is ready to submit.

Structuring the Project

When structuring the project, select an identifiable part of the work that will be your contribution. To avoid the appearance that you're merely serving as an assistant to a more senior researcher, take responsibility for specific tasks, and identify the expertise that you bring to the project. This will allow you to develop a track record that is clearly your own and is generally best accomplished by collaborating with another researcher (or team of researchers) with different, highly distinguishable areas of expertise. The products of the collaboration (articles, a book, book chapters) should also be discussed during the planning stages, along with how the writing will be done and credited.

Discuss distribution of the budget explicitly and in detail early in the project planning process. ***The most common budgeting mistake made in multi-PI projects is to simply divide the budget by the number of investigators. Budgets should be apportioned based on who is responsible for what tasks and the resources required to complete each of those tasks.*** If a project is a collaboration between an experimentalist (who needs to buy materials and supplies, pay for equipment time, and support two students

to fabricate and test specimens) and a modeler (who will support one student to conduct computer modeling), dividing the project budget in half will raise red flags for the reviewers and leave the experimentalist with insufficient resources to accomplish her part of the project.

It's almost always the case that, when the budget numbers are calculated based on the resources needed to accomplish the proposed research plan, the budget will be very tight. As the junior member in a collaborative project, you need to make sure that you'll have sufficient resources to conduct your portion of the research project. If it appears you won't have enough funds, work with your collaborator to modify the research plan to make it more realistic. Not only will this make it easier for you to perform the research successfully if you win the grant but it will make your proposal more competitive, since reviewers usually notice when a research plan is unrealistic based on the budget, and they'll hesitate to fund such a project.

MSI and PUI Faculty

If you are faculty at a minority serving institution (an HBCU or HSI) or Predominantly Undergraduate Institution, you may find that you're often invited to collaborate on multi-institutional proposals, particularly proposals to NSF, where diversity is an important review criterion. These collaborative projects can be wonderful opportunities, but it's especially important in these situations that you act as a strong advocate for your own interests. While PIs at larger institutions may have the best intentions, they often plan the collaboration from the point of view of their own needs and may not consider how the collaboration will help you build your research program. A PI may initially intend to structure the collaboration so that your role is simply to provide access to minority students who will be recruited to the lead university's graduate program. While this kind of activity may provide some benefits to the small number of students who are recruited, it will do little to help your institution or help you build your research program. Fortunately, PIs are usually very open to suggestions on how to enhance the collaboration and thereby improve the proposal.

In your discussions with the PI, let them know your research interests and capabilities, and work with them to determine what research tasks you and your students could take on. If you have a large teaching load and are dependent on undergraduates as research assistants, you may not be able to take on a big part of the project, but it's often feasible to carve out a subproject from the research that's appropriately scoped for the time and resources you have available. If you don't have all the needed instrumentation, or don't have expertise in a required methodology, perhaps the project could include funds for you and a student to work in the lab of the PI for a few weeks in the summer (NSF has [supplementary funding](#) available for this). As we mentioned above, be sure to discuss what the predicted outputs of the project will be in terms of publications, and structure your part of the project so that you'll be able to co-author one or more publications from the research. Let the PI know that you want to be a full-fledged member of the research team, and include travel funds in your

budget so that you can attend project team meetings and perhaps present your results at a conference.

What's more, by structuring the collaboration so that it benefits your research, has lasting impact on your institution, and provides high quality research experiences for your students, you'll also be helping to make the proposal more competitive. And you will develop lasting relationships with researchers at the partner institution that can lead to future proposals, perhaps with you as the PI.

Scheduling Proposal Production

When you first consider applying to a particular funding opportunity, you'll need to ask yourself, "Do I have enough time to produce a well-written proposal before the deadline?" If you don't realistically have time to produce a good proposal this semester, then it's better either to plan to apply late or to rearrange your commitments to make time. Producing a hastily-written proposal in all-night sessions the week the proposal is due will cost you precious sleep, waste time you could have spent on your other commitments, irritate proposal administrators at your institution who need time to prepare budgets and get appropriate signatures, and irritate reviewers who have to read a poorly-written proposal. Producing a good proposal takes time; understanding that will help you avoid frustration, disappointment, and strained relationships with your administrators.

How much time does it take to prepare a proposal? Of course, this varies depending on the type of program, the complexity of the proposal, whether it's a single-PI or a team-based project, and so on. However, you can estimate the time you'll need by listing the required steps for preparing a proposal along with the approximate time needed for each task. Below is a generic list that can serve as a starting point, but you'll need to add any additional tasks that might be required for your particular proposal.

- **Do your homework.** Read the solicitation or program description very carefully. Look at projects that have previously been funded through the program. Contact the Program Officer to discuss whether your project idea fits this particular program. Make sure you're up-to-date on the literature in the topic.
- **Assess whether you're in a position to be competitive for this particular funding opportunity.** Do you have enough publications in the area? Do you have preliminary data, if they are needed? Do you have the resources you need (e.g., access to required instrumentation)?
- **Recruit partners and collaborators, if needed.** If this will be a multi-investigator proposal, be sure to meet early and often with your co-investigators to plan a well-integrated project. *This is best done in person or by teleconference, not by email.* If you'll need letters of collaboration, start working on those early.
- **If cost share is required, start working on lining up your cost share as soon as possible.** The process for providing cost share varies by institution, but usually involves securing commitments from administrators at the departmental, college, and university levels. This takes time (and, often, multiple memos and meetings), so start on this as soon as you know you'll be submitting the proposal.
- **Line up mentors who agree to read your draft proposal and give you feedback.** It'll be easier to recruit colleagues to read your proposal if you ask them well in

advance. Recruit mentors in your subfield and some who are outside your subfield.

- **If the proposal will involve investigators from other departments or institutions, let your Department Head or Chair know.** This will avoid any surprises when the time comes for your Department Head to approve submission of the proposal.
- **Contact your Office of Sponsored Projects or preaward services office to let them know you'll be working on a proposal.** If you're submitting to NSF, they'll need to get you registered on Fastlane. They'll also let you know your institution's procedures for routing and approval and when you need to have the final draft of the proposal to them for final check and submittal.
- **Scope out your project and start working on the budget.** Work with your Office of Sponsored Projects or preaward services office to start developing a budget. If this is a single-PI proposal, the budget will probably be fairly straightforward, but if this is a multi-investigator proposal, be sure to go over the budget with your coPIs, and count on multiple iterations of the budget.
- **Write multiple drafts of your project narrative.** This step is usually the most time intensive. Writing a project narrative that's clear, compelling, thorough, and observes the page limits will require multiple drafts. Allow several days between drafts to permit feedback from your mentors who have agreed to read your drafts. Set aside several weeks to get this done.
- **Develop other required material.** Funders typically require a biosketch for each researcher, information on other pending proposals and funded projects, a budget narrative, an executive summary, and a number of other ancillary materials. Make a checklist of everything required for the proposal and work on these in parallel with your project narrative.
- **Finalize your budget and route the proposal and budget for approval.** Some universities require only a project summary along with the finalized budget for routing, while others want a draft of the project narrative or even the final draft of the entire proposal. Contact your Sponsored Projects or Preaward Office to learn your institution's procedures and be sure to have the documents ready in time for routing.
- **Upload and final check of the entire proposal.** Plan to have your entire proposal uploaded (either by your Sponsored Projects or Preaward Office, or by you) and ready for final check at least two days before the due date (some offices require three to five days). This will give you time to address last-minute issues that can come up, such as problems with uploading, errors due to faulty conversion to pdf format, or the realization that you've forgotten a required form (such as the Postdoc Mentoring plan required by NSF).
- **Submit your proposal.** After you give them the go-ahead, your institution's authorized representative (usually someone in your Sponsored Projects or Preaward Office) will submit your proposal. Plan to submit at least one day

before the due date. Since most proposals are now submitted over the internet, there's always the possibility that your internet connection will go down on the due date or that the website used for submission will become overwhelmed due to a large number of submissions. By planning to submit a little early, you'll ensure that your proposal will receive the funders full consideration.

Schedule your proposal development effort by starting with the above list of tasks, adding any additional tasks that pertain to your proposal, and working back from the due date. For a first proposal, it's generally advisable to begin at least three months before the due date. Also be sure to schedule time to work on your proposal; without setting time aside to complete the preparation, it may be written in a rush or not at all. Allot several hours each week to work on your proposal without interruptions (with more time allotted as you get closer to the due date). If you'll be submitting as part of a team, also plan at least weekly meetings with your team.

Producing a proposal is a time-consuming effort. As a new faculty member, you'll need to be strategic in selecting the grants to pursue and deciding when to pursue them. But developing a grant proposal can also be very rewarding; it can help you clarify your research plans, develop new collaborations, and even obtain funding to support your research.

Typical Proposal Structure

The required components for research proposals vary considerably depending on the funder and the program. Be sure to check the specific requirements of the particular grant program for which you're applying. Many agencies provide a set of overall guidelines (e.g., the Grant Proposal Guide for NSF and the SF-424 for NIH), which may be modified or supplemented by the particular solicitation. Also be sure to check page limits (listed here for NIH) and formatting requirements. A list of *typical* components is given below (different funders use different names for these components).

Component	Description
Project Summary/Executive Summary/Abstract	Typically 1 or 2 page summary of the project. Sometimes specific content is required (e.g., intellectual merit, broader impacts for NSF; type of project or list of institutions for some programs)
Proposal Narrative/Project Description/Research Plan	This is the "meat" of your proposal, where you describe what you're going to do and how you're going to do it. Some solicitations specify how to structure this component, and some leave it up to you. Typical sections may include: • Introduction/Overview/Objectives/Rationale/Specific Aims/Significance • Background/Lit Review/State of the Art/Significance; Preliminary Results/Studies • Methodology/Technical Approach/Experimental Plan/Research Strategy • Project Schedule/Milestones/Deliverables/Outcomes • Management Approach • Education/broader impacts/diversity
References Cited/ Bibliography	References cited in your proposal narrative (this section may or may not have a page limit – be sure to check).
Facilities and Equipment	Reviewers will look to make sure you have the equipment and infrastructure you need to accomplish the proposed project
Budget	Usually a form filled in with the help of your grants office
Budget Narrative/Justification	A description of each item in the budget and why it is needed
Biographical Sketch	Usually includes education, professional position, selected publications. May also include a personal statement.
Other Materials	As specified by the funder; e.g., Statement of Work, Public Health Relevance Statement, Data Management Plan, Postdoc Mentoring Plan, Letters of Support, Collaboration or Reference.
Various forms and assurances	These include the cover page and other online forms that your grants office will likely fill out for you as well as IRB, human subjects, vertebrate animals, and other forms that may be required.

The RFP as Proposal Organization Guide

The RFP is not just about the money. It is your guide to writing a successful proposal. The RFP also plays a key role in proposal organization by establishing the order, required level of detail, and focus of the research narrative in meeting the goals, objectives, desired outcomes, and review criteria established by the funding agency. It is a good idea to simply copy and paste the RFP's key sections, research objectives, and review criteria into a beginning draft narrative. This allows the RFP to serve as an *organizational template* for the full proposal. It ensures that subsequent draft iterations of the research narrative will be **continuously calibrated to the guidelines and fully responsive to all of the sponsor's requirements**. For example, an RFP will often contain a detailed description defining the agency's objectives for the program (e.g., goals, objectives, performance timeline, outcomes, research management, evaluation, etc.) that must be addressed in the full proposal narrative. This detail, including review criteria, can be copied and pasted into the first draft of the proposal itself. This RFP-based proposal template ensures your narrative responses are complete and answer every question, explicit or implicit, in the guidelines. In this way, the first draft of the proposal will fully mirror the program solicitation requirements.

This copy and paste process of transforming the RFP into a narrative template helps ensure that you address several elements key to a successful proposal at the beginning, and adhere to them throughout the writing process. Using this approach, you will ensure that the proposal narrative:

- fully responds to all requested information,
- offers information in the order requested,
- provides the required level of detail,
- integrates review criteria into the narrative, and
- makes a complete and compelling case for the significance of your research.

If the RFP refers to any publications, reports, or workshops, it is important to read those materials, analyze how that work has influenced the agency's vision of the program, and cite those publications where appropriate in the research narrative.

Writing a Compelling Project Summary

One key skill to master as you develop a more robust repertoire of research grant writing expertise is the mastery of the one- or two-page description of your research objectives and their significance, herein called the ***project summary***. Depending on the agency and the specific solicitation, this brief statement may also be referred to, or serve as, a ***project abstract, executive summary, or as the introduction to the full proposal.*** In some cases, the agency may dictate precisely the content, order, and format of the summary, while in other cases, an agency may leave the form and content fairly open ended and generic. Often the content, order, and format will be suited to a particular solicitation. Regardless, the common characteristic is brevity, typically a length of one to two pages, or a word count specified by the agency. This constraint requires that the successful summary statement be clear, succinct, and compelling . Achieving those characteristics requires significant preliminary thought, discussion, and ***multiple draft iterations*** of what will become the final project summary text.

However, whether the content of the project summary is prescriptive or open ended, it is common to succinctly present the vision, goals, and objectives of the project and address the following key details: (1) what you will do; (2) why you will do it; (3) how you will do it; (4) why it is significant in terms of value added benefits to the agency mission or impact on the disciplinary field; and (5) list the anticipated research outcomes.

When writing the project summary, keep in mind Mark Twain's comment in his correspondence with a friend: "***If I had had more time I would have written you a shorter letter***." This captures what needs to be done in ***crafting***, as opposed to merely writing, the project summary. This brief overview statement at the front end of the proposal offers you the best opportunity you will ever have to capture the interest of the reviewers early on as they decide whether or not to fund your project. ***It is here you must convince your reviewers to <u>want to read</u> the rest of your proposal***—thoughtfully, carefully, and attentively, with interest and curiosity. If you lose the reviewers here, you have likely left them without reason or interest to read the next fifteen, or twenty-five, or more pages of your proposal.   Your clarity of language, logic, and argument is critical in the project summary. You certainly don't want to write a project summary that puts reviewers in mind of H. L. Mencken's comment on an article he reviewed as "***an army of words marching across the page in search of an idea***."

Avoid the Generic Introduction

Put yourself in the place of a reviewer. You've been asked to review proposals for a DOE biofuels program, and you have nine proposals to review before you participate in a panel. You open the first proposal, and it begins, "Biofuels are critical to the national goal of achieving energy independence…". The introduction to the proposal continues on for several paragraphs, explaining the importance of biofuels and discussing why biofuels need to be developed. Of course, you've been asked to review these proposals because you're an expert in biofuels, so none of this information is news to you.

You finish reading that proposal and open the second one. It starts, "Biofuels are an important component of the US's future energy policy…". It goes on to explain why biofuels are important and why research on biofuels is needed. You open the third proposal, and guess what? It starts with another discussion of why biofuels are important – some of these discussions even stretch to a page or more. You wade through these proposals, and then you get to the sixth proposal, and it starts out, "A critical problem in making biofuels practical is making step x in the synthesis process more efficient. Our proposed project will address this problem by using the following innovative approach….", and it goes on to outline an interesting and innovative approach to the problem.

Which proposal would you remember?

The First Impression

A common mistake in writing proposals is to spend the first critical paragraphs explaining to the reviewer something that he surely already knows and probably has read in all the proposals leading up to yours. The truism that *you never get a second chance to make a first impression* holds particularly true when it comes to proposals. Your reviewer's interest is at its height when she starts reading your proposal. At that point, you can either reward her excitement or lull her to sleep. Starting with an introduction that does nothing to distinguish your project from all the other proposed projects will lull her to sleep.

To develop an exciting introduction, you need to identify the kernel of your great idea. How is your idea different from what others will propose? What important problem will it solve? Why is it innovative and exciting? Don't bury that kernel at the bottom of page 3 after you've lulled your reviewer into a pleasant stupor with generic discussions about your topic area. Put it right up front in the first paragraph. When you finish your first paragraph, it should be absolutely distinctive. If that introductory paragraph could be put into another proposal on the same topic area, delete it and start over.

Many PIs like to start their proposal with a description of the need or problem they're addressing. This approach is fine, but be sure to pinpoint the *specific need or problem* you'll be addressing (not "biofuels production needs to be made more

economical," but "step x in the production of biofuels is inefficient") and quickly follow with a discussion of how you'll address that problem (e.g., "We have an innovative idea y for increasing efficiency of that step by 40%").

Providing Context without Boring the Reviewer

It is important to demonstrate to the funder that you understand the significance of the topic area and the motivation for the program, but it's not necessary to discuss those things in the first couple of paragraphs. Save that discussion for your background section, which should be placed after an introductory section that provides a compelling overview of your proposed project. This overview should concisely summarize what you're going to do, why you're going to do it, and why it's significant. When you get to that background section, be sure to tailor it to your specific project. You'll not only want to demonstrate to the funder that you understand the funder's goals for the program but at the same time you'll want to describe how funding *your specific project* will help the funder achieve those goals.

When you discuss the state of the art, it similarly can be tempting (particularly if you've been teaching a course on the subject) to write a long section that is essentially an introductory lecture about the topic. Unless you have good reason to believe that the reviewers are not well versed in the subject of your proposal, it's best to avoid this temptation and instead focus quickly on the specific problem or challenge within the topic that is the focus of your proposed project. What have others done to try to address this problem? What holes in current knowledge must be filled in order to solve this problem?

So, taking our earlier biofuels example, that would mean discussing the state of knowledge about the specific synthesis step that you plan to improve, not providing a long description of the state of the art in biofuels. If your state of the art section could be interchanged with that from any other proposal on the topic, then you can be assured that the reviewer will be asleep by the time he finishes reading the section. Even more concerning, he will have gained no insight into the motivation behind your particular proposal, as compared to all the other proposals he has been reading.

Remember that your proposal will be evaluated along with a pile of other proposals submitted in response to the same funding opportunity. Whatever you can do to make your proposal stand out as more original, more thoughtful, more significant, or more exciting than the others will increase your chances of funding, and that starts with a strong introduction.

Writing A Competitive Proposal Narrative

The fundamental requirement of the proposal narrative at the time of submittal is that it be a well-written document that responds fully, clearly, and persuasively to the research goals and objectives and review criteria defined by the sponsor in the funding solicitation, or the agency guidelines in the case of an unsolicited proposal. All funded proposals have one common characteristic: the proposal makes a strong and compelling case that the proposed activities will being value added benefits to the agency's mission priorities and/or impact the disciplinary field in some important way. However, long before submitting the proposal narrative to a funding agency, you will find that it *plays a key role in the conceptual development of the proposed research.*

   The proposal narrative development process is akin to a slowly lifting fog, whereby a *continuous process of draft text iterations* gradually transforms initially diffuse ideas into a tightly crafted proposal narrative. Equally important, the evolving proposal narrative *serves as an incubator of ideas*, particularly in the early stages of proposal development, and *acts as the structural framework,* imposing rigor, clarity, and simplicity on evolving ideas and concepts and establishing their connectedness to operational and performance details. The proposal narrative process typically begins with a significant amount of (pick your adjective) chaos, uncertainty, vagueness, ambiguity, false starts, and indecision, among many other indeterminacies, concerning how best to meet the funding agency research objectives.   Do not be alarmed by a certain amount of uncertainty and ambiguity about the shape the final proposal will take. This is fairly common at the beginning of any proposal development effort.

   In much the same way as mathematics or a computer program helps impose rigor, relational clarity, logical sequences, and simplicity on our understanding of the behavior of the physical world, language plays a similar role in the evolving proposal narrative. The key point to understand and anticipate is that *competitive ideas evolve and converge over time; they do not appear fully and perfectly formed by a narrative genie*. Most ideas that eventually evolve and mature during the development and writing of a proposal narrative originate from your first reading of the solicitation. Sometimes ideas will come from "collaborative brainstorming" discussions with a few colleagues. In any case, if it is determined that a solicitation matches your research interests and expertise and that a competitive proposal can be written in the time available, *the path to the end product, a competitive proposal narrative, is often far from clear at the earliest stages of proposal development*. *Successful proposals converge on excellence by going through multiple iterations wherein ideas and the language used to express them are continuously refined and made clear draft after draft after draft.*

   Bringing clarity to the proposal development process typically starts with ideas, concepts, and directions expressed verbally among researchers related to meeting the research objectives of the solicitation. Depending on the type of proposal, initial

discussions, or even "brainstorming" ideas ***initially expressed verbally*** can range from slightly to extremely illusory when attempting the first draft. The real challenge occurs when it comes time ***to translate ideas expressed verbally into the narrative language required to make a compelling case for the significance of the research***. Verbal "understandings" among participants can be both illusory and transitory, ***and multiple participants may carry away multiple understandings*** from research development meetings. In fact, in the initial stages of drafting the proposal narrative, there are often many uncertainties and unknowns about the final research plan that will emerge only by the time the final proposal takes shape.

This makes the proposal writing process itself one of ***iterative exploration*** converging on a compelling and competitive research narrative over time, i.e., before the due date. What seems like a "good idea" at the start of this iterative process can often disintegrate under closer examination. Verbal epiphanies are deceptive because they lack connectedness and the appropriate balance and synthesis of ideas with detail needed for a successful narrative. It is this ***conjoining of ideas with the performance details*** that offers the central challenge to crafting a competitive proposal narrative.

However, this iterative process of translating ideas into the structure imposed by language in the research narrative serves many important functions—it helps tame the conceptual excesses and unwarranted effusiveness that may occur among some members of a research team at the early stages of proposal development; it helps define the clear boundaries, scale, and scope of the initiative; it sharpens the focus and tightens the descriptions of concepts and ideas; and it forces connectedness among ideas, and between the ideas and operational details that transition and transform ideas to clearly stated research or educational outcomes, or research deliverables.

In effect, the evolving proposal narrative helps transform ideas and anchor them in a ***common reality—the research narrative***—a reality that must be shared by research colleagues, program officers, and review panelists if the proposal is to meet with success. In this regard, a proposal narrative is not unlike a novel or a movie. It creates its own, self-contained reality. It contains all the information that the funding agency and review panel will know about your capabilities and your capacity to perform. With a few exceptions (e.g., site visits), an agency bases its decision to fund or not to fund ***entirely on the proposal narrative and the persuasive reality it creates***. The construction of this common reality through a process of writing and rewriting draft after draft of text helps test ideas in a "***language lab***" in a way not unlike experimentalists test ideas about the physical world.

Moreover, this process of defining a common reality and a common language through multiple draft iterations of the research narrative becomes particularly important in multidisciplinary efforts and collaborations. These situations require a common structure to meld multiple disciplinary research strands, or research focus areas, and to make ideas accessible to collaborators of potentially synergetic but differing disciplines. One common challenge in multidisciplinary research initiatives is the sponsor-required vision statement, or similar integrative and synthesizing statement. The key role of this statement is to unify the research effort and make a

convincing case to the sponsor that critical and beneficial synergies inhere in several research strands integrated within one research project that would not be possible were the research strands funded separately as discrete projects to unconnected PIs. ***The crafting of a research vision statement or other unifying statement is as critical to a proposal's competiveness as it is challenging to write***.

The Role of Specificity and Detail in the Successful Proposal

Common observations made by reviewers of proposals declined for funding typically include: "*it is not clear what the proposer actually intends to do*," or "*the goals and objectives are vague and general and lack specifics*," or "*this proposal is over generalized and offers no convincing performance details*." As one of the most critical components of a successful research narrative, specificity must be evident throughout project descriptions*. **Specificity grounds the research vision and goals in the key performance details unique to your research objectives, and thereby illuminates the importance of your research for reviewers**. Judiciously selected specifics make clear the uniqueness of your proposed research narrative and better define the details of your research plan, particularly as it relates to what you will actually do and how you will do it. When key research specifics are embedded in, or follow, overarching, general statements describing the research vision and project goals, they significantly enhance the clarity and persuasiveness of the research narrative and hence convince the reviewers . Well-chosen specifics and operational details serve as the glue that binds together the more general narrative statements introducing your research topic to the reviewers. In effect, specifics and operational details help transition the narrative from a research vision to actual research outcomes in a way sufficiently convincing that reviewers recommend funding.

    However, providing specificity and detail should not be confused with inflating a research narrative with technical minutiae impenetrable to the typical reviewer. Specifics and details should be clear, precise, logically ordered, and, like Goldilocks, supplied in just the right amount. They should be chosen to illuminate how you will accomplish your research goals. Specificity should sharpen rather than blur the focus of the research narrative*, **encouraging reviewers to recall the key factors that make your research feasible, unique, significant, and hence fundable**.   As in all effective narrative techniques, balance and proportion are important; therefore, you might think in terms of "Goldilocks Specifics," somewhat like the "Goldilocks Planets" that are not so near a sun, nor so far away, that liquid water does not exist on their surface. In this case, the successful narrative gives neither too few nor too many specifics but just the right amount. Make your point, but don't belabor it, ***and remember that superlatives are not specifics***. Any attempt to substitute superlatives for specifics will be quickly noted by reviewers, and likely in an unfavorable way. ***Specifics function in the narrative text as mirrors that reflect your capacity to perform.***

    For example, vision statements and project goals, such as the following from a Department of Energy funded proposal, define the proposed research landscape in broad brush strokes: "*The goals of the Greater Philadelphia Innovation Cluster (*GPIC*) for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, and to stimulate private investment and*

quality job creation in the Greater Philadelphia region, the larger Mid Atlantic region, and beyond. GPIC will focus on full spectrum retrofit of existing average size commercial and multi-family residential buildings." Think of the vision and goals statements, such as this one, as descriptions of some promised "units of change" (e.g., improved energy efficiency, improved energy operability, reduced carbon emissions, investments stimulated, and jobs created) that will occur over some "unit of time" that will result in some "unit of benefit." Essentially, vision and goals statements promise better things to come based on the proposed research. Without specifics, however, they are empty promises, or, as some might say, "all hat and no cattle."

The basic role of specifics in the research narrative is to make your research vision and goals ***believable, convincing, and memorable to reviewers***. Specifics will convince reviewers of your capacity to perform, of the reasonableness of your research plan and objectives, and of the promise that your research will advance the disciplinary field or bring value added benefits to the strategic mission of a funding agency in some important way(s). By contrast, entire proposals or sections of proposals defining a major project goal, e.g., energy efficiency, but lacking a detailed description of the research to be done, how it will be done, the justification for doing it, the people who will do it, and the benefits of doing it, offer no compelling reasons for reviewers to recommend funding. Generous reviewers of such uninspiring and generalized text might first question their own short-term memory and hold themselves at fault for flagging attention, but one important rule of grant writing is to always blame the writer and hold the reviewer blameless should the narrative fail to make a convincing case for funding. ***If reviewers must repeatedly look back in your narrative text to find and recall the essential specifics of your proposed research, then the fault lies in the writing and not the reviewers' memories***.

Why might narrative text lack specificity? It is easier and less time consuming to make general claims and promises than it is to organize a logically-connected series of specific details that illuminate your research objectives and answer the core questions listed above. ***Specifics serve to both test and prove the value of your ideas, and when they are lacking, it tells a reviewer that your ideas may also be lacking, or have yet to become fully developed.*** A proposal is judged in a kind of courtroom: the specifics of your proposal must answer reviewers' questions about how you will accomplish the proposed research to pave the way for a positive verdict, i.e., a funding recommendation.

In other cases, narrative text might lack specificity because one or more authors have mistakenly repeated various versions of the same goals and confused this repetition with an offering of specifics. Repeating goals in various ways does not address the core questions reviewers need answered. In this regard, keep in mind Richard Feynman's observation: "*You can know the name of a bird in all the languages of the world, but when you're finished, you'll know absolutely nothing whatever about the bird. So look at the bird and see what it's doing. I learned very early the difference between knowing the name of something and knowing something.*" In the example used above, think of a goal as the name of something, in this case, "energy efficient

buildings." ***Think of the specifics in your narrative as proof or validation that you know something about achieving your research goal***. In this case, it might be offering specifics about how building envelopes, smart buildings, sensors, materials, design practices, energy systems, construction practices, and the like, contribute to achieving your research goal. ***Stating a goal without then offering compelling specifics that make clear the process you will use to transition a goal to reality, i.e., a research outcome, is the domain of politicians and bumper sticker slogans and not that of the successful research proposal***.

Moreover, continuing with the energy efficiency example, specifics need to be judiciously selected and characterized by the following:

- ***Relevance to the research goal***, e.g., if your energy efficient materials research focuses on only one of several areas, such as photovoltaics, thermoelectrics, solid-state lighting, among many others, your task is to offer specifics relevant only to your proposed research and not offer specifics relevant to the entire universe of energy-efficient materials;
- ***Appropriateness of scale***, e.g., if the crystal structure of a material is not key to understanding the research, then don't belabor the Miller Index; similarly, if only the duration of an event is key to your research, then there is no need to belabor the cesium oscillator or explain the history of NIST and atomic clocks;
- ***Priority for accomplishing research goal***, e.g., offer the key specifics first that ***make your case most clearly and briefly and in a way most memorable to reviewers***, but don't offer an exhaustive list of specifics that overwhelms reviewers, thereby leaving it to reviewers to determine the most important details needed to convince them of your capacity to achieve your research goals.

Vision, Goals, Objectives, Rationale, and Outcomes

To craft a competitive proposal narrative requires that a research project description address the **vision, goals, objectives, rationale, and specific outcomes** of your proposed research. Depending on the specific solicitation, this requirement may be explicit or implicit, but either way, the care with which you address these factors will determine whether or not you persuade reviewers to recommend funding for your proposal. While the definition of these terms may differ somewhat by disciplinary domain, or by funding agency, e.g., the term "specific aims" may be used at one agency and "objectives" at another, it is helpful in research grant writing to define these terms in ways that best reflect what might be considered the generic narrative structure of most research proposals. Some funding agencies are very prescriptive in defining a narrative structure, such as the U.S. Department of Education, whereas other agencies, such as the National Science Foundation, allow the author greater flexibility in choosing a narrative structure. Regardless of agency, the organizational structure of the narrative differs mostly in the agency specific nomenclature used for major section headings within each solicitation, as noted above for the interchangeable terms "specific aims" and "objectives." Moreover, as noted previously, the key information embedded within this organizational framework invariably requires addressing the following core points: (1) what you will do; (2) why you will do it; (3) how you will do it; (4) why it is significant in terms of value added benefits to the agency mission or impact on the disciplinary field; (5) your capacity and expertise (preliminary data, results of prior support, publications, etc.) to perform the research; and (6) anticipated research outcomes.

Of course, when a specific agency or solicitation prescribes a required organizational format for a research narrative, then that format must be followed exactly as the sponsor presents it.   This is most often the case when responding to a program announcement, and it is very helpful to the proposal author(s). Successful grant writers use the narrative organizational format given in the solicitation and copy and paste it into the first draft of the project narrative description, along with the review criteria, as a template for writing the proposal. This (1) ensures that your proposal is organized exactly as the funder requires; (2) ensures that your research narrative is fully responsive to the agency guidelines; (3) ensures that you fully answer all questions required by the solicitation; (4) ensures you respond to all questions in the order asked; (5) ensures that your narrative makes it clear how your proposed research meets the review criteria; and (6) ensures that your proposal is "reviewer friendly" by making it easy for the reviewers to compare your project description to the program guidelines and review criteria in making the funding decision.

However, in cases where the agency or the solicitation leaves the research narrative structure open or even undefined, then it is helpful to have in mind your own conceptual framework for best presenting your ideas to program officers and reviewers (see previous chapter *Typical Proposal Structure*). Moreover, it is common in

the case of unsolicited or investigator-initiated proposals for only a very general narrative framework to be defined by the agency, or by program officers. Finally, the five core elements of a successful proposal (vision, goals, objectives, rationale, and specific outcomes) discussed herein are scalable, from large center proposals to small research grants and to white papers and concept papers that may initiate an invitation to submit an unsolicited proposal.

These five elements provide a series of sequential waypoints or critical touchstones that, in the aggregate, validate the merit of your research. Addressing these five core elements in your project description will enable reviewers to determine the value of your proposed research compared to that of your competitors. In essence, they form the critical building blocks of a compelling research narrative by *giving reviewers the structure, order, detail, scale, and perspective needed to easily judge the merit of your proposed research, as addressed below*.

❖ Vision Statement

A vision statement provides the global, unifying, thematic overview of the research to be accomplished over the proposed funding period and its significance and value-added benefits to the funding agency mission, or to the research field itself. For example, the vision statement might address some *significant research breakthrough that will occur over the grant period*. This might range from large-scale transformations made possible by center-level research funding, or a transformation on a small scale related to a very narrowly focused research question. For example, a vision statement might read: "*The vision motivating this research is to implement a next generation electric smart grid that optimizes the use of renewables and novel storage options, ensures robust self-healing from power disturbance events, enables active participation by consumers in demand response and energy exchanges, and is resilient against physical and cyber attacks*."

Thomas Edison, however, made the observation that "*vision without execution is just hallucination.*" This is excellent advice, as well as an admonition, on the role of the vision statement in relation to the rest of the research narrative.   While not all proposals require a vision statement, many do. Some are highly prescribed, some are implicitly described, and others are made to function as an opening designed to quickly capture reviewers' interest.

Vision statements can be challenging to write since they require a clear, concise distillation of a significant research question or research outcome of sufficient importance to make the transition from good science to exciting science in the reviewers' minds. A successful vision statement needs to be brief, typically under 100 words, and memorable to reviewers. It may be among the most challenging 100 words to write in the entire research narrative.

The vision statement is typically introduced in the first sentence of the research narrative, for example, "*The vision motivating the proposed research is to… *", followed by 50-100 words describing the vision. A well-crafted vision statement will intrigue the reviewers and elicit curiosity and enthusiasm to learn more about the proposed

research. Done well, the vision statement motivates the reviewers to read the next 15, 20 or more pages of the research narrative with an enquiring spirit.

❖ Research Goals

A research vision is enabled by ***describing one or more research goals to be achieved over the term of the award***. The research goals are more specific than the research vision and serve as the major organizing framework for the proposed research activities. For example, the five major enabling goals for the above smart electric grid vision statement might represent core research activities related to (1) renewables (perhaps wind and solar); (2) novel storage devices; (3) self-healing technologies; (4) smart devices on the customer side and customer energy exchanges (e.g., customer energy generation by wind and solar), and (5) physical and cyber security of the grid (e.g., cyber security to prevent and/or detect malicious counterfeit time stamps infecting grid operations and causing catastrophic failure). .

Goals are defined both in terms of representing one or more research milestones or major accomplishments and in demonstrating how the goals intersect over the performance period to ensure research synergy and not research silos. For example, a research center proposal will present an overarching research vision to be achieved by specific research goals that, when integrated over the performance period of the grant, allow research synergy (the gold standard of proposal success) to be achieved in some way. Institutional transformation proposals, e.g., NSF ADVANCE, AGEP, CREST, among others, all define a vision and then list programmatic goals that, when achieved, make the vision possible. Smaller grants may have only one or two goals. It is also important, however, given the emphasis on performance metrics and evaluation at federal agencies, that you define your goals in ways that render them easily evaluated, both by reviewers and, on larger proposals, by a sponsor's annual performance review. Don't confuse goals with nebulous wishes. Goals need sufficient clarity and specificity to permit reviewers to evaluate them for their potential impact on the agency's mission, or for advancing the research field in some way.

❖ Research Objectives

Once the research goals have been defined, clearly state the ***key research objectives***. Unfortunately, the definition of goals versus objectives can cause organizational confusion in the writing of a project narrative, most often when these terms are used interchangeably. Think of objectives as the step wise, more fine grain research activities required to achieve a goal. In the above example, which begins with the vision statement of an electric smart grid and the subset of five research goals required to enable the vision, the enumerated research objectives related to achieving the goal of physical and cyber security of the grid might entail research specific to: (1) use of data analytics and Smart Grid Big Data sets related to real time sensors to develop algorithms to detect and predict intrusion patterns; (2) technical advances and algorithms for detecting and eliminating counterfeit data in grid operations; (3) detection of GPS coordinate spoofing that degrades temporal and spatial grid operations.

For research grant writing, even if the terms "*vision, goals, and objectives*" are not defined in the solicitation, it is important to produce a clear, compelling, and easily understood project narrative for reviewers that makes these distinctions. For instance, *defining goals* as the overarching, longer-term outcomes, milestones, or accomplishments of the research, and *defining research objectives* as the critical operational subsets *used to achieve each goal* works well as an organizational framework for the narrative and allows the reviewers to quickly grasp the significance of the research at various scales. For example, research objectives in aggregate define a key research goal; research goals in aggregate define a research vision. The intent here is to provide reviewers clarity. *The foundation of clarity is defining an organizational framework for the research narrative that allows distinctions to be easily made and in a logical sequence.* The increasingly finely-grained sequence of vision, goals, and research objectives offers one such narrative pattern that can be used to make a proposal more easily *accessible and memorable to reviewers*.

❖ Research Rationale

Moreover, reviewers must *understand the rationale motivating your research*, for example, why are you doing this research, what are your research hypotheses or results from prior support, why your research idea is a good one; why your research is important and significant, how you will conduct the research; why your research approach will be productive; why your research expertise makes you qualified to advance the proposed research; why your institutional research infrastructure (equipment, instrumentation, support, resources) will enable your research; your experimental methods and procedures, the context of your research in relation to the state of knowledge in the field; why your research plan is appropriate, effective, and efficient, how you will anticipate and overcome possible barriers to research success, etc.. Keep in mind that various agencies use various terms for encapsulating the above information. "*Research Approach and Rationale*" is often used, in other cases it may be noted as the "*Research Plan,*" or "*Plan of Work and Methodology,*" whereas in other cases it may simply be generalized as an umbrella heading such as the "*Project Description,*" leaving it up to the author(s) to make more fine grain subsection headings.

❖ Research Outcomes

Reviewers need to understand the *specific outcomes* of your research in a way that helps them judge the   value of funding your research, either to the agency mission or research field or both. Bottom line: at the conclusion of reading your proposal reviewers and program officers will want to know what they will get for the money invested in your research—they expect a significant return on the investment, perhaps in important research questions answered, technical challenges overcome, an important engineering challenge met, a disciplinary advancement in the field, etc. For example, NSF has often described expected project outcomes as the "*Unit of Change,*" that is, over the grant period of performance, what will change in some significant way if your research is funded, or what institutional advancements will take place, or what new knowledge will be gained, of what engineered system will be improved, etc.

Finally, it is important to define expected research outcomes in a way that allows a rigorous evaluation of your research performance over the term of the grant, or for annual performance reviews. Given the emphasis on research metrics at federal agencies, clearly listing your expected research outcomes will give you a significant advantage in the review process.

Don't Build Your Proposal Out of Spare Parts

Learning how to develop and write successful proposals begins with gaining an understanding of some of the key generic strategies, as opposed to agency specific strategies, that enhance the competitiveness of proposals regardless of discipline or agency. As one NIH deputy director famously noted: *"There is no grantsmanship that will turn a bad idea into a good one, but there are many ways to disguise a good idea."* For example, while there are many reasons proposals are declined for funding the most common reason is they are poorly written and poorly organized. Writing well is one of the many core generic strategies that form the necessary foundation for presenting your research idea most effectively to program officers and reviewers. Equally important, the counterpart to understanding successful proposal writing strategies is to understanding unsuccessful "strategies," or unsuccessful practices that diminish the competitiveness of your proposal by disguising the importance of your research idea. The point is, we learn from good examples of grant writing what to do well and from bad examples of grant writing what not to do. As one NSF program officer put it: *"Don't reinvent the flat tire."* Successful grant writing is a practitioner's art—we learn by doing. In that regard, there is nothing so helpful to developing your skills as a grant writer than to get thoughtful, conscientious reviews explaining why your proposal was declined for funding. If you write grants you will have many more opportunities to learn from mistakes made on declined proposals than examples of what you did well on a funded proposal.

In fact, a list of common mistakes, or common misconceptions, made in the development and writing of proposals can be of enormous value to new and junior faculty beginning a research career, as well as to more experienced investigators seeking to continuously improve the success rate of their proposals in a difficult funding climate. This critical information often comes from a senior faculty mentor with a history of successful funding, or it can come from research development and grant writing professionals who have benefitted from working with highly successful researchers on successful proposals of all sizes.

The most successful faculty researchers tend to be those whose success in funding begins with smaller grants of a few PIs and grows over time to large grants. These researchers can develop a capacity to frame the development and writing of the proposal by thinking strategically about every part of the proposal narrative, from the overarching vision statement to the smallest details that illuminate the research team's capacity to perform.

New and junior faculty can learn from successful researchers that successful proposals represent new and exciting ideas originating from the PI and the PI's research team, or, as NSF and NIH might characterize the research, it must be "***transformative***" research. ***This requires that the research narrative be as close to perfect as possible***—perfect in its vision, perfect in the operational details that advance the vision, perfect in

its synthesis and integration of all component parts with the overall goals and objectives, and perfect in every section and subsection required to respond fully to the solicitation. There is little margin for error in writing successful proposals since the funding success rate is typically in the range of 10% to 20% regardless of agency, and the funding rate on large interdisciplinary grants may is often less than 5%.

Therefore, it is important not to be tempted to use "spare parts" from older proposals (successful or unsuccessful), or information archived in database files, or narrative text created as so-called boilerplate by known or unknown authors. While writing a successful proposal narrative that advances new ideas in a compelling way is hard work, it cannot be made easier by the use of off-the-shelf text or boilerplate text written by others, or your own regurgitated text from prior efforts, or some preexisting narrative content of one form or another. On the contrary, **your proposal can be significantly harmed by that practice.** Moreover, keep in mind that agencies look for plagiarism in the research narrative and deal with it harshly, particularly NSF.

In specific terms, **the use of boilerplate imposes a distorting structure on the proposal narrative** that should evolve logically, consistently, proportionally, and integratively from a core research idea. This consistency should apply to the ideas advanced by the principal author as well as the language patterns and structure used by the author to describe those ideas. Unfortunately, no antirejection drugs exist to ameliorate the harm done by attempting to transplant boilerplate text into a proposal in hopes of making it more successful. In the successfully crafted proposal narrative, ideas and language interweave to create a coherent and seamless synthesis. Boilerplate or recycled text will destroy the needed symmetry at all scales.

What else is not a successful proposal? Edited collections of many short articles, or sections written by an army of authors, some known and, in the case of boilerplate, some unknown, lacking a coordinated evolution of the research ideas, will not meet with success. Unfortunately, however, once a proposal narrative has been built in a way that reveals gaps between sections, parts, or topics, renovating that inchoate narrative will require significant time and energy. If a researcher also introduces boilerplate into the proposal narrative, either verbatim or modified, she will push the narrative structure further in the direction of a crazy quilt of ideas rather than a seamless integration of text and ideas.   In many ways, the use of boilerplate text is akin to distributing a few counterfeit bills among the legal currency you use for cash purchases. At its worst, boilerplate text may come near to flirting with unintentional plagiarism, depending on the source of the text, and it is certainly not something federal research agencies would expect in a proposal that presents itself as a persuasive argument for the significance and merit of the proposed new research.

Having understood the disadvantages of boilerplate text, it's worth taking a moment to ensure that we all understand what this term means. Most successful PI's don't use this term (or the text itself), but inexperienced and eager researchers may use it. While various professions may use the term to refer to various types of text, **in most cases it refers to inferior, off-the-shelf writing, often of unknown and dubious origin, that operates as a static, plug-in set of phrases, sentences, paragraphs, or conceptual**

outlines. By definition, boilerplate fails to change or to reflect the evolving set of ideas associated with the successful proposal.

Boilerplate is frozen in time, whereas the successful research proposal originates with a good idea that evolves during the development and writing of the proposal narrative to make an original and compelling case for funding. Moreover, ***even the most excellent writing has a very short shelf life***, perhaps a matter of months. In fact, most often by the startup period of a grant, perhaps six to twelve months after the submission of the proposal, the successful narrative is typically dated and showing signs of age. If you are maturing research and educational ideas, then the ideas you have six months from now should be more robust and better explicated than the ones you have now. ***Do not encumber your good ideas with spare parts developed by someone else with absolutely no knowledge of why your ideas are significant and how best to configure those ideas within an integrated proposal narrative.***

When the term "boilerplate" in used by those who develop and write proposals-- typically within private sector consulting firms (engineering, architectural, scientific, etc.)-- then it typically refers to a description of past performances on similar projects in a capabilities section of the proposal. This recycled language is used to bolster the case that a contract awarded to the applicant would once again result in successful deliverables of one kind or another. However, when the term begins to migrate from contract work into proposals describing exploratory and transformational research to federal agencies, ***it has crossed the boundary from an appropriate to an inappropriate use of the term***.

While faculty should avoid boilerplate, they can become knowledgeable about successful models for some of the common sections required in a proposal, particularly in larger proposals, such as those related to institutional infrastructures, access to equipment, instrumentation and facilities, plans for undergraduate research or post-doc mentoring, management plans, diversity plans, data management plans, and the like. Descriptions of these resources may be adapted judiciously to inform possible topic points but not as transplanted text that disturbs the context of the proposal narrative. Moreover, research development professionals can make this information much more robust by working with successful PIs during the start-up period of grants where the concepts defined in the proposal may be significantly modified to work more effectively in actual operation. This represents one place where the use of boilerplate, for example related to NSF's "broader impacts" requirement, can do a real disservice to the PI. Boilerplate is like the minispare tires that come with new cars: it is not intended for use on your extended research journey.

Bottom line: if you are proposing new research ideas, express the significance of those new ideas, and all topic components of them, in newly-crafted writing for every word of the proposal narrative. Success in proposal writing will not be achieved using after-market parts. ***Successful proposals are not renovations of the past but a creation for the future and the compelling arguments you make for the place and significance of your research ideas in that future***.

The Challenge of Integrating Multiple Authors

Larger proposals that include multiple research partners pose a particular challenge to the coherence of a project narrative. Individual team members typically contribute individual narrative statements featuring their prior and future research **but with little or no recognition of how that research will integrate with other team members' contributions to the proposed project.** These "stand-alone" statements fail to describe how each research strand complements every other strand, adding up to an integrated set of contributions to the project's vision, goals, and objectives. These individual narrative contributions often do not address the overarching questions that motivate the research, nor do they describe each of the multiple research strands in a context that clearly demonstrates their relationship to the motivating questions or hypotheses.

Too often, these typically one- to four-page **descriptive only** contributions to a proposal narrative resemble a series of isolated numbers comprising the combination to a safe, but lacking the sequence required to open it. In the case of a project narrative, the combination needed for funding must be a **logically ordered sequence** of questions, or hypotheses, or perhaps statements of need, depending on the agency and type of research, that explain the novel and significant features of the research activities described in the narrative.

Descriptions of research activities or capacities improperly sequenced and explained within the overarching context of a research vision, goals, and objectives **turn the narrative into something of a mystery for readers and reviewers.** You don't want reviewers asking themselves and other review panel members after reading the research narrative "*why are all of these descriptions about various research capacities important and what exactly does this research team intend to do*?" However, this will be the result if the research narrative evolves, to use the current vernacular, as a collection of "**stove-piped**" or "**siloed**" contributions by multiple authors.

For example, a proposal addressing an issue related to sustainability may be comprised of research team members from geosciences; physical, biological, and agricultural sciences; engineering; computational sciences; and the social and behavioral sciences. Perhaps the research focus is on the sustainability of a coastal ecosystem impacted by climate change. In this case, it is easy to envision multiple research contributions by those with research expertise in climate, water, modeling, sensors, coastal biology, social and economic impacts of sustainability on affected stakeholders, and research expertise on one or more species in the coastal estuaries that serve as indicators of ecosystem health. Moreover, it is easy to see how researchers in one of the foregoing research areas important to the sustainability of coastal ecosystems may be tempted to write their narrative contributions as "**siloed text.**"

This will most likely occur when the vision is still evolving as the research contributors draft their narrative contributions, or when the overarching questions motivating the research have yet to be fully defined, or are in the process of being re-

defined. ***The vagueness or incompleteness of the research vision can increase the likelihood that a first full draft of the proposal will read as a series of siloed statements unintegrated with one another***.

Moreover, it is often the case that the ***research team members attempt to do too many important tasks simultaneously but in isolation from each other.*** In these cases, finding time to draft text is often difficult enough let alone adding the requirement of reading and considering others' contributions. This difficulty can be compounded by electronic communications among team members that fluctuate between periods of silence and cascades of electronic messages, often including drafts of graphics, figures, and multiple track-edited versions of an evolving project description that can quickly become a blizzard, or rainbow, of track edit colors.

These issues all cry out for an orderly resolution grounded on a well-crafted proposal development schedule. This planning tool will help meld the vision and goals of the project and communicate them continuously via a defined production timeline to all of the contributing authors. This will better ensure that the text evolves in a way that not only describes the importance of each research-specific strand or research contribution but also describes how it interrelates with every other research strand included in the project description. It is not an easy task, but this integration holds the key to success. The team is well advised to find someone among its own members or from a campus research office who can ***assist the PI in bringing informed coordination to the proposal development process.***

Another pitfall of a multiply authored research narrative or project description lies in writing these ***statements as if the authors were contributing to an edited collection or a journal issue rather than to the single, integrated statement*** identified as the research vision. This occurs most often on multi or transdisciplinary proposals that evolve ad hoc rather than from a well-planned proposal production schedule, or when the decision to submit these complex proposals occurs only a month or several weeks before the due date. In this last case, the proposal schedule can lead to a "fire drill" in which potential new research partners are added concurrently with the writing of the first drafts of the research narrative.

These situations can produce several drafts of the project description at a rapid rate as multiple contributions are added to the narrative. The complete draft of the project description may give the illusion of completeness***, but on closer examination it may lack an overarching organizing theme or research vision that synthesizes the component contributions resulting in a coherent and logically sequenced whole***. Correcting this document after it has evolved can be difficult; unfortunately, such a draft is likely to amount to ***nothing more than a siloed collection of research descriptions*** loosely associated and lacking a narrative thread that can persuade reviewers of its coherence. Once a complete narrative structure has emerged, contributors resist making major renovations to it. However, if the collaborators understand that the first full draft of a research project narrative is best viewed as a preliminary set of loosely associated descriptions, then the principal investigator can call for major revisions designed to produce a more integrated statement.

Indicators of a failed, or a weak narrative may reveal themselves sufficiently before the due date to allow the time and effort required to transform a weak narrative into a competitive narrative. Perhaps the best indicator of a weak complete first draft of the research project description begins with a nagging sense of unease after reading it. It doesn't seem to convey a clear sense of what specifically is being proposed, what questions are being asked, or hypotheses posed, nor does it explain why the research is unique, innovative, or advances the field in some way. It may also fail to convey a sense of how the multiple research descriptions meld to an integrated whole. Another indicator of a failed or weak narrative is a difficulty in clearly explaining the significance of the project and its outcomes after closely reading the 15 or 20 pages describing it.

It is a mistake to assume that your sense of uncertainty and vagueness following the reading of the proposal indicates a lack of technical expertise to critique the narrative, i.e., that the fault lies with the reader and not the writer. Two good reasons to dismiss that thought implicate both you and the proposal author(s): (1) federal research agencies, particularly the major ones that most often comprise the overall research portfolios of universities, advise writing the research narrative for the intelligent reader, not the expert reader. NSF, for example, advises writing to the reader of *Scientific American*, or the scientifically literate reader. (2) Moreover, research agencies that fund large, often transdisciplinary proposals, will have blended review panels comprised of members from various disciplinary backgrounds, including the social and behavioral sciences and, in some cases, the humanities. Research collaborators must describe their research in a way that convinces the entire review panel, not just those from specific disciplinary domains, to recommend the project for funding. So if you are asked to critique a proposal, ***do not hesitate to note when you do not understand clearly what is being proposed***, or when the project's goals and objectives appear ambiguous. Recall Professor Albert Einstein's observation that put a heavy burden on scientific authors: "*If you can't explain it simply, you don't understand it well enough. Most of the fundamental ideas of science are essentially simple, and may, as a rule, be expressed in a language comprehensible to everyone*." The bottom line: ***When proposals lack clarity, the fault lies with the author and not a review panel***. In practice, it is better to be presented with a challenging critique and penetrating questions in response to a draft project description than to hear those challenging critiques and penetrating questions from a review panel and program officer. In this case, your ***second chance is likely to occur one year in the future when a resubmittal is possible.***

Of course the best solution to the above issues is to formulate a plan for the proposal's production that anticipates such core issues as partnership configurations, vision, and goals in a logical sequence that allows time for a draft narrative of the project description to evolve continuously. A poorly planned proposal has little likelihood of success. Walt Kelly's Pogo once famously observed, "We have met the enemy and he is us!" That observation perfectly fits a ***poorly planned and poorly coordinated*** proposal development effort. But preparation and continuous coordination and communications can save you from becoming your proposal's enemy by avoiding the issues discussed above. A well-planned and well-coordinated proposal

development effort cannot turn ideas of modest importance into ideas of compelling significance, but it can give your ideas a chance to be realized. A well-crafted proposal will anticipate continuous revision to ensure that the project as a whole includes and exceeds the sum of its individual contributors.

Graphics as a Narrative Integrator

Just as the [Feynman diagrams](#) brought clarity to understanding the interactions of subatomic particles, on a less grand scale, diagrams, graphics, figures, tables, pictorial representations, and other visuals play a key, albeit too often overlooked, role as an integrator of the research narrative. This holds true particularly in the case of complex project descriptions whose narratives describe interaction among multiple research strands. Good writing forms the underpinning of any successful proposal, which explains why grant writing workshops, faculty grant mentors, and proposal development professionals all emphasize the importance of writing well.

The same advice is not always given, unfortunately, for the use of visuals as a complement to and integrator of the narrative text. The graphical representation of a research vision, or diagrams that show how the component goals and objectives of a large research project relate and interact together to form a coherent, synergized whole, can make the ***proposal narrative less challenging both to write and to read***. In fact, graphical representations of the main ideas of a proposal discussed and developed concurrently with the drafting of narrative text, can help the members of the research team write their contributions to the overall narrative with more clarity and focus than might otherwise be possible. The end goal, of course, is to achieve a project description that integrates narrative graphics and narrative text so closely as to make both easily accessible to review panels and program officers, especially in those cases where complex interactions among various research strands must be accessible and memorable. ***Good ideas deserve and benefit enormously from the illuminating interplay between well-crafted narrative text and accompanying graphics.***

Graphics can play a critical role in proposals of any size, but become increasingly important in large research proposals describing how the integration of multiple research themes achieves a synergy impossible without the value-added benefits that occur at the intersections and interfaces among research subtopics. The melding of graphical skills and writing skills can energize a research narrative. Moreover, the graphics provide a visual reference point for reviewers as they read the typically 15 to 40 pages of text required by the specific solicitation. Graphics can quickly illuminate the key points of intersection among the research topic descriptions and clarify the interrelatedness of topics in ways that can be quickly understood. Even in well-written proposals, it can be a challenge for readers and reviewers to ***capture and hold*** an understanding of 3, 4, or even 5 research strands that will be integrated into a coherent research vision.

Narrative text is linear. It is grounded on a logical sequence of explanations made coherent and persuasive by the author's writing skills. Graphics, however, function as a "***visual language***" able to capture complex relationships in a simple and unifying way; hence the importance of the Feynman diagrams to physics for nearly 65 years, or, more recently, the use of computer-generated visualizations as a way of understanding huge

datasets, ranging from the atmospheric sciences to petroleum engineering, among myriad other examples. With this in mind, high-quality graphics can make a significant contribution to the overall success of a proposal by offering a robust counterpart to the narrative text that serves to communicate the core research idea to reviewers and program officers in an alternative and memorable form.

It is particularly important when working on large proposals to identify early any graphics expertise that may reside within the research team, or any research office that may help with the proposal.   Do not wait until a full draft of the proposal narrative starts to cry out for graphical support. Graphics, like the narrative text, need to be developed in tandem with the evolution of the vision, goals, and objectives of the research plan, and the text and graphics need to be logically intertwined to gain the potential synergy inherent within them. Moreover, just as you wouldn't write a proposal using spare parts from other proposals, don't borrow graphics from other proposals, or, worse yet, look around in a clip-art library for your visual materials.

Always keep in mind that graphics should deepen the understanding of the research ideas being proposed in the narrative text and illuminate the interrelatedness among them in a simple and clear way. Graphics should function as a proposal integrator. Given the significant benefits of well-planned and well-crafted graphics to the success of the proposal, it is important that members of the research team give the integration of graphical information into the narrative text the consideration it is due as a potentially valuable contribution to a proposal's success.

Developing Timelines and Milestone Charts for Your Proposal

Many solicitations require that you provide a schedule, timeline or milestone chart for your proposal, and even when they aren't explicitly required it's often a good idea to include one. These schedules can serve a number of essential functions:

- They help reviewers understand how you plan to stage and conduct your project tasks (and in the process, reassure the reviewers that you actually do have a detailed action plan).
- They help provide evidence that you have a plan to finish the work in the time allotted.
- They provide an easy-to-find list of the main tasks you need to accomplish in order to achieve your proposed goals.
- For team proposals, they can also provide a summary of who will have responsibility for which tasks.

However, many PIs are unsure how to develop timelines and milestone charts. Below we provide an overview of various approaches to developing this component of your proposal.

Understand the Expectations of Your Funder

When developing a project schedule, it's important to understand the level of detail expected by your funder. Of course, if the solicitation specifically states what must be included in the project schedule, you need look no further. However, solicitations are often not that explicit. In that case, consider the culture of your funder and the complexity of your project.

Basic research agencies such as NSF, NIH and the DOE Office of Science are accustomed to giving researchers broad discretion in how they conduct their basic research projects, so you don't need to provide a highly detailed schedule, but you do need to communicate your approach and the major tasks you will need to accomplish as part of that approach. Therefore, schedules for single-PI or small team proposals to basic research agencies are typically high-level, with several subtasks under each main objective or aim, specified based on semester or quarter. Even so, don't make it so high level that it doesn't communicate your plan of work (such as just including your aims or objectives by year). So, for example, if you were a reviewer considering Schedule 1 in a proposal…

Schedule 1 (main objectives only)

Task	Year 1	Year 2	Year 3	Year 4	Year 5
Objective 1: Development of the hoosit	███	███			
Objective 2: Assess XYZ		███	███	███	███
Objective 3: Integrate the hoosit with XYZ			███	███	███

…what is your impression of how well the PI has planned the proposed project compared to if Schedule 2 provided more detail as below?

Task	Year 1	Year 2	Year 3	Year 4	Year 5
Objective 1: Development of the hoosit					
Integration and calibration	███	█			
Optimization of frumpits measurement methodology		██	█		
Objective 2: Assess XYZ					
XYZ spectroscopy	███	███	███	███	██
MOA microscopy	███				
ABC testing			███		
Pandax studies			██	███	███
Objective 3: Integrate the hoosit with XYZ					
Instrument integration			██		
Instrument testing			██	███	███
Demonstration				██	███

For larger team proposals or more logistically complex projects, even the basic research agencies are likely to expect a more detailed schedule. Think about your project from the reviewers' and program officers' point of view. Are logistics likely to be a challenge? Are there several tasks (perhaps led by different members of the team) that must be coordinated? Is there one critical task that could derail the project if it isn't accomplished on time? What is the "critical path," i.e., the sequence of tasks that determine when the project will be completed? If these and similar schedule-related questions are likely to be of concern to your reviewers, be sure to include enough detail in your schedule to show you have a plan to address them. For team proposals, it's usually a good idea to indicate next to the task who will be leading that task.

In addition, mission agencies often expect more detailed project plans and more finely detailed schedules. For example, the Department of Defense tends to place a high priority on scheduling and accountability, and often expects schedules down to the month (and even sometimes down to the week). In these cases, a project schedule could take up a half page or more. However, this is not always the case, so you should talk to your DoD Program Officer to determine what the expectations are for the particular program.

What is the Difference Between a Scheduled Task and a Milestone?

Many PIs, particularly those who haven't worked in industry, are confused by the requirement that "milestones" be shown. Simply put, a milestone is an event that occurs (or should occur) at a specific point in time and is an important indicator of progress of your project. It might be the start or completion of an important task (e.g., "all study subjects have been recruited," or "flight testing begins"), a deadline such as "final report submitted", or a short event, such as "meeting of External Advisory Board." If your project has any "deliverables," i.e., products (hardware, software, data, reports, etc.) that you must supply to the funder, the dates when you will provide those deliverables usually should be specified as milestones. Milestones, which are often

shown as triangles or diamonds, are usually interspersed within the schedule along with tasks that require some significant length of time. When you specify these milestones, remember that, should you win the grant, they will be key indicators that the funder will use to determine whether your project is on schedule, so consider carefully where you place these milestones and make sure they are realistic.

The Gantt charts shown above are very simple and don't show the relationships between various tasks: for example, cases where one task can't be started until a previous task has been completed. However, you can configure your Gantt task to do that using arrows to indicate tasks that depend on each other (Schedule 3).

Schedule 3. Gantt chart with milestones that also indicates dependent tasks

Task	Year 1	Year 2	Year 3	Year 4	Year 5
Objective 1: Development of the hoosits (Dr. Jones lead)					
Integration and calibration				Frumpet optimization complete	
Optimization of frumpits measurement methodology					
Objective 2: Assess XYZ (Dr. Wang lead)					
XYZ spectroscopy					
MOA microscopy					
ABC testing					
Pandax studies					
Objective 3: Integrate hoosit with XYZ (Dr. Ramirez lead)		Instrument integration starts			
Instrument integration					
Instrument testing					
Demonstration					
Final report submitted					

Formatting

The most commonly used format for providing schedules is the Gantt Chart, such as the ones shown in Schedule 1 through 3 above. While Gantt charts at the level shown above are of limited use in actual project planning, they are easy to read in a proposal and don't take up too much space. Gantt charts can easily be generated using MS Word's table function or Excel. There are also numerous Gantt chart software packages available for use in the actual planning and management of your project, such as GanttProject, which is free.

Flow charts are also sometimes used, such as Program Evaluation and Review Technique (PERT) Charts (**Figure 1**). This format has the

PERT network chart for a seven-month project with five milestones (10 through 50) and six activities (A through F).

Figure 1. Wikipedia's example of a PERT chart, which is usually used more for project management because of its complexity.

advantage that you can show the critical path, but it is relatively difficult to read and takes up quite a bit of space in a proposal. For this reason, you may be asked to provide
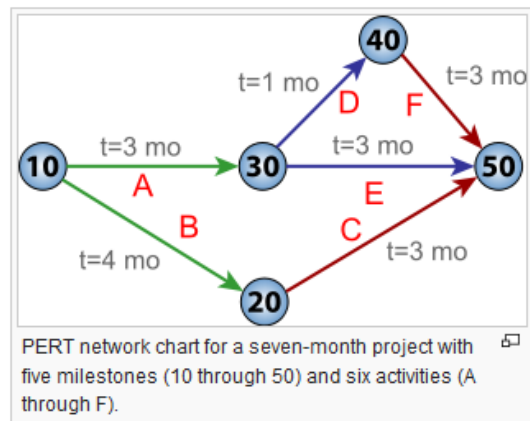
a Gantt chart in your proposal and then, after the award or as a supplement, be asked to provide a PERT or similar chart with more detail.

A modified flow chart with better labeling can help show the work flow, which may be helpful in some cases where the work flow may be confusing to reviewers (Figure 2).

Other Formats

There are also a number of other formats (usually versions of Gantt charts), many of which are produced by project management software. The figures below provide some examples. The key to deciding which format to use is to put yourself in the reviewer's place and think about what that reviewer needs to know about how your project will get done, what likely questions they will have, and what risks you need to address. The answers to these questions will help determine the level of detail and kind of information you should include. **Most importantly, be absolutely sure to double-check that the tasks and timing that you show in your schedule are consistent with what you say in your proposal text and with your budget.**

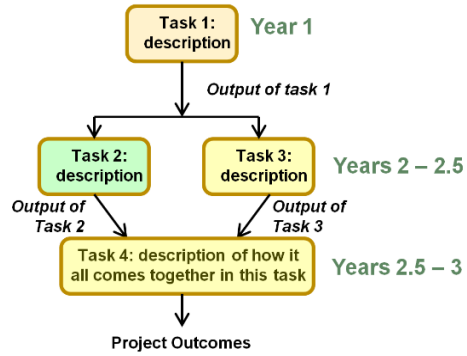

Figure 2. A task flow chart that provides information on how the tasks interrelate as well as some general scheduling information.
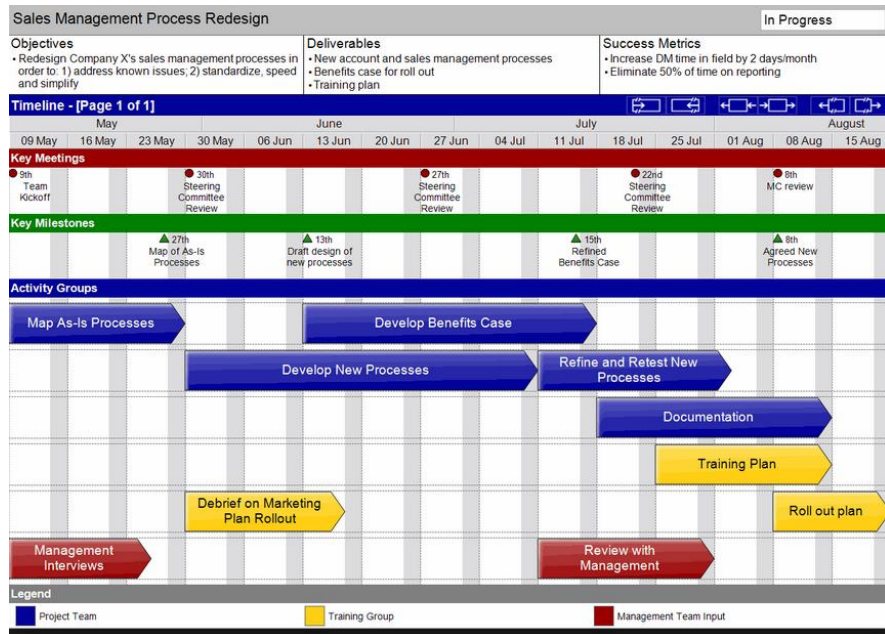

Figure 3. This version of a Gantt chart is produced by Swiftlight project management software.
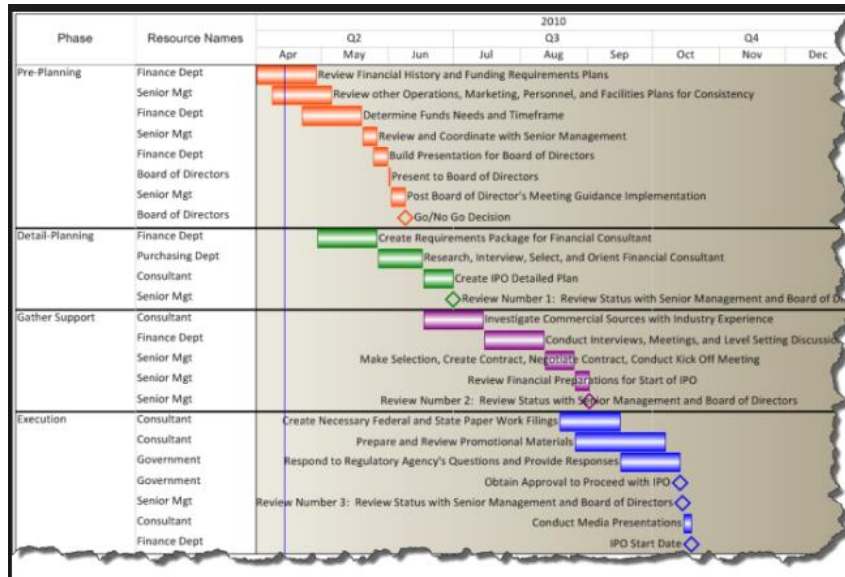
96

Figure 4. Another example with project phases resources (which could also be faculty team members or project thrusts/themes) from Chronicle Graphics.

Writing Unsolicited Proposals & White Papers

As we discussed earlier, many agencies, including NSF, NIH, DoD, DOE, DoED and DARPA, fund research through "unsolicited" or "investigator-initiated" proposals. While not all agencies accept unsolicited proposals, those that do have a variety of mechanisms for providing guidance to researchers on the types of unsolicited proposal they want to see. Moreover, as in the case of solicited proposals, agencies will have specific guidelines describing the goals, objectives, review criteria, and research or mission outcomes that will be used to evaluate unsolicited proposals.   Depending on the funding agency and program areas within a specific agency, the unsolicited proposal process may involve several steps that act as preliminary filters to an invitation to submit an unsolicited proposal. In most instances, regardless of the funder, talking to a program officer about your interest in submitting an unsolicited proposal is very helpful. This is especially important at the federal mission agencies where developing a research relationship with the program officer will be an important factor in your long-term funding success.   Preliminary discussions with a program officer will help ensure that your research objectives fit the agency mission priorities. Moreover, after discussions with a program officer, you may discover preliminary gates to be navigated prior to submitting a full unsolicited proposal to the agency.

One of the more common preliminary gates to submitting an unsolicited proposal is the preparation of a brief, **_perhaps three to five-page white paper_** that demonstrates the significance of your research to advancing the agency research mission objectives in specific areas defined in the agency guidelines for unsolicited proposals, or often defined in Broad Agency Announcements that are open for a year or more. The fact that many BAAs that include instructions for unsolicited proposal are open for such long periods of time, up to several years in some cases, offers another important opportunity to develop a relationship with the appropriate program officers. These open BAAs may be modified during the open period in ways that change the research priorities listed in the BAA when it was first published, or add new research priorities that better fit an evolving agency mission. Program officers offer the best sources of information about how these changes to a BAA affect the focus of what the agency wants to fund through the unsolicited proposals process.

The purpose of the white paper, according to DoD, is to preclude unwarranted effort on the part of an applicant whose proposed work is not of interest to the agency. Based on assessment of the whitepapers, feedback will be provided to the proposers to encourage or discourage them to submit a full proposal. White papers should present the effort in sufficient detail to allow evaluation of the concept's technical merit and its potential contributions of the effort to the agency-specific mission.

Mission agencies may ask occasionally for the submission of a quad chart as part of the unsolicited proposal process. This is a very abbreviated process wherein a one-page

document divided into quadrants serves as a template for responding to four key questions related to your research and its relevance to the agency mission. (An example quad chart template can be found [here](), but required formats vary depending on agency and funding opportunity.)

This abbreviated application process comprised of discrete and briefer preliminary review gates (quad chart/white paper) limits your initial commitment of time and effort. ***However, your success depends on your capacity to distill your research vision, goals, and objectives into a very succinct and clearly written response that allows agency program officers to quickly grasp the significance of your research and how it advances the research mission of the agency***.   **A white paper must quickly connect the significance of your research and the research mission of the agency.**

Here, too, the more knowledgeable you are about a funding agency's research mission, strategic plans, research culture, investment priorities, and the rationale behind them, the better able you will be to develop highly competitive responses in the form of quad charts, white papers, preliminary proposals, pre-applications, and full proposals as required by the agency-specific process.

The brevity required by the white paper format demands clarity and precision, together with an easily understood and compelling statement of significance. Crafting a white paper of five double-spaced pages, for example, requires a laser-like focus and distillation of your research idea into its core essentials, **followed by a convincing mapping of that research core to the agency's research mission and program-specific priorities**.

Once you identify federal agencies that fund research in areas of interest to you, it is appropriate to explore the process of submitting unsolicited proposals. The agency website is the starting point for this process. The generic strategies of writing competitive white papers (or abstracts) and proposals will be similar across most agencies and disciplines; however, each agency will have specific guidelines for submitting unsolicited proposals with which you must become familiar in detail. Become as knowledgeable as possible about the agency-specific guidelines for unsolicited proposals and the research areas for which they are appropriate before contacting a program officer to gain a deeper and more nuanced understanding of the process for submitting an unsolicited proposal to a specific agency.

Some agencies, such as the Department of Energy, have standardized the process for submitting unsolicited proposals across the entire agency as outlined in the DOE *Guide For The Submission Of Unsolicited Proposals***.** DOE funds research across a very broad spectrum of academic disciplines and a review of the unsolicited proposal guide will give you not only an insight into what is required at DOE but a good understanding of the unsolicited proposal process itself at all mission agencies. The National Science Foundation and the National Institutes of Health, two major funders of basic research awarded to universities, make, respectively, 50% and 80% of their awards through the unsolicited or investigator-initiated process.

The National Science Foundation addresses the unsolicited proposal process in Proposal and Award Policies and Procedures Guide. The National Institutes of Health

developed Parent Announcements for use by applicants who wish to submit what were formerly termed investigator-initiated or unsolicited applications. Other agencies, for example, the defense agencies, have information on the submission of unsolicited proposals distributed by agency (Navy, Army, Air Force, DAPRA) websites and also detailed in long-range funding announcements, or BAAs.

The Department of Education's Institute of Education Sciences announces its interest in considering unsolicited applications for research, evaluation, statistics, and knowledge utilization projects that would make significant contributions to the mission of the Institute. The Department of the Interior's US Geological Survey considers unsolicited research proposals in support of any field of study that helps fulfill its mission objectives. More information can be found in their Guide for Submission of Unsolicited Proposals.

The preferred method for submitting ideas and concepts to DARPA is to respond to a Broad Agency Announcement (BAA) in lieu of submitting unsolicited proposals. Interested parties are encouraged to make preliminary contact with appropriate field personnel before preparing a detailed unsolicited proposal or submitting proprietary data. Such contact may provide insight into the general need for the type of effort contemplated. Unsolicited proposals to DARPA must adhere to the policies and procedures concerning the submission, receipt, evaluation, and acceptance or rejection of unsolicited proposals set forth in FAR 15.6.

Many private foundations encourage or require interested applicants to submit a "letter of inquiry" that is similar to a short white paper. The foundation will then provide feedback on whether to submit a proposal. Guidelines for letters of inquiry are often provided on the foundation website.

As we mentioned earlier, a Google search is a good way to find information about the unsolicited proposals at federal agencies or programmatic areas within agencies of interest to you. For example, a search on "***submitting unsolicited proposals to 'AGENCY'***" will often turn up the information you are seeking.

Understand Plagiarism and How to Avoid It

Plagiarism is considered research misconduct. It is taken very seriously by federal funding agencies and universities. At the National Science Foundation, for example, every six months the NSF Office of Inspector General (OIG) issues a *Semi-Annual Report to Congress* on findings of research misconduct by university faculty for data falsification, fabrication, and plagiarism. The consequences for research misconduct at NSF are severe, ranging from criminal prosecution related to fiscal malfeasance on NSF grants to debarment from submitting future proposals to NSF for data falsification, fabrication and plagiarism, all effectively career ending outcomes. NSF, for example, uses software that compares any new proposal submitted to that agency to any prior proposal submitted to that agency, funded or unfunded, as well as to databases of electronic journals, doctoral theses, and all manner of technical reports, workshops, and scientific and engineering documents available in electronic form.

Keep in mind here that NSF does not sit back and wait to stumble on plagiarism in a serendipitous way, but actively seeks it out in a very aggressive way. How else to explain that NSF OIG found plagiarism in a new submittal to the agency by finding instances where narrative text was copied from both a proposal already funded by the agency and a proposal already declined by the agency and then went on to identify plagiarism in the PI's dissertation. This should be a real heads up to anyone that writes or contributes to the writing of the research narrative to be cautious in the extreme in terms of making absolutely sure that the research narrative is original text and not in any way derived in an inappropriate way from any prior proposal, either funded or unfunded at NSF, or from scientific articles, etc. NSF may not be partnered with NSA, but NSF OIG reports clearly reveal that it has put in place very powerful protocols to search for and identify instances of plagiarism in proposals submitted to that agency.

Therefore, for those involved in the writing of proposals to federal agencies, particularly NSF, some reflection OIG's investigative audits related to plagiarism is clearly warranted (see NSF OIG Reports). The sections of your proposal to be scrutinized at NSF include both the core research narrative, the broader impacts-related proposal sections, as well as biosketches and commitment letters, which are reviewed for plagiarism, data fabrication, and other embellishments of the facts. Moreover, to those who confuse using so-called "boiler plate" as a substitute for actually developing your own ideas in the proposal narrative, these OIG audit reports should come as a clear shot across the bow that not only is the use of "boiler plate" the sign of ineptness but also, according to this OIG audit investigation, "such actions may constitute civil and criminal false statements and false claims."

Moreover, university research offices have protocols on research misconduct, including plagiarism. If you do not fully understand what constitutes plagiarism, address this issue with someone from your campus research office. Also, keep in mind that there may be variations in how different federal research agencies seek out plagiarism

in proposals and what constitutes plagiarism at the specific agency. Below are excerpts quoted verbatim from several NSF OIG reports related to plagiarism over the past several years that serve to illustrate what is considered plagiarism in the research community. Reading through these excerpts (emphasis ours) will be helpful to anyone writing research proposals.

"Professor Plagiarizes in Two Proposals
Our investigation determined that a PI at an Ohio university recklessly committed plagiarism in his NSF proposal. The PI admitted that he plagiarized, but asserted that in his native culture plagiarism is, in certain circumstances, encouraged, and that persons who plagiarize in such circumstances are considered well-educated and knowledgeable. We concluded that, regardless of whether his statement accurately reflected the practice in his native culture, when submitting a proposal to NSF he is required to abide by U.S. standards of scholarship and NSF policy. We recommended that NSF require certifications for one year."

"Professor's Incomplete Citation Practices Result in Plagiarism
A professor at a Colorado university recklessly plagiarized in his CAREER proposal that NSF awarded with ARRA funds. The professor cited most of the published papers, but did not distinguish the copied text by quotation marks or indentation. Additionally, he did not cite his colleagues' unpublished manuscripts from which he also copied text."

"Former University Official Wrote Plagiarized Proposals for Staff
We ascertained that two proposals nominally submitted by different PIs from the same institution contained nearly identical text, and both proposals contained text apparently copied from an awarded NSF proposal submitted by another institution."

"NSF-Supported Graduate Student Admits to Data Fabrication and Falsification
*A former graduate student who conducted NSF-funded research at an Illinois university admitted that he fabricated and falsified data in a publication and his Ph.D. dissertation. Based upon the admission, the **university revoked the student's Ph.D.** and requested the publication be retracted."*

"The Importance of Accurate Information in Biosketches and Letters of Collaboration
*An NSF proposal consists of multiple sections, and PIs have a responsibility to ensure that each section contains accurate information. Our office regularly receives allegations where key information was omitted, or information was fabricated, in the proposal's biographical sketch ("biosketch") and letters of collaboration or support. Padding one's biosketch and altering letters of collaboration or support are a violation of the standards of scholarship; in an NSF proposal, **such actions may constitute civil and criminal false statements and false claims."***

"Plagiarized Material from a Funded NSF Proposal

*PI from a Puerto Rico university **plagiarized material in a funded NSF proposal**, which was suspended and subsequently terminated, resulting in over $150,000 of funds put to better use. As described previously, the PI included **plagiarized material in a funded NSF proposal and an unfunded proposal**. The PI's university concluded that she committed research misconduct. The PI asserted during the investigation that student assistants prepared portions of the proposal; however, she had no evidence regarding student involvement. **The university reprimanded the PI and required that her writing be monitored for three years, that she successfully complete a university course regarding proper citations practices within one year, and that she complete a refresher workshop the following year**. Our investigation concluded the PI committed research misconduct by knowingly plagiarizing material in two proposals, constituting a significant departure from accepted practices. **We also identified plagiarism in the PI's dissertation**. We recommended that NSF require the PI submit certifications and assurances for three years and certify compliance with university-imposed requirements."*

Plagiarism at a Michigan University

*A PI at a Michigan university "submitted an NSF proposal **containing three pages of apparently copied text in the proposal's five-page literature review**. The PI asserted that he had used the American Psychological Association (APA) citation style, that common language use was coincidence, and that he used the author's words to avoid misinterpretation. We determined the PI's citation practices did not meet APA standards, found his other responses contradictory, and referred the investigation to his institution. The PI asserted that: 1) **NSF policies are nuanced and in conflict with his own literal interpretation**; 2) **NSF's requirements for quotation use conflict with other disciplines' standards**; 3) **his field is eclectic and not addressed by NSF policy**; and 4) **the research proposal is not really research**. The university refuted all of these assertions and **concluded that the PI committed plagiarism**, at least recklessly, which was a significant departure from accepted practices. **The university required the PI to participate in a supervisory meeting to discuss the seriousness of his actions, identify steps to prevent future occurrences; take training about plagiarism prevention; and submit all grant proposals to a university official for review for two years.**"*

When Your Proposal Isn't Funded: Responding to Reviews and Strategies for Resubmission

If you talk to any well-funded researcher, he'll tell you that he has a drawer full of proposals that were declined for funding. In fact, even extremely successful researchers typically have had more proposals declined than funded. As a faculty member just starting your career, you should expect to have your first several proposals declined. When a funding agency decides not to fund your proposal, there are three ways to respond:

1. Become discouraged and stop applying for funding;
2. Disregard the reviews and resubmit essentially the same proposal, hoping you'll get more intelligent reviewers next time; or
3. View it as a learning process: carefully analyze the reviewers' comments, and revise your proposal for resubmission, or, if appropriate, scrap that idea and start over with a new idea.

Successful researchers take the third approach. They expect to have to revise and resubmit proposals just as they often have to revise submitted publications. They understand that reviewers' comments are meant to provide guidance, and they study them carefully. In cases where it is clear from the reviews that their idea is not a good fit for that program or agency, they either look for a new funding source that's a better fit, or they try a different idea.

When your proposal is declined (remember, this isn't a question of "if," but a question of "when"), take a quick look at your reviews. (If you applied to a foundation or agency that doesn't supply reviews, you'll need to talk to the Program Officer, if possible, to determine what contributed to the decision.) It's very likely that at first reading you'll feel the reviews were unreasonable and that the reviewers obviously didn't understand your proposal and were probably incompetent.

Put the reviews away for a few days and then, after you've had some time to calm down, pick them up again and read them carefully. Reviews can be analyzed in several ways, which we'll discuss. (Since funders use a variety of review processes, it's likely that not all of the statements below will apply to your specific situation, so be sure you understand the review process for the particular agency and program to which you applied.)

➢ **The reviewers felt the project wasn't a good fit for the program.**
The Program Officer is usually the person who instructs reviewers regarding the priorities and scope of the specific funding program, so this issue can easily be explored by talking to the Program Officer. You can respond to this critique by either submitting your proposal to a different program that's a better fit, or by modifying your project so that it better fits the program based on the Program Officer's advice.

> **The reviewers felt the scope of the project was inappropriate (either too ambitious for the funding and time available, or not ambitious enough).**

Talk to colleagues in your field to assess whether the reviewers might be correct. If you still feel that your project's scope is appropriate, revise your proposal to directly address this issue. Include a detailed project timeline showing how long it will take to accomplish each task. If reviewers felt the project was too ambitious, discuss your previous experience that demonstrates that you can accomplish what you're promising in the time allotted.

> **The reviewers had specific technical concerns.**

This is usually the easiest issue to address. Determine whether the reviewers' concerns are valid. If they are, revise your project plan accordingly. If you don't agree that the reviewers' concerns are valid, talk to colleagues to get their assessment. If you're still confident that you are correct, revise your proposal to specifically and respectfully explain, using data if possible, why those technical concerns aren't a problem.

> **The reviewers felt your research wasn't exciting or significant enough.**

This is a more difficult problem to address. First, honestly assess your project. Are they correct? If so, remember that the degree of innovation and impact expected varies by agency, so a project that may not be innovative enough for NSF might be considered by the Air Force Office of Sponsored Research, if it meets one of their specific needs. (This is often the case for research that is more applied than basic.) In that case, you might want to explore revising and submitting your proposal to a different agency. If you do feel the project is significant, then you may simply need to do a better job of explaining that in your proposal. In that case, revise the text of your proposal to make a more compelling argument.

> **Most of the reviewers liked your proposal, but one reviewer panned it.**

This is a classic case where talking to the Program Officer can be extremely helpful. Usually the Program Officer was in the room during the review process and can give you some insight into the discussion. It's often the case with review panels that most of the reviewers are not experts in your particular subfield. If the reviewer who didn't like your proposal happened to be the reviewer who was most knowledgeable in your field, then that person's comments likely carried a lot of weight with the other reviewers, and you'll need to take those comments very seriously. However, if the one negative reviewer simply had a dyspeptic disposition or was acting on a pet peeve, and if reviewers change with each cycle, the Program Officer may encourage you to resubmit with minimal changes. If it was clear from the reviews that the sole negative reviewer was not knowledgeable in your field, or his comments seemed to come out of "left field," don't use a lot of space responding to those comments in your proposal revision unless you're reasonably confident that that particular reviewer will be on the next panel.

➢ **The reviewers didn't seem to understand your proposal and brought up concerns that weren't applicable or that were addressed in the proposal.**

In this case, it's tempting to dismiss the reviewers as incompetent. However, it's more likely that your proposal wasn't clear. Remember that reviewers aren't necessarily experts in your subfield; they may have to review a large number of proposals in a short period of time, and they may be reading your proposal at two a.m. Your project description needs to be clear, well-organized, and easy to follow. You need to make it very easy for reviewers to find the main points and to locate where you address each review criterion. Revise your proposal text and ask colleagues from outside your field to read it. If they can understand it, then it's likely that a tired reviewer reading your proposal at two a.m. will be able to understand it.

➢ **The reviewers weren't convinced that the project was likely to succeed (either because of a lack of preliminary data or because they felt the PI or team weren't sufficiently qualified).**

Reviewers want to fund projects that are likely to succeed. If your project appears to be risky, then you'll need to give the reviewers some evidence that these risks are manageable. If the reviewers identified one particular aspect of the project that they felt was too risky, you may need to generate some preliminary data to convince the reviewers that that issue is actually not risky, or you'll need to develop a plan to work around problems in that area to convince the reviewers that the project can still be successful even if that particular program component doesn't work out. If reviewers weren't convinced that you or your team had the required expertise, you might address that concern by generating preliminary data (and, ideally, publications in the topic). Another approach is to bring in a collaborator with the requisite background. If your idea is a high-risk, high-payoff idea, and you don't have the resources to generate the needed preliminary data, check to see whether there might be other programs set aside to fund such ideas (e.g., NSF's EAGER grants). In some cases, you may need to carve out a smaller project (for example, cutting back to a one-year project to allow you to develop proof-of-concept data rather than asking reviewers to risk three years of funding); or, you may need to find another funder that is more comfortable with higher-risk research (e.g., DARPA). This is another case where the Program Officer can give you invaluable advice.

➢ **The reviewers were generally complimentary, but didn't give the proposal a high enough score to be funded.**

This can be one of the most frustrating kinds of reviews – the reviewers were all generally complimentary; they might have brought up a few minor points but didn't mention any major shortcomings of the proposal, but they just didn't give the proposal high enough ratings to be funded. In fact, if it was an NSF panel, they might have recommended the proposal for funding, but didn't "highly recommend" it. In all likelihood, your project idea had merit, but it didn't excite the reviewers as much as some other proposals did. This is another case where it's important to talk to the Program Officer. Often, the Program Officer can give you an idea of how close you were

to being funded, and she can tell you whether any other factors played a part (for example, yours may have been one of several good proposals in a narrow subtopic, and they only wanted to fund one). If the reviewers just weren't as excited about your proposal as they were about others, you may need to rework your proposal to explain more compellingly what the ultimate outcome of the research will be, why it's significant, and what the impact will be. Be sure that you clearly communicate the big picture – how will this research advance your field? How does this particular project contribute to your long-term research goals? Ask your colleagues to read the reworked text and tell you whether they find the arguments persuasive.

Based on the information you've gathered by reading the reviews carefully, talking to your colleagues, and talking to the Program Officer, you can then decide whether to: (1) revise the proposal and resubmit to the same program; (2) revise the proposal and submit to a different program within the same agency; (3) revise the proposal and submit to a different agency; or (4) start over with a new or significantly modified project idea. Just remember that even when your proposal isn't funded, you have learned something from the process, and your next proposal is likely to be more competitive.

Conclusion

As with many things related to research, competing for grants can be both an enormously rewarding and an enormously frustrating endeavor. It's important to remember that writing research proposals is a learned skill. You have recently earned a doctorate and landed a faculty position—good evidence that you have the expertise, determination, and (most likely) the small streak of masochism needed to compete successfully for research funding. However, as we've discussed in the preceding pages, winning a grant is not simply the inevitable outcome of articulating a great idea to funders who are waiting to hand out money. Identifying the right funding opportunity and writing a competitive proposal requires a thoughtful, disciplined approach and the development of new skills that you likely weren't taught in graduate school. What's more, with funding rates typically less than 20%, you are virtually assured of having many more proposals declined than funded.

Why go through all that trouble, then? Most obviously, when you do win funding, it can be extremely useful in helping you accomplish your research. However, even when you don't win that grant, the process of developing the proposal can provide a number of benefits. It can help you more clearly define your research ideas and plans. It can provide opportunities and a focus for developing collaborations. It can help you to connect with the broader research community in your discipline, particularly if you get to know the Program Officer and perhaps have the opportunity to become a reviewer. And it can help you vet your ideas with experts in your field (the Program Officer and reviewers).

The single biggest predictor of success in winning research funding is *not giving up* after you've had those first few proposals declined. Learn from your reviews, talk to the funders, continue to develop your research ideas, generate preliminary data and publications if you can, and work with your mentors to further develop your proposal writing skills. These activities will help you not only win funding, but also to build a successful academic career.

APPENDIX: More About Grantsmanship

In an effort to keep the length of this guide manageable and avoid overwhelming you with information, we have intentionally left out some grantsmanship topics or discussed them only briefly.

In this appendix, we include more discussions about various topics related to grantsmanship that you can peruse as time allows or as they become relevant to your proposal writing endeavors. These discussions were taken from various articles we've written over the years for our *Research Development & Grant Writing Newsletter* and reflect grantsmanship challenges that we commonly encounter as we work with faculty on their proposals.

Grantsmanship Topics Discussed in the Appendix:
- Confessions of a Grumpy Reviewer
- How Reviewers will Read Your Proposal
- Understand What Reviewers Want to Know
- Writing Smaller Team Grants
- Team Grant Training for New Faculty
- Avoid the "Trust Me" Research Narrative
- Common Ways Proposals Fail
- Ways to Organize the Proposal Narrative
- Organization is Key to a Successful Proposal
- How to Win Your Grant on Page 1
- Editing Your Proposal: Checklist for Success
- Proposals for Basic Research: Why You Need a Theoretical Framework
- Writing Proposals for Highly Mathematical Projects
- Make Your Funding Case with Value-Added Benefits
- The Importance of Clarity in the Research Narrative
- Don't Bury the Lead: Get to the Point Quickly
- Proposal Writing Tips for Non-Native English Speakers
- Too Much "Why" and Not Enough "How"

Confessions of a Grumpy Reviewer

PIs often approach writing grant proposals as they do writing journal articles. However, there is a key difference between the journal article reader and the proposal reviewer: your colleague who chooses to read your journal article is already interested in what you have to say and has made the choice to read your article; in contrast, the reviewer reading your grant proposal may have no special interest in the topic you're proposing and is obligated to read your proposal. In addition, reviewers are specifically tasked with the role of being critical and helping to winnow down numerous proposals to just the ones with the best ideas. As a result, proposal reviewers are a much more challenging audience. They may be tired; they often are reading your grant proposal as one in a large stack of proposals; and they may be grumpy. It's therefore very important to engage and excite your reviewer and make him or her your champion. Most critically, avoid irritating your reviewer.

There are many ways to irritate your reviewer. Below we list mistakes that PIs often make—some can significantly hamper the clarity of your proposal, while others are admittedly pedantic. However, like a small pebble in a shoe, even minor irritations can become significant for a reviewer who is reading your proposal at 2 am.

First, the big mistakes that can hamper clarity:

- **Illegible figures and graphs.** This can drive reviewers crazy and lead them to conclude that the PI really doesn't really care whether the reviewer understands the proposal or—even worse—that the PI has something to hide by making key graphs or charts impossible to read. Graphs may be illegible because the axis labels or units are missing or too small, or because there is no clear legend for multiple lines. Figures are often illegible because text in the figures is too small, or because the figure is too complex. Beware taking a PowerPoint slide and shrinking it down to figure size – this is almost always a bad idea. Simplify the figure and redraw it so that it is legible at the size it will be in the proposal. If it's too complex, consider breaking the figure into two figures or focusing only on the core concept and explaining the rest within the text. Also beware of blurry, low resolution figures. This adversely impacts the impression of competence that you want to convey to the reviewer.

- **Very lengthy figure captions.** The main point of including a figure is to provide a visual way for the reviewer to easily and quickly grasp key concepts. However, some PIs see it as a way to get around the font limitations by including a lengthy discussion of the figure in the caption in 9 point font. A grumpy reviewer will just skip the entire figure. If the figure merits a lengthy discussion, include that in your main text. In the caption, provide a concise description of the main points you're making with the figure.

- **Failure to clearly state your project goals and objectives early in the proposal.** Many reviewers tell me that if they have read two (some say just one) pages of a

proposal and they still don't know what, ***specifically,*** the PI is actually proposing to do, they will put the proposal down and go on to the next one. Remember that you can always provide background later in the proposal; don't irritate your reviewer by making him read several pages of background information he probably already knows in order to find out what you're proposing to do.

- **Typos and grammatical mistakes**. These kinds of mistakes, which reviewers see as sloppiness, signal to the reviewer that the PI didn't care enough about the proposal to ask someone to proof read it (or at least use spell check). Reviewers see this as sign the PI will do sloppy research, and they also see it as lack of respect for them as the reader.

- **Walls of text with no subheadings.** When a reviewer opens a proposal, and she sees large blocks of text with minimal headings and no subheadings, a deep feeling of dread settles on her. This proposal is likely to be difficult to follow, and it will be a challenge to find where in the text the review criteria are addressed. This makes the reviewer's job much more difficult and, consequently, makes her extremely grumpy and disinclined to give the PI the benefit of the doubt on any aspect of the proposed project.

- **The garden path proposal.** Usually, when a topic is introduced early in a proposal, it's a signal to the reader that the topic is central to the proposed project. However, some PIs introduce a topic and discuss it at some length, and then never return to it in the rest of the proposal. Instead of discussing an important point, that part of the proposal was just an interesting aside (perhaps motivated by the PI's perceived need to acknowledge work that is tangential to the proposal or that might be of interest to the review panel). In this case, the PI has led the reviewer down the proverbial "garden path," signaling to him that the proposal was going one way, and then suddenly taking a 90 degree turn in an unexpected direction. Reviewers often find this deeply confusing and, at 2 am, deeply irritating. If a topic is not really central to your proposal, don't discuss it at length early in the proposal. If you feel you must address it, put it later in your proposal and clearly explain why you are discussing the topic and how it relates to your proposed project.

- **The ghost team project.** Often, proposals for team projects fail to describe the team, their qualifications, and what the roles of team members are until the management plan, if there is one, at the end of the proposal. The project plan is often written in passive voice, e.g., "The specimens will be fabricated and tested …" As a result, the proposal reads as if key tasks will be done magically by no one in particular. Team projects are more expensive and complex than single-PI projects, so there needs to be a strong reason to fund a team. That reason usually stems from the skills and experience that each team member brings to the team. If you fail to describe your team and the qualifications of each member early in the proposal, you have left out one of the most important aspects of your project, and reviewers are unlikely to recommend funding.

- **The tentative or uncommitted proposal.** Some proposals read as if the PI is not really sure what he will do if he wins the grant. The research plan is peppered with

words like "might," "could," "would," "it might be interesting to," "X can be done," etc. This kind of tentative wording weakens your proposal and makes it appear that you are not really committing to a clear course of action, which makes reviewers uncomfortable. Everyone knows that there are no guarantees in research, but as the PI, you need to have the courage of your convictions. If you appear to be unsure of what you will do or whether you're likely to be successful, why should your reviewer place her faith in you? Wording such as, " We will do x" is always more convincing than, "We plan to/might/could/would do x."

- **Using jargon or lab shorthand.** Some PIs are so accustomed to talking to their graduate students and close colleagues that they end up using language in their proposals that is inaccessible or unclear to reviewers who are not in their particular subfield. You may say to your grad student, "Go scan these specimens," or "Analyze the interface," and your student will know that you want a differential scanning calorimetry analysis done of the specimen to determine its glass transition temperature or that you want the interface examined using transmission electron microscopy to determine its structure. However, if you write in your proposal that you will "scan the specimens" without being specific, it will be unclear to the reviewer what you'll actually be doing. In addition, even if the reviewer can figure out what you mean, she is likely to see this kind of imprecise wording as sloppiness, which will irritate her.

- **Vague claims.** PIs will often say that their research will improve or reduce something without giving any numbers. If you make claims that your research will "improve the efficiency" or "reduce the cost" of a step, the reviewer will want to know if you anticipate a 200% improvement in efficiency or a 0.02% improvement. If you don't give at least some estimate of the magnitude of the impact along with rationale for that estimation, reviewers will often disregard the claim altogether.

- **Inconsistent descriptions of tasks.** In many proposals, the project schedule at the end of the proposal lists the specific tasks to be accomplished in satisfying detail, but the research plan/methodology section doesn't describe many of the tasks, or describes different tasks. Alternatively, tasks may be mentioned early in the proposal but not addressed in the research plan. Inconsistencies of this type makes it difficult for the reviewer to know what you actually plan to do and also make it appear you may not be sure what exactly you'll do if you get the grant.

- **Overuse of acronyms.** Nothing is more annoying to a reviewer than having to search for the definition of an acronym that was defined on page 2 and then used again on page 9. Terms that are used just a few times in a proposal shouldn't be converted into acronyms unless the acronyms are universally used in your discipline and the reviewers all share your discipline.

Below are some more pedantic complaints which, nonetheless, can be deeply irritating at 2 am:

- **Using "proposal" when you mean "project."** The proposal is the grant application document you are submitting; the project is what you will do if you are awarded the

grant. Therefore, you should not say, "the goal of this proposal is to [research goal here]." That's the goal of your ***proposed project***. The goal of your proposal is to convince the agency to fund you. However, you can say, "In this proposal we will first discuss x and then y…" because that refers to the document itself.

- **Use of overly colloquial wording.** This is most commonly an issue for non-native English speakers who may not realize that some words are too informal for use in a proposal. The most common of these is the use of "nowadays," which in the US has a distinct "grandpa in a rocking chair on the front porch" feel and might be followed by a discussion of what the "whippersnappers are up to." Better wording would be "currently" or "to date."

- **Use of "notice" when you mean "note."** This is also most common for non-native speakers. "Notice" connotes casually seeing something that may or may not be important, whereas "note" generally connotes paying attention to something, which is usually the correct meaning in a proposal.

- **Use of quotation marks for emphasis.** Some PIs write things like "*This approach is "novel" because…*" There is already copious griping on the internet and in writing guides about this kind of misuse of quotation marks, but we include it here because it's still a common mistake and is especially problematic in a proposal. Putting "novel" in quotation marks implies that you are quoting someone else, and it may not actually be novel—the opposite of what you want to communicate to the reviewer.

As you work on your proposal draft, remember that even though there is no review criterion called, "Did not annoy the reviewer," these kinds of annoyances can often impact your reviews in less explicit ways. Do your best to avoid the mistakes discussed above, and ask your friends and colleagues to read your proposal draft and give you feedback on how reader-friendly they found your proposal to be.

How Reviewers Will Read Your Proposal

An article by Elisabeth Pain in the March 21, 2016 issue of *Science* entitled "*How to (seriously) read a scientific paper*" offers many observations collected from a dozen scientists about the strategies and techniques they employ to avoid the difficulties of reading scientific papers while promoting a better understanding of their content. This article also has relevance to those who work with faculty in the planning, development and writing of proposals. An understanding of how a dozen scientists approach reading a scientific paper to determine its importance to them transfers readily to an understanding of how many peer reviewers will likely review proposals for federal research agencies.

In both cases, the reader is attempting to understand complex information quickly and clearly and, most importantly, **to determine whether or not the value of the proposal or paper warrants a further close reading**. At the point where the reader of either a proposal or scientific paper determines that there is not sufficient value and merit in the research to continue the review, the review process stops either with a "do not fund" recommendation or by setting the paper aside.

While it is well understood that a research proposal amounts to a compelling sales pitch promising potentially transformational results of significance to the field, and that a scientific paper reports on the results of research, there are some commonalities. For example, both research proposals and scientific papers are typically peer reviewed by sending them to outside experts who provide written evaluations on the significance and impact of the research to the disciplinary field. Also, both proposals and scientific papers, while differently organized, contain similar sections that typically include an abstract (aka project summary), introduction and background, research goals, hypotheses or critical research questions, results (aka results from prior support), methodology, references, etc.

In this case, Pain's article of March 21 was published as a more serious response to an earlier satirical article by Adam Ruben, PhD, entitled "*How to read a scientific paper*" published in *Science* January 20, 2016. In this article, Ruben introduces the topic with observations on how stupid he often feels reading scientific papers that are "ultra-congested and aggressively bland manuscripts so dense that scientists are sometimes caught eating them to stay regular." He goes on in the article to enumerate the "*10 Stages of Reading a Scientific Paper*," including "optimism, fear, regret, corner cutting, bafflement, distraction, the realization that 15 minutes have gone by and you haven't progressed to the next sentence, determination, rage, and contemplation of a career change."

The common thread between a research paper and a research proposal is that, in both cases, the reader is trying to digest complex information quickly in order to make a determination on the value of the research. In so doing, *the reader is looking for shortcuts* that help them do an "end run" around the organizational structure of the

document *in a non-linear way* in order to more quickly determine whether or not there is value to be gained from a continued reading.   Pain's article reveals that a scientific article does not get a full and close reading unless the reader is intrigued by a quick review of the abstract, research goals and objectives, and conclusions. As one scientist Pain quotes noted, "*I nearly always read the abstract first **and only continue on to the paper if the abstract indicates that the paper will be of value to me**.*" Or as another scientist noted, "*It is important to realize that **shortcuts have to be taken when reading papers** so that there is time left to get our other work done, including writing, conducting research, attending meetings, teaching, and grading papers.*"

Because these situations are so similar, there are several "take-aways" here for those who write research proposals. For example:

- Write a compelling proposal project summary that will entice the reader to ***complete a reading of the proposal***. Note that Pain's article reveals that most of the scientists ***used the abstract as a gate to determine whether or not they would read the article in full or in depth***;

- Structure your narrative in a way that ***gives the reader the most important information quickly***, i.e., on the first page of the proposal. Pain reveals that readers determined how closely they would read an article by giving it a non-linear scan to determine its value;

- ***Make sure the narrative is well written***, which implies well edited and well organized, to ensure the reader is not put off by mangled syntax, poor grammar, and convoluted sentence structures. Again, the Pain essay quotes one scientist on poorly written articles, "*Simultaneously, some papers are written terribly and are not worth the effort. Someone else has surely written about the concepts more clearly **so that I can keep my confusion focused on understanding substance rather than poor grammar.***"

This last observation is a critical one to keep in mind when writing, editing or revising a proposal prior to submission.

Understand What Reviewers Want to Know

A well written proposal is one that answers all the questions reviewers need answered to make an informed funding determination. Many of these questions are known early on, both to you and the reviewers, from a close and repeated reading of the funding solicitation, including the review criteria and possibly other referenced documents. In many ways, these function as enumerated "checklist" questions that can guide your writing of the research narrative. In many solicitations, the list of questions you must address in the narrative can be very extensive. Failure to address any one of them will introduce a fatal flaw into the narrative, and is one of the more common reasons proposals are declined for funding.

Proposals flawed by a failure to address the agency's expectations are simply inexcusable, but, again, not uncommon. A funder's questions can be used to improve the writing, rewriting, and editing of a proposal by simply listing these questions from the solicitation, comparing them to the narrative, and making sure each is addressed. This is the rationale for using the funding solicitation as a narrative template to ensure a proposal fully responsive to an agency's every question.

In this context, it is important to also keep in mind that reviewers are selected to ensure that, as an aggregate, they bring to the review process a suite of expertise that faithfully complements the full scope and scale of the solicitation's research objectives. For example, as solicitations become increasingly interdisciplinary, so too must the composition of the review team. Moreover, many solicitations, particularly from NSF, often include additional program components that complement the research core, e.g., perhaps education and training, or many of the other areas that typically fall under a broader impacts umbrella.

The point here is that this inclusion will diversify the review team considerably. You will have to anticipate such a diversification based on the scope of the solicitation and write your research narrative with this in mind, i.e., *you need to write to your audience* (review panel), keeping in mind that that it likely will not be comprised entirely of experts in your field. *Moreover, having a more diverse set of reviewers will mean a more diverse set of likely questions about your narrative during the review process*. For example, if you are writing a large-team proposal to NSF, you can expect an education and training component to the proposal. In such a case, you would assume the review team will include a member with a background in education, training, and evaluation. Consequently, you would take care to write a research narrative that is accessible to every member of the review team, not just a technical subset of experts in your field.

In addition to the known questions the reviewers will expect to have answered in your research narrative, there will be less obvious questions, *and it is here that you need to learn to think, question, and write as a reviewer*. These questions may arise from the way you have written the proposal and are specific only to your narrative. For

example, questions may arise from unsupported or insufficiently supported claims made in the research narrative. An author may write, "Our proposed research is transformational and will significantly impact the field," yet offer insufficient details and specificity to validate the claim, thereby leaving the reviewers to wonder "Why is this research transformational; how specifically does it impact the field; is there sufficient research detail to warrant funding?" etc.

In other cases, reviewers at basic research agencies may question whether the proposed research is sufficiently fundamental to meeting the solicitation's intent, a question often asked by NSF review panels, and one best anticipated and convincingly answered by those who write proposals to that agency. These are the kinds of questions reviewers will ask and the questions you must anticipate while writing the narrative to prevent them being asked, or, if they are asked, to ensure they can be answered by convincing information provided in the narrative.

Of course, as you write, you must always keep in mind the overarching questions reviewers will seek to have answered in your narrative, such as: *What do you propose to do; why do you propose to do it; how will you do it; why is it significant; how will it impact the field and advance the discipline; where does your research fit in the current context of the field; why is it transformational, etc*. These questions are really a **generic distillation** of the specific overarching review criteria of federal research agencies such as NIH and NSF.

For example, NSF advises reviewers: "*When evaluating NSF proposals, reviewers should consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits would accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions*."

Applicants may also lack insight into more specific agency instructions to reviewers. Most of these can reasonably be surmised, but it is also helpful to deepen this insight by talking to colleagues who have reviewed for specific agencies about the review process. In other cases, that information is provided by the agency online to reviewers. In these cases, it benefits the applicant to read this information. Your goal is to read these instructions as a reviewer might.

NSF provides the below instructions to reviewers of proposals to that agency, all good questions to keep in mind as you write:

"The following elements should be considered in the review for **both criteria**:

What is the potential for the proposed activity to:
1. advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?

3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or institution to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home institution or through collaborations) to carry out the proposed activities?"

In terms of the actual review, NSF instructs reviewers on "things to do in a review," including:
1. Detail the strengths and weaknesses, including **why** they are strengths or weaknesses.
2. Provide specific information that supports your rating, referring to each of the merit review criteria.
3. Write a summary statement providing a justification for how you arrived at your overall rating based on how you weighted the two merit review criteria: intellectual merit and broader impacts.

   With these instructions in mind, the author of a research narrative will want to address these issues in the proposal in a clear and organized way ***to make life easy for reviewers*** and to capture the essence of the significance of the research. Moreover, because what you write in the narrative will be used (often verbatim or paraphrased) by the reviewers in drafting their reviews, ***you want to make it easy for them to summarize your strengths and relate them to the review criteria***. Doing your job well makes it easier for reviewers to do their job well. So, if you write like you are a reviewer, you will keep reviewers happy and that will work to your funding benefit.

Writing Smaller Team Grants

The dramatic increase in interdisciplinarity as the core characteristic of research grant solicitations at smaller scales has transformed how proposals are planned, developed, and written. As the complexity of scientific challenges has increased, spurring the need for more interdisciplinary teams, and the competitive benefits of teaming on large grants became apparent, interdisciplinarity and teaming have become inseparable and now represent a fundamental given for success on smaller and smaller grants. As a result, more and more faculty have had to learn to navigate a much more complex proposal development process as smaller funding solicitations have transitioned from the long-standing highly focused disciplinary grants with a few principal investigators to interdisciplinary efforts with multiple principal investigators in a transdisciplinary environment. For new and junior faculty, team grants are the future.

For example, a principal challenge in writing a large, interdisciplinary team grant is to integrate multiple narrative contributions written by disciplinarily distinct authors into a project description that accomplishes narrative synergy and avoids silos. This is no less the case on small interdisciplinary grants. While smaller in scale, *small grant team dynamics can be as challenging as the large team dynamics on large grants.* While scholarly writing on the theory of the ideal teaming process is prevalent in the literature, in practice, it is always a much more messy process than the ideal envisions. This is so because the common and most critical challenges faced in writing an interdisciplinary team proposal center around the "*nuts and bolts*" aspects of proposal production, which involve planning, scheduling, writing, and integrating numerous drafts by multiple authors of the research narrative.

In practice, many factors impact the proposal production process and require coordination. These factors include ensuring that team member clearly understand (1) the solicitation's research objectives, (2) their role in the project, (3) their writing role, (4) the person who will perform the role of narrative integrator for each draft iteration, (5) their prior experience working in a coordinated writing environment, (6) their knowledge of how to coordinate team members' schedules and availability for participation in meetings, (7) their understanding of the time team members have to devote to the project, and (8) their ability to communicate protocols among team members for document sharing and reviews, among others.

Writing team proposals is a critical skill to be learned by new and junior faculty as well. Junior faculty must learn this skill to better prepare them for successfully competing in an environment where small, interdisciplinary team grants have become the norm. Similar to larger team grants, smaller team grants are shaped by the complexity of the scientific problem being addressed, by the disciplines required to address the problem, by the value-added benefits team research brings to solving the problem, by the capacity of the team-research approach to finding synergistic solutions

to the problem, and, often, by the capacity for developing new technologies, scientific innovation, and commercialization.

As in the case of larger team grants, small team grants are unique and more complex to plan, develop, and write than are traditional smaller grants with a narrow disciplinary focus. Successful small team grants must communicate a compelling research vision; demonstrate major **value-added benefits to the team structure**; achieve research synthesis, integration, and synergy; address multiple program components that build on the research core; offer a management plan that enables the team research vision; propose a convincing research strategic plan over the life of the project; and convince program officers and reviewers that the proposed research is transformational and not merely incremental.

As interdisciplinary team grants at all scales become the norm, more and more faculty at all academic levels, including newly hired faculty, are confronted **with new and often unfamiliar challenges to writing competitive proposals**. One of the more difficult challenges to address is always the formation of the research team. In an ideal world, a research team already exists with a history of collaborative success that is perfectly positioned to respond to a new funding solicitation the day it is posted. But now that rarely happens in the real world of research development, **as smaller interdisciplinary grants become increasingly ubiquitous**. Again, it is a "new normal" of teaming at all scales.

In the "new normal" of interdisciplinary teaming at all scales, new and unique funding opportunities often arise that present major challenges to a timely team formation. For example, there may be a possible interdisciplinary research team configuration that could compete for a funding opportunity but would represent a "new team" without a track record of significant research collaboration in the past. Moreover, many new interdisciplinary solicitations are truly unique and complex in their research objectives, and while it would be nice if a perfectly fitted team were already in place, that is increasingly less common. When it comes to teaming on smaller scale interdisciplinary grants, the strategy is becoming "**build as you go**," somewhat analogous to "just in time" manufacturing.

The end result is that, in many cases, the teaming process itself has to be "jump started" and accelerated in order to assemble a competitive team comprised of members across multiple disciplines that can be fully responsive to a solicitation by the due date. **That presents a vetting challenge to the PI of such an interdisciplinary effort who must get the right collaborators on board**. Clearly, the key to team formation is the research expertise of the team members as it maps to the research objectives of the funding agency. Too often, however, **that is the sole criterion used in bringing a new member onto a team to the exclusion of other factors that also have a major impact** on how competitive the proposal will be.

There are other important characteristics of a good team member that also need to be considered when forming a team and vetting members to respond to a specific solicitation. For example, does the potential team member have **sufficient time available to participate** in team meetings, conference calls, and proposal writing, likely

as an author of a narrative section? Does the potential team member ***show a commitment to the project*** by taking the time to read and understand the solicitation and the role of each team member in meeting the agency research goals? Does the potential team member ***understand that the goal of interdisciplinarity*** is a synergistic and not siloed team dynamic? Does the potential team member ***write well and meet narrative draft deadlines***? And does the potential team member ***communicate well*** with other team members? As much as possible, ***these questions need to be answered before a potential team member is asked to join a team***, **not answered after,** when the absence of these important characteristics is noted in the proposal development process to its detriment.

Team Grant Training for New Faculty

Research office strategies for assisting faculty with planning, developing, and writing large-team grants have traditionally supported senior faculty submitting center proposals to federal agencies, including NSF, NIH, and DOE, among others. The focus on senior faculty has made sense when you consider that large-team and center grants require a demonstrable history of research funding, successful collaborations, and a research management track record sufficient to convince program officers and reviewers to make a large-scale agency investment in the proposing PI's project. After all, one lynchpin to success in obtaining center-level research funding for large, interdisciplinary team grants is a convincing management and research performance plan for the proposed project, something new and junior faculty are not in a position to offer.

That said, new and junior faculty currently planning a research career will be entering a research environment significantly different than the one their major advisor or mentor entered years ago. For example, over the last several years, new and junior faculty have begun to compete for funding in an environment increasingly dominated by interdisciplinarity and the research team configuration required to compete successfully in that domain.

To see where this is all going, one only has to look at some of the future funding directions outlined in the the most recent federal budget requests presented to Congress by the federal research agencies (see the current [Federal R&D Budget analyses posted on the AAAS site](#)). In particular, note some of the common interdisciplinary research priorities put forward by multiple federal agencies in the areas of antimicrobials.

These initiatives, such as the ongoing Brain Initiative ([NSF](#), [NIH](#), and others), have the common characteristic of being priority research investments at multiple federal research agencies. Each agency puts its own mission imprint on the research area, but there is an overarching interdisciplinarity to the topic. For example, the kinds of research funded at NIH and NSF under the Brain Initiative may differ significantly, but the research is aligned under the common overarching research theme. Likewise, over the coming years, research funded by NSF, USDA/NIFA, DOE, and others related to the food, energy, and water nexus will take on the "flavor" of the particular agency mission but also will align under the common overarching research theme.

These examples demonstrate to new and junior faculty assisted by research offices that an interdisciplinary landscape unlike that of their research advisors will define much of the future in which they must compete. Fortunately, however, the past strategies and expertise developed by research offices for assisting senior faculty in pursuing center-level proposals is easily scalable to assisting new and junior faculty to prepare for a research future where understanding the principles and best practices of

planning, developing ,and writing interdisciplinary team grants, regardless of size, will be critical to successful funding.

Moreover, assisting junior faculty in this way has several advantages beyond preparing them to be more competitive on smaller, interdisciplinary team grants submitted in collaboration with their peers. For example, in many cases, junior faculty may be invited to participate in a large research or center-level grant led by a senior faculty member. In this scenario, junior faculty may play various roles on a large-team grant, including joining one of multiple subsets of research teams assigned a research thrust area on a large grant, offering some specialized area of expertise to a larger grant, or offering expertise in a required broader impacts component, perhaps related to the social and behavioral sciences. Moreover, it is not unheard of for a senior faculty member serving as the PI on a large center proposal to engage one or more junior faculty members in the task of drafting narrative sections of a proposal.

As stated, it is very unlikely a junior faculty member will serve as the PI on a large-team grant, but short of that role, there are numerous ways and a significant likelihood that junior faculty will play an important role in smaller team grants. These roles can include serving as the PI, or a support figure in larger-team grants. They will be prepared for these roles through team grant training by a research office or by one-on-one discussions with research office staff. This preparation will give them a competitive edge with the funder or, perhaps equally important, will identify them as a valuable team member by senior colleagues.

A good place to start in this process of preparing junior faculty for the world of interdisciplinarity and team grants is to prepare them for the core generic questions sponsor's typically ask on team grants, regardless of size or disciplinary scope. Of course, discussions of what characterizes a good team member will prove invaluable as well, since that gets to the heart of team dynamics, the essential ingredient of success.

First off, team proposals, regardless of size, require synergy not silos to be successful. The team must be able to answer such key questions in the research narrative as:

- Why are we a team?
- What synergies and benefits not otherwise possible result from our team configuration?
- What are the key team research interactions and interdependencies that will enable success?
- Does each team member understand how his or her research will be impacted and enabled by the research of other team members?

Research collaborators must convince reviewers of the significant value in the interdisciplinary team structure and of the important research interactions and synergies that will occur among the disciplinary partners that would otherwise be impossible.

When it comes to what makes for a good team member, junior faculty should emulate the following:

- Read and understand the solicitation
- Bring value-added expertise to the team
- Write well-crafted and prompt narrative contributions
- Act as an integrator— build synergy not silos
- Help the team communicate
- Help build consensus
- Help find a path forward past barriers

And finally, junior faculty should demonstrate the following characteristics:
- Earn trust of other team members
- Demonstrate the capacity to perform
- Respect team development principles
- Gain confidence of other team members
- Demonstrate reliability (e.g., meet deadlines!)
- Stay engaged
- Be well informed (e.g., reads the RFP!)
- Bring valuable expertise to the proposal
- Acts as a good communicator
- Play well with others…not looking for a free ride

Avoid the "Trust Me" Research Narrative

"Blue Sky" proposals, commonly known as "Trust Me" proposals by agency program officers and reviewers, have more in common with political stump speeches than they do with skilled grant writing. ***They are long on vision and short on facts***. By analogy, it is the difference between Israel Kamakawiwoʻole singing *Over the Rainbow* and LAPD detective Sergeant Joe Friday's famous catchphrase "*Just the facts, ma'am*" immortalized on *Dragnet* in the 1950s. ***A "trust me" proposal is essentially a vision statement run amuck***. It is a repetitive restatement that promises an idyllic outcome devoid of validating facts, rationale, and a stepwise description of **exactly how** the visionary outcome will be accomplished. It is the research equivalent of "*free beer and wide roads*," without a roadmap of how to get to this promised land. The basic request of a "trust me" proposals is "*give me the money and I will figure it out.* ***Trust me***!"

Bottom line: **The successful proposal narrative is all about balance.** It is not just a description of vision or procedure but a thoughtful balance of many key narrative components. Research narratives are guided by an overall vision, but that vision is only validated in the minds of program officers and reviewers if it is made clear **how that vision will be achieved**, including clearly stated goals and objectives, rationale, significance, possible barriers, research protocols, performance timelines—the core narrative sections that explain what you will do, how you will do it, why you will do it, and its significance and impact to the agency mission or disciplinary field.

Unfortunately, it is surprising ***how many proposal narratives are out of balance***, and how many proposals ***confuse a vision statement with a "how to" statement*** or believe a vision statement obviates the need for any further explanation of "how I will accomplish this research vision." While it is the extreme case that a proposal amounts to nothing more than a long vision statement, it is very common for proposals to be disproportionately focused on the visionary promise of greatness rather than on how the research promise will be achieved. After all, a promise to do something significant is not the same as an explanation of **how** it will be done. The successful research narrative requires both, and most often the research **vision** needs to be brief and succinct, while the **how to** needs to be more detailed and specific, while following a stepwise logic that not only clearly tells reviewers where you want to go but ***demonstrates how you will get there.***

Proposal narratives that devote too much space to what you will do and too little space to how you will do it likely will not be funded. After all, proposals recommended for funding have convinced reviewers that you not only have a vision for significant research but have a plan for achieving it, and have gained the reviewers' trust that you have the capacity to perform. That requires a well-balanced and skillfully reasoned research narrative. This is a good reason to always ask a colleague or a research office professional to read your proposal and offer comments.

Common Ways Proposals Fail

A few of the more dangerous waypoints along the proposal development road, which traverses from your Current Location to your Desired Destination (Recommended for Funding), include the following:

Navigation: **Is the roadway clearly mapped and understood?** The roadmap for a proposal is the funding solicitation and referenced documents. It can be a long and winding road to follow, and one where a navigational error caused by not explicitly following the guidelines is *a common reason a proposal never arrives at its funding destination*. Moreover, if you do run off the road or take a wrong turn caused by a too casual or careless reading of the solicitation guidelines, the process of recalculating a new route to your funding destination is not as simple as it is on Google or Apple Maps. Too often, mistakes made by misinterpreting the funding guidelines lead applicants to take a wrong turn onto the "Road to Perdition" instead of the Road to Funding. Moreover, do not assume anything when reading the program guidelines—certainty, not ambiguity, is required. Remember the old adage, "*To assume makes an ass of u and me*." Any ambiguity in the solicitation must be clarified, either by repeated readings or a call to a program officer; otherwise, the proposal is off the road and in the ditch before the journey begins.

Self-assessment: **Should you be on this road at all?** This gets to the heart of Hamlet's famous soliloquy on proposal writing: "*To submit, or not to submit--that is the question*." This should always be one of the first questions asked after reading the funding solicitation, and one answered based on a *hard-headed self-assessment of your capacity to submit a competitive proposal.* Do not assume, for example, that you are a fit for the agency, that you are competitive at the agency, that your great idea is of interest to the agency, that you can write a competitive proposal by the due date, that you have a research team in place to be fully responsive to the research objectives, that you have the support and resources to develop a proposal, etc. Competitive proposals require, in addition to a compelling idea, significant *time, thought, effort, and resources* to plan, develop, write, and submit. Make sure that you conduct a realistic "*submit or not to submit*" analysis before you start your proposal journey to make an informed decision on your competitiveness.

Narrative clarity: **Will your idea hold up under an arduous examination?** Keep in mind that the funding solicitation in many ways represents a *very scripted and probing interrogation* designed by the funding agency to *elicit your narrative answers to key questions* that will help program officers and reviewers determine your capacity to meet the research goals of the program and the value-added benefits your proposed research might contribute to the agency mission or the field. The most common reason proposals run off the road is because the research narrative withered under the very probing questions posed in the solicitation and failed to respond fully to the questions being asked or the description of the research significance required.

Keep in mind that the questions asked in a funding solicitation are not framed in a general way, but are meant to elicit very concise, convincing responses supported by specifics and details that give program officers and reviewers an in-depth and clear understanding of the value of your research and the benefits of funding it. ***The hardest transition to make in proposal development is the one that translates <u>verbal</u> discussions about the proposed research ideas into a clearly <u>written</u> narrative text***. This critical transition from the initial generalized and often elusive verbal discussion of ideas to a concrete conceptual framework for presenting the proposed ideas in the research narrative is one that ***sends many proposals careening off the road and into funding oblivion***.

Ways to Organize the Proposal Narrative

The organization of the proposal narrative (aka project description) is a key factor in determining a proposal 's competitiveness in the review process. It determines how accessible the proposed research is to reviewers, how easily it is understood, and establishes the stepwise logic used to present arguments on the importance of the proposed research. Determining the organization of the research narrative is a critical first step to making it easier to write the proposal, edit the proposal, and revise the proposal multiple times prior to submittal.

Unfortunately, *the organization of the proposal narrative often occurs as an afterthought rather than a first thought*, especially on interdisciplinary team proposals with multiple research strands. In such situations, contributing authors often begin writing research sections with little attention to the final shape of the proposal, *or without a full awareness of what co-authors are contributing to the project description*. There are few things as discouraging to those who assist faculty with the writing of proposals than to be asked to help edit or rewrite narrative text that is poorly organized and requires a major narrative renovation and re-organization to become competitive.

The organization of a proposal is determined by the solicitation guidelines specific to an agency and the funding opportunity. In some cases, the organization of the proposal narrative is highly prescriptive, and in other cases less so, but in either case, it is detailed within the solicitation. There is, therefore, no excuse for a poorly organized project description, since it requires only that the proposal authors copy and paste the required narrative organization into the first draft of the proposal and respond to what is required.

In other instances, however, the program solicitation may not contain guidelines for organizing the research, but may refer applicants to another document where these are contained. This is the case for many NSF proposals, particularly cross-cutting programs with multiple participating directorates. In these cases, the guiding document for organizing the project description is the Grant Proposal Guide (GPG), Section II, Proposal Preparation Instructions.

The project description must also contain a separate section within the narrative, labeled "Broader Impacts." NSF guidance on the order of the project description is very general: *"The Project Description should provide a clear statement of the work to be undertaken and must include the **objectives** for the period of the proposed work and expected **significance**; the relationship of this work to the **present state of knowledge in the field**, as well as to work in progress by the PI under other support. The Project Description should outline the **general plan of work**, including the broad design of activities to be undertaken, and, where appropriate, provide a clear **description of experimental methods and procedures**. Proposers should address what they want to*

do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful."

NSF does not provide specific guidance on the order of the research narrative. This can be good for the experienced grant writer and challenging for those less experienced in planning, developing, and writing a research narrative. However, while not specifically stated, the order to the proposal narrative implied in the above NSF quote is clear—the research narrative will need to address the bolded items above. For example, based on above, a project description outline might include the following basic sections: (1) Introduction/Project Overview; (2) Background, Current State of the Field & Significance of Proposed Research; (3) Goals, Objectives, Rationale, and Outcomes; (4) Plan of Work/Methodology; and (5) Broader Impacts.

While some variant of this may be sufficient for a single PI proposal, or a proposal with a single disciplinary focus, interdisciplinary team proposals with multiple research strands will require additional sections or more detailed subsections incorporated into the above sections. However, some thought needs to be put into arriving at a sequence of section headings for the project description, particularly when the governing document is the Grant Proposal Guide, because the nature of the research itself will most often suggest important section headings as well as the order in which they are listed in the research narrative.

For example, for interdisciplinary team proposals involving distinct disciplines from multiple NSF directorates, researchers will want to ask: "***What is the story I want to tell about the importance of funding this research and what is the most effective order in which to tell that story***?" The answer(s) to this question will suggest how to organize the project description. For example, one of the more challenging organizational questions to address in a team proposal is the optimum structure of the project description for addressing multiple research strands in a way that is integrative and convinces the reviewers and program officers that the proposed effort is synergistic and not siloed.

For instance, perhaps a research project has three research strands from three distinct disciplines involving co-PIs from three separate NSF directorates. It can be challenging to organize these research tasks within the narrative structure ***to best clarify for the reviewers the interdependency of the proposed research and the value-added benefits of the team configuration***. These three research tasks typically would each be addressed separately, e.g., as subsections to a major section heading of Goals, Objectives, and Outcomes, by one or more of the co-PIs or senior research personnel.

The challenge lies in coming up with an integrated narrative organization that all contributing authors agree upon before beginning the process of writing narrative text. In the above example, it may be that each of the three research subtasks is organized under some overarching goals, objectives, and outcomes that address the project's overall research vision, hypothesis (or questions), and anticipated outcomes or results. It is often the case that a narrative section addressing anticipated project outcomes will need to be very strong to make the case for funding, since it will demonstrate the value of the research to the agency.

The question that needs to be answered in this instance is whether each research task-specific subsection requires its own outcomes discussion, followed later in the narrative by a concluding major section, perhaps entitled "Expected Outcomes, Potential Pitfalls, and Significance" that clarifies, along with the required Broader Impacts section, why, in conclusion, your proposed research will provide significant value.

Also, depending on your proposed research, you would likely have to make a decision on where to include, i.e., in this section or perhaps in a section where you discuss the research plan and methodology, a discussion related to potential project pitfalls that occur when things do not go as planned. After all, it is rare indeed that a proposal is a perfect predictor of what will transpire during a multiyear performance period of a funded proposal. It is important to address these potential pitfalls and discuss workarounds in your research narrative to demonstrate to reviewers that you have thought about the proposed project in sufficient depth to give assurances that you can successfully manage the unexpected.

The take away here is that *a proposal organizational plan should be one of the first tasks accomplished once a decision is made to respond to a funding solicitation*. As noted, in some cases this is done for you within the solicitation guidelines. But in other cases, as in the case of the NSF when the GPG is the operative authority, you will have to spend sufficient time to think through, hopefully as a team of contributing authors, which organizational narrative structure makes the best sense for the proposed research. *Of course, the end goal here is to make it easy for the program officers and reviewers to read your project description and make an informed funding decision*.

Organization is Key to a Successful Proposal

For those asked to review or edit a draft proposal narrative several days prior to the due date, the most dispiriting narrative to receive is what might be called the "***Jackson Pollock Narrative***." This is a narrative produced by those who see little or ***no connection between the solicitation guidelines and the organizational structure and content of the research narrative***. Jackson Pollock, of course, was the highly influential abstract impressionist painter in the late 1940s and early 1950s made famous for his "drip style" or "action style" of painting that involved spontaneously and impulsively dripping, smearing and pouring paint onto the canvas as inspiration dictated.

The lasting value of the paintings created by Pollock and his many contemporary imitators using this "drip style" technique is best left to art historians, but anyone involved in research development and grant writing knows the "drip style" of impulsive inspiration does not work well when applied to the research narrative. The drip style narrative produces a **mess** lacking the organizational structure that allows the reader to (1) ***compare what is proposed in the narrative to what the funding agency asks applicants to address and in the order asked***, and (2) follow a linear narrative structured on a logical and stepwise presentation of the ***core generic components of a successful proposal. The welcoming proposal, by contrast***, explains, <u>specifically</u> and in <u>detail</u> (1) what you propose to do, (2) why you propose to do it, (3) <u>**how**</u> you propose to do it, (4) why it is important to do it, (5) why you have the capacity to do it, (6) how the outcomes will impact the field in important and non-incremental ways, and (7) how the outcomes will bring value-added benefits to the funding agency's mission.

By contrast, the Jackson Pollock Narrative spontaneously and impulsively drips, smears and pours words onto the page as inspiration dictates, while ignoring the many questions asked by the sponsor in the funding solicitation, or answering so few of them in such a disorganized way that the reader/reviewer cannot know exactly what is being proposed, let alone how what is proposed will be accomplished.

The Jackson Pollock Narrative avoids **specificity** as if it were a new and more deadly strain of avian influenza; omits **operational details** as if they were to subtract from inspirational, yet unsubstantiated, claims of transformational impact; provides a **tsunami of general introductory background details** as if the proposal were a textbook on the topic rather than a sales pitch; presents **ideas untethered** to the core seven questions enumerated above; and, ***overall, reads like an exercise in stream of consciousness writing.***.

How dispiriting it is to be asked to review and comment on or edit and rewrite a Jackson Pollock Narrative cannot be overstated. It literally just takes your breath away! So what to do? Well, in fairness to the author(s), honesty, tempered by subtlety, is the best policy. The authors must be told that the narrative as written will not be funded because it fails to respond to the funding solicitation, and hence will require massive renovation to make it even competitive for funding, let alone successful. You may wish

to ask the authors "*Did anyone actually read the solicitation in detail*?", or "*Why wasn't the solicitation used as a narrative template to ensure you answered every question asked in the order asked in the solicitation*?" or "*This is a complicated solicitation in a new research direction; why was no thought given to a Red Team review of the solicitation prior to writing*?" Unfortunately, time is short, and time spent on what might have been just takes time away from what still might be possible.

If you decide that the narrative might be salvaged by a total renovation, time is of the essence. Of course, this assumes the author(s) agree with your assessment that the proposal as structured and written will not be funded. Your credibility here is likely a function of your past history working with the author(s), or your general reputation as a research development professional among PIs on your campus. If you are in a research office, it can help to suggest that a second opinion be sought from a faculty member who has served as a reviewer at the funding agency, or a PI who has been funded in a related area from the same agency.

Most often, however, a very thorough verbal "walk through" of the narrative with the author(s) comparing what is required in the guidelines with what is lacking in the research narrative, ***both in content and <u>organizational structure</u>***, will be sufficient to convince the author(s) to agree to ***begin the proposal anew and set the existing narrative aside***. At a certain point, a poorly structured existing narrative becomes almost impossible to renovate because the narrative is so embedded in a failed narrative structure that it imposes too many constraints on any attempt to do a major rewrite. So, as with auto insurance, a proposal involved in a major narrative wreck is best "totaled" so that you may proceed to finding a new vehicle.

In this case, the new vehicle is a narrative template created from the funding solicitation that ***lists <u>in order</u> every goal, objective, question, etc. addressed in the guidelines***. **This is your roadmap to narrative redemption**. Next, the author(s) have to draft narrative responses to every item listed in the template, and then weave those responses together into a new narrative that responds fully to the agency guidelines. This does not guarantee funding, but it does guarantee that the reviewers will be able to clearly understand and evaluate the ideas you propose for funding and make a determination based upon that. The original, i.e., failed, proposal narrative may be used as a reference in this process, but very cautiously. Resist the temptation to copy and paste huge sections of it into the new template, which can quickly metastasize the failed logic structure into the new effort. Unfortunately, in grant writing, as in life, you sometimes just need to start over to get it right.

How to Win Your Grant on Page 1

Grants are won on page one. This is where you set the stage for the all subsequent narrative text. This is where you win over reviewers to your great idea. This is where you begin explaining not only what you will do but ___how you will do it___. By the end of page one, the reviewers will need to know *what you will do, why you will do it (rationale), how you will do it, your capacity to do it, and why it is significant and innovative in the context of the state of the field or agency mission*. Moreover, as NSF notes, page one is where you start to "*build trust in the reviewers that what you can't fit in the page limit is within your grasp.*"

That reviewer trust will rest on how well you answer the foregoing questions with clarity and specificity and detail rather than vague generalities. Generalities on page one invariably metastasize into the rest of the narrative. Reviewers are left with only two logical interpretations for generalities rather than specifics, neither good for establishing reviewer confidence in your capacity to perform—either you are sufficiently uncertain yourself about the proposed research objectives or you are woefully unable to explain them to others, in either case, it does not bode well for a funding recommendation.

If reviewers get to page two still searching for convincing answers to the foregoing questions you will be at a serious competitive disadvantage. Page one must offer reviewers clarity and not present them with an ambiguous puzzle to solve going forward in reviewing the research narrative. If fact, if you don't convincingly respond to the foregoing questions on page one, you will leave reviewers with little interest or enthusiasm for reading the rest of your narrative, and some reviewers, by all accounts, will not.

Of course, answering the foregoing questions in a convincing and compelling way is not an easy task, and, unfortunately, one done inadequately in the majority of proposals submitted, something evident in the very low success rate of grant applications where often 80% of applicants fail. If you read reviews of declined proposals, you will soon see that a common denominator of the reviewers' decision to recommend against funding is that these questions were not adequately addressed in the proposal. This is the case regardless of disciplinary area or funding agency. In most cases, the foundation of funding failure can be traced back to how well or how poorly these questions were addressed on page one of the proposal. After all, if you can't get this right on page one, there is no reason to believe you will get it right in the rest of your project narrative.

The main reason these questions are poorly answered is that they are poorly planned for during proposal development discussions among principal investigators. A lot of groundwork has to be in place to begin to answer these questions in a convincing way. A well-crafted page one of your proposal requires a lot of planning, going back to the earliest stages of proposal development. Every question that needs to be answered on page one of the proposal should be answered in a preliminary way before the writing

begins. Moreover, these questions should guide the research development discussions among the proposal team, including the key initial decision every applicant must make of whether or not a submission is warranted based on an assessment of proposal competitiveness determined in large part on how well these core questions can be answered.

Most principal investigators struggle with answering these questions clearly and concisely in the initial stages of proposal development and writing. The successful ones are persistent, going through iteration after iteration, both in team discussions that address these questions and in the narrative drafts that come out of these discussions. This is important because page one needs to be concise and succinct. It cannot be inflated in any way in hopes that if you throw a tangled mass of verbal spaghetti at the reviewers they will hopefully find something in it that they like. To quote Dr. Seuss, "***The writer who breeds more words than he needs, is making a chore for the reader who reads***."

Editing Your Proposal: Checklist for Success

Success in proposal writing is all about answering questions—questions posed in the funding solicitation, during the review process, and questions posed by team members during the planning and writing of the research project narrative. Those in research offices or elsewhere in universities asked by faculty to review a proposal prior to submission find it helpful to have a template or "*editor's checklist*" of those **key questions that are generic, fundamental, and relevant to any proposal submitted in any discipline to any federal agency or foundation**. In effect, a good proposal editor excels at "channeling" the reviewers by knowing the questions reviewers and program officers will want answered in the project narrative.

Of course disciplinary focus and the mission of the specific funding agency will influence how these overarching generic questions are answered at the level of project specific detail. But focus and mission will not alter the fundamental question(s) being asked. For example, regardless of discipline or agency, every proposal must answer, hopefully on the first page, one of the most important questions invariably posed by program officers and reviewers: *Why is the proposed research significant?*

Failure to answer this fundamental question convincingly is arguably the single most common reason a proposal is declined for funding. The details used in framing the response to this question will differ by disciplinary focus and agency, but regardless of whether the proposal is to NEH or DOD, you will want to configure your response to demonstrate that your proposal advances the mission of the funding agency and/or the disciplinary field in some important way(s). That is the core, overarching question. The details will determine whether or not this question is answered in a way that explains how your proposed research to NEH adds to our knowledge and understanding of the humanities, or how your proposal to DOD advances our understanding of how the quantum entanglement effect can double laser beam data capacity and why that is important.

The first step in reviewing a proposal requires a careful reading of the solicitation and review criteria <u>before</u> reading the actual draft of the research narrative or project description. Reading a proposal draft without first understanding the solicitation and review criteria would be somewhat like a building contractor starting to build your home without looking at the architectural drawings that give the details of what you envision as your dream home. Consider Lewis Carroll's observation in *Alice in Wonderland*: "If you don't know where you are going, any road will get you there."

This goes to one of the more common mistakes made in writing research grants and, hence, one of the more common reasons proposals are declined for funding, i.e., **the research narrative does not respond fully to the solicitation**. Therefore, make every attempt to filter your observations about a draft proposal through the lens of the solicitation, i.e., **what the agency wants**, focusing on the agency's research objectives

and the review criteria used to judge how well the proposal meets those research objectives.

Your point of view, or perspective, in critiquing a draft proposal includes both the expertise you bring to the process and the ***important requirement that you also represent the agency's point of view as you understand it from <u>a close reading of the solicitation</u>.*** Think of yourself as representing the interests of the funding agency in your critique of a draft proposal, effectively serving as a surrogate reviewer for the agency, and thereby best serving the interests of the person who asked you to critique a draft proposal. ***After all, it is the agency's research priorities, <u>not</u> the proposing researcher's, that are paramount in the decision to fund or not fund the proposal***.

If you are part of a research office, academic department, college, center, or other academic unit and asked by faculty to review and comment on proposals, it is important to ***develop your own checklist of questions*** that need to be answered in the research narrative. Some common generic review questions applicable to any proposal to any agency are listed below:

1. **Does the proposal respond fully and convincingly to the goals and objectives of the funding solicitation?**
   1.1. Is every question asked in the solicitation answered in the proposal?
      1.1.1. Does the proposal follow the order of the questions asked in the solicitation?
      1.1.2. Is it easy to compare the solicitation requirements with the requirements addressed in the project narrative?
      1.1.3. Do responses to questions provide sufficient detail, specificity, and clarity so the reader is not left confused or uncertain by vagueness, generality, or poorly supported replies?

2. **Does the proposal address all the review criteria listed in the solicitation?**
   2.1. Is it easy to compare the review criteria listed in the solicitation to ensure that they are addressed in the project narrative?

3. **After reading page one of the proposal, is it clear to you**:
   3.1. What research is being proposed
   3.2. Why the research is being proposed
   3.3. How the research will be accomplished
   3.4. Why the research is significant
      3.4.1. Why it is significant to the mission of the funding agency
      3.4.2. Why it is significant to the disciplinary field
      3.4.3. The value-added benefits the research brings to the agency
      3.4.4. The value-added benefits the research brings to the field
      3.4.5. Whether the research opens up new lines of inquiry, answers important questions that advance the field, enables other research to be conducted, etc.
      3.4.6. Is it clear where the research stands in relation to the current state of the field and how it will impact the field, i.e., in the context of the disciplinary field, is the research innovative, transformative, cutting edge, etc.?

3.4.6.1.   Are claims of research innovation convincingly supported with specifics, details, and appropriate references rather than just being asserted without support? Do the author(s) follow the "***explain don't merely claim***" axiom of grant writing?

3.4.7.   What will research success look like—what will be different as a result of this research?

3.4.7.1.   Do the proposal author(s) clearly describe the project's "***unit of change***"—what will become better and how after the proposed research is completed--in terms of its impact on the agency's mission, or the field, or both? Or does it provide broader societal benefits?

3.5. Why the proposer(s) is the right person(s) to conduct the research

3.6. What are the anticipated research outcomes?

3.7. Do the preliminary data or results from prior support convincingly demonstrate the author(s)' capacity to perform the proposed research?

3.8. Are barriers and challenges to achieving results identified and a plan for overcoming them proposed?

3.9. Is the proposed research cost effective? Is the "bang for the buck" apparent?

4. **Is the proposal well written?**

4.1. Is the narrative free of errors in grammar, spelling, usage, punctuation, typos, etc.

4.2. Is the narrative written in an organized way, for example:

4.2.1.   Starts with an important research idea stated clearly and simply so reviewers can quickly grasp the research questions or hypotheses

4.2.2.   Explains why the research is unique and supports this with sufficient specificity and detail to make a convincing case

4.2.3.   Explains the importance, significance, or value-added benefits of the research to advancing the field, or advancing the research mission of the funding agency

4.2.4.   Provides reviewers with a clear statement of the significance of the project from a precisely written project description that is supported by specificity and detail

4.2.4.1.   Uses specifics to ground the research vision and goals in the key performance details unique to the research objectives, and thereby illuminate the importance of the research for reviewers

4.2.4.2.   Uses specifics to both test and prove the value of research ideas

4.2.4.3.   States a goal and offers compelling specifics that make clear the process used to transition from a goal to reality

4.2.5.   [Note: Conversely, generalities often escape many authors' notice, yet appear as glaring flaws to readers and reviewers alike, especially those searching for the specificity needed to make an informed critical judgment on the project's merit]

4.2.6.   Avoids ambiguity, which introduces significant uncertainty into the research narrative. ***This is because ambiguity in the project description***

imposes unwanted riddles on program officers and reviewers alike. It
forces them to guess at the meaning

4.3. For collaborative and team proposals, is it clear in the project narrative
- 4.3.1.   Why a team approach is important
- 4.3.2.   Whether there is a history of collaboration among team members
  - 4.3.2.1.   Research partnership preliminary data
  - 4.3.2.2.   Funded projects/results from prior support
  - 4.3.2.3.   Publications
  - 4.3.2.4.   Patents
  - 4.3.2.5.   Prior participation in research affinity groups
- 4.3.3.   What synergies and benefits result from the team configuration not otherwise possible
- 4.3.4.   What are the key team research interactions and interdependencies that will enable success
- 4.3.5.   Does each team member understand how his or her research will be impacted and enabled by the research of other team members?
- 4.3.6.   Is the value in the interdisciplinary team structure made clear and justified?
- 4.3.7.   What important research interactions and synergies among the interdisciplinary team partners will occur not otherwise possible outside the team structure?
- 4.3.8.   Is there narrative synergy not silos?
- 4.3.9.   Is there a strong research management plan that convinces program managers and reviewers that the project will be well managed and successful?

Proposals for Basic Research: Why You Need a Theoretical Framework

When proposals for basic research are declined, a common reviewer comment is that the proposed project "lacks a theoretical framework." PIs are often puzzled by what, exactly, this means. The PI has proposed to conduct research on fundamental phenomena and address important questions in the field – what more is required? As it turns out, the ability to place your proposed research within the context of a theoretical framework is key to writing a competitive proposal to many programs within NSF, NIH and DOE that focus on basic research. This doesn't just apply to the physical sciences; many of the social and behavioral science programs at NSF are particularly focused on ensuring that programs have a theoretical framework.

(First, a caveat: this discussion is meant to address theoretical frameworks in a relatively loose sense in the context of research proposals. For more rigorous discussions of theoretical frameworks in the context of research study design in your discipline, you'll want to see literature in your field.)

What is a Theoretical Framework?

In a project with a theoretical framework, the answers to the project's research questions or hypotheses will inform a broader, and often mechanistic, understanding of how things work and why – this is your theoretical framework. Your framework should inspire your hypotheses and research questions and, in turn, be informed by the results of your research. It's perhaps easiest to explain how a theoretical framework functions by describing what happens in its absence. Here are several examples of types of projects that lack a theoretical framework.

The descriptive project: In this kind of project, the researcher typically proposes to measure or observe something without a clear hypothesis for what results they expect and why. Research questions are generally along the lines of, "What happens if we expose a cell to an acoustic field?" or "How many sharks are there along the Gulf Coast?" or "Are students from rural areas less likely to pursue careers in STEM?" or "What are the electrical properties of a gold nanoparticle with a titanium outer coating?" All of these may be legitimate questions that can lead to important research, but without a theoretical framework, the broader implications of the answers aren't clear. Generally, these kinds of projects are considered to be exploratory and aren't mature enough to be funded by basic research programs at the federal agencies. However, the answers to these questions can be part of your preliminary data and inspire hypotheses or research questions that fit into a theoretical framework.

The make-it/test-it project: In this type of project, the PI proposes to make or develop something (e.g., a machine, a sensor, an algorithm) and then test it to see how well it works or how it behaves. She may then propose to iterate on these results, returning to the make-it phase armed with the testing results. If there is no larger framework informing this process, this is often considered *development* by reviewers

rather than basic research. (In fact, this kind of process is sometimes termed "spiral development" in software development circles.) Note that this kind of project, while it may result in a good product (machine, sensor, algorithm), doesn't help to generate knowledge that can be generalized beyond that product because the PI followed what was basically a trial-and-error process and therefore didn't necessarily learn any larger lessons from the research.

Developing a model: Often, PIs will propose to model a phenomenon or process. If you do this, it's important to keep in mind that models are tools, not ends in themselves. For example, a PI might propose to develop a model of how populations perceive and respond to the risk of hurricanes. How will the model help to answer important questions about the phenomena or processes you're modeling? If you plan to validate the model (for example, by comparing model predictions with experimental or survey results), how will you handle discrepancies? What will you learn from them? And, of course, how will this model contribute to your theoretical framework? Simply developing a model should be just the first step – it needs to be informed by, and/or inform, a theoretical framework related to some basic understanding of the process or phenomenon you're modeling.

How do you develop and use a theoretical framework?

There may be established theoretical frameworks related to your research topic in the literature or it may be up to you to develop a new theoretical framework. Generally, these frameworks help to connect observations with an underlying theory of causal mechanisms and forces at work. They then can provide the basis for new hypotheses. Note that it's not required that these frameworks are already broadly accepted; your research can help to inform, disprove or support the framework, and in that way you are helping to move your discipline forward. However, you will probably need some evidence to convince your reviewers that your framework and hypotheses may be correct. This could be in the form of preliminary data if there is no existing evidence in the literature.

So, to revisit one of the example descriptive projects discussed above, a theoretical framework related to how cells respond to an acoustic field could be that the cell behavior is determined by the elastic properties of the cell, that the cell has a resonant frequency determined by the cell's radius, density, and stiffness, and that the cell will rupture at that resonant frequency if the cell deforms to the point that internal stresses cause the membrane to break, which is determined by the cell's stiffness and dimensions. Based on this theoretical framework, you might hypothesize that you can rupture your test cells using acoustic waves in a certain frequency range by choosing cells with specific properties. Your results will either support your framework or they will point to ways that you may need to modify the framework (for example, you might find that the rupture frequency depends on the cell shape in addition to its size). Whether or not your hypothesis is supported, your results will contribute to the body of knowledge. Comparing this project to the descriptive project described in the previous section (where you proposed to simply see what happens if you expose a cell to an

acoustic field), you can see that this project will have a much higher impact on the body of knowledge on this topic because it has a clear theoretical framework *even though your experiments might be essentially the same.*

Turning to the make-it/test-it project, this kind of project would be enhanced by a theoretical framework that suggests hypotheses for certain characteristics or processes that might yield a better product (sensor, machine, algorithm, etc.), with reasons for why that arise from hypotheses or knowledge about underlying mechanisms. These hypotheses can then be tested as the product is made and evaluated. As a result, even if the product does not meet the desired goals, the PI has learned important things about the underlying mechanisms and processes that will inform future attempts. If the product does meet the goals, the lessons learned will help to inform the development of other products that use similar processes or mechanisms. In either case, the state of knowledge has been advanced.

So, for example, the PI might identify stability of the sensor's nano-engineered sensing element as a key challenge to performance. She might then refer to a theoretical framework that relates stability of the sensing element to the oxidation behavior of nanoparticles in the element. She might then hypothesize that if she can process the material so that oxidation of nanoparticles is minimized, which she will do by processing at a lower temperature, the sensor will be more stable. Thus, she can try processing at a lower temperature, then checking the oxidation of the nanoparticles, evaluating the stability of the sensing element and, finally, evaluating the stability of the sensor. The results will yield important new knowledge whether or not the resulting sensor works better. (Note that in a "make-it/test-it" project, the PI might have proposed to just try processing the sensing element at various temperatures and see which works best, but without the underlying framework that posits that element stability depends on the degree of oxidation of the nanoparticles in the sensing material, her results will still only apply narrowly to this specific sensor and will not help to advance knowledge in a broader context.)

The principle is similar for modeling projects. For example, if the PI is developing a model for how populations perceive and respond to the risk of hurricanes, he needs to discuss what framework will inform the development of that model (such as current theories related to risk perception and the influence of media) or how the model will allow him to improve risk perception models (for example, if the PI's model is based on statistical data on evacuation, he might then use the model to test the hypothesis that types of media consumed is an important factor in evacuation likelihood). Simply developing a model isn't enough — the model needs to inform a broader understanding of the topic.

Lastly, be sure you understand the expectations for the particular program or funding opportunity to which you're applying. Not all projects require theoretical frameworks. For example, proposals to develop new tools or methods need to focus more on the need and the new science that will be enabled. And, of course, proposals to programs or agencies that favor more applied research may not require a theoretical framework. However, if you're proposing a basic research project, you should talk to

your Program Director and your colleagues to ensure that you understand expectations regarding the theoretical foundations you need for your project.

Writing Proposals for Highly Mathematical Projects Without Losing Your Reviewers

It's late at night, and you're a reviewer. You're taking a plane tomorrow afternoon to serve on a panel at NSF, and you still have a stack of six proposals left to review. You've been preparing your lecture for a class you have to teach in the morning before you leave for the airport, and now you turn to those proposals. At this time of night, after a full day of work, you're not at the height of your intellectual powers or your patience. You start reviewing one of the proposals, and it looks rather interesting, but when you turn to page 3, it looks like this:

$$\frac{\partial}{\partial t} \iiint_V \rho \, dV = - \oiint_S \rho \mathbf{u} \cdot d\mathbf{S}$$

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{u}) = 0$$

In the integral formulation of this equation, body forces here are represented by f_{body}, the body force per unit mass. Surface forces, such as viscous forces, are represented by $\mathbf{F}_{surf}$, the net force due to stresses on the control volume surface.

$$\frac{\partial}{\partial t} \iiint_V \rho \mathbf{u} \, dV = - \oiint_S (\rho \mathbf{u} \cdot d\mathbf{S}) \mathbf{u} - \oiint_S p \, d\mathbf{S} + \iiint_V \rho \mathbf{f}_{body} \, dV + \mathbf{F}_{surf}$$

$$\frac{D\mathbf{u}}{Dt} = \mathbf{F} - \frac{\nabla p}{\rho}$$

$$\rho \frac{Dh}{Dt} = \frac{Dp}{Dt} + \nabla \cdot (k\nabla T) + \Phi$$

This, in turn, leads to the expression based on the Taylor expansion:

$$\varphi = \varphi_b + (z+h) \left[\frac{\partial \varphi}{\partial z}\right]_{z=-h} + \frac{1}{2}(z+h)^2 \left[\frac{\partial^2 \varphi}{\partial z^2}\right]_{z=-h}$$
$$+ \frac{1}{6}(z+h)^3 \left[\frac{\partial^3 \varphi}{\partial z^3}\right]_{z=-h} + \frac{1}{24}(z+h)^4 \left[\frac{\partial^4 \varphi}{\partial z^4}\right]_{z=-h} + \cdots,$$

where $\varphi_b(x,t)$ is the velocity potential at the bed. Invoking Laplace's equation for φ, as valid for incompressible flow, gives:

$$\varphi = \left\{ \varphi_b - \frac{1}{2}(z+h)^2 \frac{\partial^2 \varphi_b}{\partial x^2} + \frac{1}{24}(z+h)^4 \frac{\partial^4 \varphi_b}{\partial x^4} + \cdots \right\}$$
$$+ \left\{ (z+h) \left[\frac{\partial \varphi}{\partial z}\right]_{z=-h} - \frac{1}{6}(z+h)^3 \frac{\partial^2}{\partial x^2} \left[\frac{\partial \varphi}{\partial z}\right]_{z=-h} + \cdots \right\}$$
$$= \left\{ \varphi_b - \frac{1}{2}(z+h)^2 \frac{\partial^2 \varphi_b}{\partial x^2} + \frac{1}{24}(z+h)^4 \frac{\partial^4 \varphi_b}{\partial x^4} + \cdots \right\},$$

since the vertical velocity $\partial \varphi / \partial z$ is zero at the – impermeable – horizontal bed $z = -h$. This series may subsequently be truncated to a finite number of terms.

$$\frac{\partial^2 \eta}{\partial t^2} - gh \frac{\partial^2 \eta}{\partial x^2} - gh \frac{\partial^2}{\partial x^2} \left(\frac{3}{2} \frac{\eta^2}{h} + \frac{1}{3} h^2 \frac{\partial^2 \eta}{\partial x^2} \right) = 0.$$

You turn the page, and there's more of the same. So, with five more proposals in the queue for the night, what are you most likely to do?

a) Laboriously go through the derivations to make sure you clearly understand what the PI is trying to say.
b) Quickly skim the equations to try to get the gist before moving on to a page that's not filled with equations.
c) Skip the equations and look in the subsequent pages for a summary of the points the PI is trying to make.
d) Close the file and go out for a beer.

Clearly, the PI's expectation is that you will choose a), and the proposal will be at a disadvantage if you don't. However, depending on exactly how tired and grumpy you are, the chances that you will indeed choose a) are probably not great. So, what is a PI who is proposing a highly mathematical research project supposed to do?

Recognize that even when your discipline and that of your reviewers is in a highly mathematical field, it is usually a bad idea to include pages of derivations in your research proposal. Just as, in an experimental field, you wouldn't present long tables of raw data, but would instead present your hypotheses, questions and conclusions along with just enough data to illustrate and support your points, you should include just enough equations to provide examples of your approach and confirmation of any conclusions or assertions you're making.

What's Your Point?

Think about the points you want to make and how you can make them without including pages of equations. Generally, in a proposal you need to communicate several things:

- What you plan to achieve
- How you will achieve it
- The current state of the art and gaps in knowledge that you will be addressing
- What you've done so far
- How your approach is different from what others are doing
- Why the outcomes of your project are significant

Even in highly mathematical projects, all of these points can be made using words instead of, or in addition to, equations. In fact, if you depend only on equations to make these points, you often run the risk that, even when they do take the time to follow the math, reviewers will not come to the same conclusions you did based on the derivations you provide. For example, if you are discussing the current state of the art, you might provide a number of derivations from the literature, but if you don't describe in words the gaps or limitations that are motivating your proposed research, your reviewer may not identify those gaps based just on the equations.

Describing Prior Work

PIs often resort to long derivations when they are presenting preliminary results or prior work. Again, you're usually much better off if you describe the main points in words in the text along with just enough equations to support your point or provide key specifics. In the case of preliminary results, how are they relevant to your proposed project?

- Do they illustrate that your proposed approach is viable?
- Do they provide intriguing results that motivate your proposed project?
- Do they show that you have the skills to successfully accomplish what you're proposing?

Make those points in words, including specifics. One helpful approach is to imagine you're sitting next to the reviewer going through the equations and explaining their significance. What would you say? Try putting those words in your text and then see if you can provide just the key steps in the derivation or key equations along with your explanation.

Describing Your Approach or Methodology

When describing your proposed approach, try describing your general methodology and then stepping through the project plan verbally. What will you need to derive or model first? If you're developing a model, describe what the inputs and outputs will be and the phenomena or processes that will be taken into account in the model. Can you give an example of a specific scenario that would be modeled?

It's especially important to point out **specific challenges** or **research questions** you'll need to address in order to successfully achieve your goals. For example, perhaps there are discontinuities at various scales that you'll need to bridge. Describe verbally the approaches you will use to bridge them. Perhaps you'll need to make some approximations in order to keep the calculations manageable. What are the risks and questions associated with making those approximations, and how will you investigate them? Perhaps there are certain parameters that will be difficult to quantify, and you will need to employ some innovative strategies to approximate them. These kinds of points are best made using words along with strategically placed equations. You may also cite your publications or that of others for reviewers who are want more details about a particular derivation.

All this is not to say that it's OK to be vague. Statements such as, "We will develop a theoretical framework to better understand X[broad phenomenon]" will just frustrate your reviewer unless you follow that statement with specifics. Below is an example of a highly mathematical approach described verbally, but specifically, without the use of lots of equations *(many thanks to Dr. Oleg Komogortsev for generously sharing excerpts from his successful CAREER proposal, submitted in 2012)*:

To carefully model OPC distributions, a "dual approach" by Mood & Graybill [106] and Box & Tiao [107] will be used. In the dual approach, Bayesian posterior information is used to suggest functions of the data for use as population-based estimators. Prior distributions play an important role in Bayesian statistical modeling [108]. An "informative priors" approach will be

used due to the complexity of the model being investigated in combination with small-to-moderate sample sizes. Specifically, in the case where sample size is small and models are complex, the informative priors approach provides a mechanism for achieving greater accuracy [108-110] in posterior summary estimates of parameters as opposed to using a diffuse, strictly non-informative approach (i.e., objective priors distributed uniformly over the distribution of a parameter). Assigning priors during model formulation will provide an analytical updating engine for the Markov chain Monte Carlo (MCMC) estimation process (e.g., the Gibbs sampler also known as an "alternating conditional sampler", Gelman, *et al*., [111], p. 287). As an example, 9 semi-conjugate priors for *OPC* parameters (e.g. means) in the existing formulation and covariance ξ ~ inverse-Wishart or, for example, negative binomial are able to be modeled as approximately multivariate normal (~N 0, 4) or negative binomial. The values of 0 and 4 may be selected based on the distributional properties of the multivariate normal time series model [107, 112]. As a result, a confidence value will be returned when matching two biometric templates and will be indicative of confidence in liveness (on the scale specified by NIST standard [44]) and statistical likelihood of the templates being from the same person.

Reading this excerpt, it's clear that mathematical content hasn't been "dumbed down." Instead, the motivation, challenges, and advantages of specific methods and approaches are explicitly explained. This verbal explanation actually contains much more information and a much clearer explanation of what he will do, and why, than two pages of equations would.

So when you're writing your research proposal, if you find yourself tempted to include a page of equations, consider: What point are you trying to make? What does the reviewer need to understand about this derivation? Try stating those points in words, along with a few strategically chosen equations, and not only is your reviewer more likely to read your entire proposal, he or she is more likely to understand the information you're trying to communicate.

Make Your Funding Case with Value-Added Benefits

How well you describe the value-added benefits and impacts of your proposed research to the mission of the funding agency and/or the research field will be a principal factor in the decision to fund or not fund your proposal. Regardless of whether your proposed research is basic or applied, or to which federal research agency you submit your proposal, your funding fate will be determined by ***how well you make a compelling and convincing case for the value-added benefits of your research***.

Sometimes research agencies are very explicit in characterizing the meaning of "value-added benefits," while in other cases their importance will be addressed more generally in the review criteria. In still other cases, the importance of addressing value-added benefits in the research narrative will be implicit in the mission of the agency itself, e.g., from reports, strategic plans, workshops, funding patterns, etc.

In all cases, a competitive research narrative needs to present a thoughtful, convincing, and informed case for the value-added benefits of the proposed research. ***There are typically four overarching backdrops or domains to which you will map the value-added benefits description in your research narrative: (1) agency mission, (2) research context/state of the field, (3) research synergies, and (4) broader impacts/dissemination, the latter meant in the generic sense and not necessarily in the NSF "broader impacts" specific sense***.

Moreover, mapping your value-added benefits description to one or more of these core domains is not a trivial task, although it need not be an onerous one if you have a thoughtful strategy for organizing your key arguments. Too often, however, ***proposals are declined for funding as the result of failing to address the value-added benefits requirement at all, i.e., <u>it is simply overlooked</u>***, regardless of whether that requirement was explicit or implicit in the solicitation. In other cases, the value-added benefits discussion in a declined proposal were inadequately addressed, ***most commonly by overly general narrative claims unsupported by sufficiently convincing details and specifics***. This is a common error in grant writing overall-- ***making generalized claims without convincing validation grounded in specificity***.

Excessive narrative generalizations lacking specifics are a tell-tale sign that the author(s) has not done the hard work of conceptualizing the proposed research in the ***core value-added/impacts contexts*** defined above, or is unable to do so. Either way, absent a credible and convincing value-added benefits description in the narrative, program officers and reviewers will find little reason to fund the research.

The four components above ***form a narrative platform or structure for your value-added benefits descriptions in your research narrative*** and each requires a thoughtful and informed response to be compelling and convincing to program officers and reviewers.

For example, at mission agencies, the value-added benefits of your proposed research to the agency's mission are ***paramount in the funding decision***. Unfortunately, many proposal authors fail to become ***sufficiently informed about the agency mission***. And it stands to reason that t will be impossible to make a convincing case for the value and impact of your research ***if first you do not clearly understand the agency's mission-critical research priorities to which your proposed research must map***. To belabor the point, since it is an important one to funding success, if you don't understand the mission of the funding agency, ***how can you possibly indicate how your proposed research advances that mission***?

This is a surprisingly common oversight, given the simplicity of resolving it, i.e., take the time to read through the solicitation and the review criteria carefully to understand the reasons the agency is funding the proposed work and what motivates the solicitation itself. In addition, review any referenced documents, reports, technical workshops, agency or program area strategic plans, etc., noted in the solicitation and seen by the agency as important influences on why the research is being funded and further elaborating on its importance to the agency mission.

Agencies reference documents in solicitations for a reason—they want you to knowledgably propose research that will advance their mission in some important way(s) and ***not waste your time or theirs on writing and reviewing proposals that have no significant relevance to the agency mission***. For example, those submitting a preliminary proposal October 23 for an NSF ERC, at least those who will be competitive, will likely be well versed in the Engineering Grand Challenges promulgated by the National Academy of Engineering, along with other references in the solicitation.

At both mission agencies and basic research agencies, the value-added benefits of your proposed research will often have to be described in the ***research context/state of the field***, i.e., your proposed research must advance, impact, or transform the research field in some significant way. Similar to understanding an agency's mission in order to make claims about how your research brings value-added benefits to that mission, in this case you must be sufficiently knowledgeable about the research context/state of the field in order to make credible claims about how your proposed research advances the field in some important ways.

A common requirement in research solicitations will state that ***the agency will only be funding research that is novel, innovative, and transformative***. Implicit in this statement is the requirement that the author(s) of the research narrative do more than merely echo, without detailed elaboration, the agency language about proposing novel, innovative, and transformative research. Making unsubstantiated claims for the novelty of the proposed research is a common failing of declined proposals. Think of program officers and reviewers as all being from Missouri—the Show Me State, or the elderly lady in the Wendy's commercial that asks "**Where's the beef!?**" ***Merely claiming your research to be novel does not make it so***. You must demonstrate why the proposed research is novel in a credible way, ***including appropriate references to the literature***. Here again, you cannot make a credible claim that your proposed research is novel and

at the frontiers of your field, as NSF likes to describe it, without knowing the state of that frontier and the context in which your proposed research fits.

In other cases, the value-added benefits of your proposed research lie in the *research synergies* created. Success in research funding is all about being able to convincingly describe the research synergies that will occur if your research is funded. Moreover, keep in mind when writing your description of the *value-added benefits derived from project synergies,* that *research synergies occur at various scales*. For example, first and foremost, particularly on interdisciplinary research and team proposals, you must clearly describe the project's core synergies that come about from multiple research strands that, in aggregate, comprise your overall research goals and objectives. Of course the common flaw in unfunded proposals is that the research strands are siloed rather than integrated in a way that promotes the value-added benefits of synergy. At the next scale, you may describe how these research synergies impact the agency mission, the field, and possibly other fields. *Convincing descriptions of research synergies at multiple scales make for a very compelling research narrative and one likely to be funded*.

Lastly, the value-added *benefits that accrue from your description of the broader impacts of your proposed research cast a very broad net* that goes well beyond the direct benefits to the agency, the field, and the research synergies, and encompasses such domains as STEM education, societal benefits, training and innovation, among many others that you will argue are specific to your proposed research.

Thinking about the value-added benefits of your proposed research in a structured, well organized, specific, and detailed way when writing the research narrative will go a long way towards ensuring you funding success.

The Importance of Clarity in the Research Narrative

It is open to debate whether or not Julian Barnes's observation in his 1984 novel *Flaubert's Perrot* was actually meant as guidance in writing the research narrative. But on its face, his noting that "*Mystification is simple; clarity is the hardest thing of all*," is excellent grant-writing advice, regardless of the author's original intent. The wisdom of this observation will be clear to those who review proposals, either for funding agencies or for research colleagues.

Unfortunately, for anyone who has read, reviewed, or critiqued a considerable number of research narratives, either pre- or post-submission, "*mystification*" is a common response, often winning hands down over *clarity*. As William Raub, Former Deputy Director, NIH, noted "*There is no grantsmanship that will turn a bad idea into a good one, but there are many ways to disguise a good one*." While there is a long list of possible ways to disguise a good idea, when it comes to grant writing, a lack of clarity, particularly organizational clarity, will be seen as a capital offense, in this case punishable by a mandatory sentence of "*Do Not Fund*!".

As Barnes noted, "*mystification is simple…clarity is hard*." This explains a lot about the state of many research narratives, not just in initial drafts but often, unfortunately, in the final submitted narrative. *No special skills are needed to write a bad proposal—anyone can do it, and many do*. As NEH chairman Bruce Cole (2001-2009) noted in a 2002 issue of the journal, *Humanities*, "*Writing is thinking. To write well is to think clearly. That's why it's so hard*."

These are important points to keep in mind for anyone assisting faculty in the planning, developing, and writing of a proposal. It is especially important in the current environment where funding agency budgets have often flat lined while the number of research grant applicants has surged. As "state-assisted" institutional budgets have declined, or institutions plan for increasing research expenditures as measured against peer rankings, we can expect this environment to intensify. Moreover, many funding agencies now describe and characterize fundable research using superlatives on steroids—transformational, cutting edge, novel, paradigm shifting, etc., *tempting researchers to cloak their work in the same superlatives*.

In fact, common advice to faculty in grant-writing workshops and similar forums is that "*agencies fund compelling research, not merely good research*," or agencies fund "*exciting science, not just good science*." While that is true, it is also a bit of a red herring. The distraction here is that too often this is interpreted to mean that a magical "witch's potion" can be applied to an otherwise lackluster research narrative in the days prior to submission that will transform it into a winning proposal. NOT!

The best advice is to realize that no grant writing legerdemain or slight-of-hand or waving of a magic wand can transform an unfundable narrative into a fundable one. Invariably, when an attempt is made to transform (pick your synonym) an uninspired,

unimaginative, dull, bland, prosaic, dreary, or tedious research narrative into a compelling or exciting one, the tools of resuscitation tend to be a liberal sprinkling of hyper-adjectives and superlatives, *as if merely claiming research novelty is sufficient to make it so*. NOT!

 However the solution to this conundrum is simple: narrative clarity. Ultimately, whether or not the proposed research represents a compelling and exciting project is up to the reviewers to decide. The most important narrative characteristic required for reviewers to make this decision is a clearly written and well organized research narrative. *Value clarity above all else in the research narrative and take your chances*. It may well be that clarity reveals to the reviewers why your research idea is not a fundable one. On the other hand, a poorly written and poorly organized proposal may be disguising a fundable idea. Of course, the worst thing to do is to clutter the research narrative with unsubstantiated claims of research exceptionalism while self-anointing the proposed research with laudatory adjectives and superlatives that infest the narrative like a cloud of annoying mosquitoes.

 The most important thing about clarity in the research narrative is to *plan for it <u>before</u> you begin to write, <u>not after</u> you have written the first full draft of the proposal*. Attempting to bring clarity to a proposal by a major rewrite is an arduous and painful task, even to the most skilled editor or grant writer. *The first step in planning the research narrative is a plan for organizational clarity*. Organizational clarity is the cornerstone of narrative clarity. If you don't get this right from the get go, all subsequent narrative planning is for naught. In most cases, the funding solicitation itself will serve as the organizational template for writing the research narrative. This will ensure that you answer every question asked by the funder *in the order asked*. It is not unusual for larger solicitations to require the applicant to answer upwards of 50 or more questions relating to the proposed project.

 Also, keep in mind that *reviewers do comment on narrative clarity and organization*. Well written and well organized proposals are often acknowledged by reviewers, whereas poorly written and poorly organized proposals are not only noted by reviewers but elaborated upon in other ways that doom them to failure. *The most damning inference reviewers can make is to assume that a poorly written and poorly organized proposal is a tell-tale sign of problems that would likely occur with the research itself were the project to be funded*.

 If a proposal is written and organized in a way that makes it difficult to follow, *reviewers will see that as a reflection of the applicant's difficulty in articulating and implementing the research project itself*. Errors in grammar, spelling, and usage, for example, will leave reviewers to wonder whether these sloppy errors will migrate into the proposed research, i.e., *inattention to perfection in the research narrative strongly suggests that the applicant may be inattentive to perfection in performing the proposed research*.

Don't Bury the Lede: Get to the Point Quickly

The most commonly given sage advice in journalism is "***Don't bury the lede***." It is excellent advice for those involved in the planning, development, and writing of grants as well. In journalism, the meaning of this phase is simple: ***put the most important facts first in your story***. The most important fact in a newspaper article is the lead. In an abbreviated form, the lead may serve as the headline for the story as well, making it a more compelling read, much like Vincent A. Musetto's immortalized headline in the *New York Post* of April 15, 1983: "***Headless Body in Topless Bar***," a story about another horrific crime in New York City at a time, unlike today, when crime there was rampant.

In journalism, the lead answers the ***key generic questions of "who, what, where, when, why and how***." It is followed by other details important to the story, and finally concludes with general information or background, sometimes referred to as a "kicker." In journalism, this narrative structure is called the "***inverted pyramid***." The inverted pyramid serves as a journalistic template, much like the solicitation functions as the grant writer's narrative template, designed to prioritize information and provide an organizational structure to the news story, or, in grant writing, to organize the research narrative.

The inverted pyramid structure plays another important role as well, in a way particularly relevant to grant writing, in that the ***reader gets all the important information in the first paragraph***, and all subsequent paragraphs further elaborate upon the lead paragraph with additional detail and specifics. Again, excellent advice to the grant writer. In this case, to "***bury the lead***" means to begin a news story with general background information without a "***compelling hook***" to induce the reader to read further in the story. This the reader is left to skim down through subsequent paragraphs to find the point of the story.

Of course, a few morning newspaper readers, perhaps powered by caffeine, may be willing to indulge the writer and patiently wait to get to the point of the story after a few paragraphs. But ***reviewers of a 15- to 40-page research proposal definitely will not be so indulgent of a buried lead***. Too often, however, authors of a proposal's research narrative invert the journalist's inverted pyramid, orienting it "right side up," forcing the reviewer to first read lengthy general background information that does nothing to make quickly clear to the reviewers what the proposer actually proposes to do and why it is important and deserving of funding.

Journalists write mostly about what ***others have already done <u>in the past</u>***, or perhaps speculate, albeit with little certainty, about what others might possibly do in the future. The authors of a research narrative, however, must write about ***what they will do of importance <u>in the future</u>*** with convincing certainty supported by specificity and detail, often given credibility by what they have done in the past, i.e., preliminary data. Journalists write about the past; grant writers write about the future. Moreover, the lead of every story written by a journalist is unique. For the grant writer, the lead is

always the same in every proposal: ***the significance of the goals and objectives of the proposed research***.

Finally, like journalists, grant writers tell a story, too, and it must be a compelling one stated clearly if you are to have any chance of funding. Grant writers also have their own very similar version of the journalist's ***key generic questions of "who, what, where, when, why and how" that must be answered in the lead paragraph to "hook the reader," i.e., "what research do you propose to do, why do you propose to do it, why is it significant to the field or agency mission, why are you the person to do it, how will you do it, what is your research rationale, do you have preliminary results or results from prior support that help validate your capacity to perform?"***

So, don't bury the lead, or your proposal may end up buried in the declined for funding pile.

Proposal Writing Tips for Non-Native English Speakers

Proposals often require specialized language, providing a special challenge for non-native English speakers even though they may be very proficient in English. Because grammatical errors and awkward phrasing can distract reviewers from the content of the proposal, PIs should make every effort to avoid these mistakes. Below are a few mistakes that are commonly made by PIs whose native language is not English.

Use of the articles "the" and "a"

Because many Slavic and Asian languages don't use articles, native speakers of those languages often struggle to understand when to use articles in their proposals. The rules for when to use articles in English are admittedly convoluted, and most native English speakers couldn't explain them if asked – they just know what "sounds" right – so it's understandable that non-native speakers would find this confusing. However, incorrect use of articles can not only distract the reader, it can actually change the meaning of your sentence. So if you're writing a proposal it's worth the effort to get this right. Here are a few tips that may help:

- Use "the" when you're referring to a specific noun. For example, if you have been describing how you will prepare a specimen, you might then describe the next step as "We will then test <u>the</u> specimen to determine…" because you are referring to that specific specimen (the one whose preparation you just described). Similarly, if you have been describing a 700 MHz nuclear magnetic resonance (NMR) spectrometer that is available to you on your campus, you would then say, "we will use <u>the</u> NMR spectrometer to analyze…"

- Use "a" when you're referring to one of a general category. So, considering the example above, if you had been describing how you will prepare a number of specimens, and the next step is to test one of those specimens (and it doesn't matter which one), you would say, "we will then test <u>a</u> specimen to determine…" Similarly, if you have not been discussing a specific spectrometer but want to convey that you will be analyzing a specimen using spectroscopy, you would "we will use <u>a</u> spectrometer to analyze."

- Note that for all of the examples above, we did use an article (either "the" or "a") since we were referring to a singular noun (either one specimen or one spectrometer). A common mistake is to omit the article altogether, as in "we will test specimen," which is grammatically incorrect and distracting to the reader. It also omits the information carried by the article (whether you're referring to a specific specimen or a general specimen that is one of a category), which may in some cases be important to understanding your procedure.

- You can instead use the plural form of the noun without an article, if appropriate to your meaning. So, you might say "after preparation, we will then test

specimens to determine…" if you will test multiple specimens. You may also say, "after preparation, we will test <u>the</u> specimens to determine…" if you want to emphasize that you will test those specific specimens. Because some languages don't modify nouns to indicate the plural form, some PIs neglect to do this in English. This can add another layer of confusion for the reader, who may struggle when encountering "we will test specimen," trying to understand if the writer meant to make the term plural, or meant for it to be singular but neglected to include an article.

- Mercifully, there is one case where article use is clear. **When you're referring to the PI of the project, you should almost always use "the"**. A common mistake is to say something like, "PI will oversee …" To avoid making this mistake, do a global search of your draft, and everywhere you see "PI" put a "the" in front of it. If you do this, you'll be correct 99% of the time.

Avoid other common mistakes

Some of the usages listed below are grammatically incorrect, while others are just awkward or wordy. In either case, in the interest of clarity you'll want to avoid these common mistakes:

- **British English usage**. PIs who learned British English rather than American English often use "Britishisms" such as "researches" rather than "research," "learnt" rather than "learned," and "whence." While this type of usage is not incorrect, it can be distracting to an American audience and is best avoided.
- **Overuse of the "ing" verb form.** Non-native English speakers tend to overuse the "ing" form in their writing, as in "we will use the xyz test method for revealing.." Whenever you find yourself using the "for *verb*-ing" construction, consider instead using the infinitive ("to *verb*") form, as in "we will use the xyz test method to reveal…" Similarly, instead of saying "Our objective is mapping…" it is better to say, "Our objective is to map..." and instead of writing "This method will allow overcoming…" you should write "This method will allow us to overcome…"
- **Using the wrong homonym.** Some words commonly used in proposals that sound the same but have different spellings are "complement" (meaning "add to") rather than "compliment" (meaning "say something nice") and the always-confusing "affect" (verb) and "effect" (either a noun or a verb meaning "implement").
- **Misplaced plural.** If you have a compound noun such as "cell array library" or "nanoparticle property" remember that to make it plural, put the "s" on the noun not the modifiers. So the plural of the terms above would be "cell array libraries," not "cell arrays library" and "nanoparticle properties" not "nanoparticles property." If you place the plural on the modifier, that changes your meaning.
- **Overuse of "both."** While not incorrect, this can contribute to wordiness. So, for example, a PI may say, "We will conduct both mechanical testing and chemical

analysis." Unless it's important to emphasize that you will do both things rather than just one or the other, it's more concise to eliminate the "both" and just say "We will conduct mechanical testing and chemical analysis."

- **Avoiding the possessive form.** Non-native English speakers tend to use "of" rather than the possessive form, which can result in less direct and more wordy sentences. Instead of writing "The potential of the sensor to...," consider saying "The sensor's potential to ..."

- **Overuse of "as well as."** When writing lists, many writers tend tack "as well as" onto the last item. This usage is appropriate when the last item doesn't necessarily fit with the rest of the list, but if that's not the case, it just contributes to wordiness. So, instead of saying, "We will conduct mechanical and chemical, as well as physical testing of the specimens," consider saying "We will conduct mechanical, chemical and physical testing of the specimens."

- **Informal usage.** It's best to avoid informal constructions such as omitting "of" in sentences, such as "All the specimens will be tested." Since proposals are generally conceptually complex, it's best to be as clear as possible and instead write, "All of the specimens will be tested" even though that construction requires an extra word. Similarly, wording such as "nowadays" is too informal for most research proposals; you should instead use more formal terms such as "currently," or "to date."

- **Use of "notice" when you mean "note."** "Notice" implies someone observes something that may or may not be important, whereas "note" means you are directing the reader's attention to an important point. However, before changing that "notice" to "note," consider whether you need it at all. It's more concise to omit the "Note that.." altogether and just make your point. In addition, the shorter sentence is often stronger.

- **Use of "such as" when you mean "including."** Remember that "such as" is a weak term. So, for example, if you say " We will test the unmanned vehicle in conditions such as high winds, rain, and hilly terrain" that means you will test the vehicles in various conditions, which may or may not include high winds, rain and hilly terrain. This implies you're somewhat unsure about exactly what kinds of testing conditions you will use, and being vague is never a good idea in proposals. If instead you write, " We will test the unmanned vehicle in conditions including high winds, rain, and hill terrain," that communicates to the reviewer that you will definitely test under those conditions and may also test under additional conditions. This is a much stronger statement.

- **Indirect statements.** PIs often use indirect statements that are more appropriate for journal articles, such as "It would be interesting to..." or "It is important to understand..." These statements communicate tentativeness. Remember that a proposal should communicate what you will do, and the more definite you are about your plans, the more confidence your reviewers will have that they understand what you plan to do. So consider replacing those phrases

with "We will…" (If you're not sure if you will do those tasks, describe the factors that will affect your decision.)

As you review your proposal draft, try to eliminate these usage problems. As a result, your proposal will be more clear and concise, and easier to follow, which will likely make it more competitive.

Too Much "Why" and Not Enough "How"

Put yourself in the place of a reviewer. You've already read three proposals. It's getting late, and you're getting just a little grumpy, and you start reading a proposal that starts this way:

> "The world is in urgent need of an invisibility cloak. If the US had an invisibility cloak, we would enjoy unquestioned military superiority. Without an invisibility cloak, we have numerous problems, such as being shot at. In the last 200 years, over 400,00 people have been shot at and killed because they didn't have invisibility cloaks. In Afghanistan alone, if our military had access to an invisibility cloak, it would have saved 30,000 lives."

… and it goes on like that for two pages. You read on to the Background/State of the Art section, and it reads:

> "In the past, people have tried being invisible by using camouflage, but that has not been very effective [6–8]. Maneuvering at night is also a strategy that has been tried, with mixed results [9-12]…etc."

and the PI continues to describe all the ways that people have tried to make themselves hard to see. As a (somewhat grumpy) reviewer, what are you thinking? Probably something along the lines of, "*Of course* it would be nice to have an invisibility cloak – I'm not an idiot – but **how are you going to do that?**" If the PI doesn't get around to explaining how he's going to make that invisibility cloak until page 5, he has lost the reviewer by then. Worse yet, the PI may only provide a relatively vague plan for how he will accomplish this goal and continue to focus on all the wonderful benefits of the expected outcome of the project.

This is an extreme example, but it is emblematic of a mistake that PIs often make. If they're proposing to develop a new technology that will result in more efficient solar cells, they spend the first few pages discussing the importance of energy independence and improving the efficiency of solar cells. If they are proposing a new instructional strategy to improve undergraduate physics education, they spend the first few pages talking about how important it is to improve students' understanding of physics. Generally, the importance of these goals is self-evident; the question is *how* are they going to accomplish those laudable goals, but that explanation is buried deep in the proposal.

In cases such as these, it's sufficient to include one or two brief statements (ideally with statistics or hard facts) that make the case for the importance of your ultimate goal, and then move on to describing *how* you'll accomplish that goal, what's different or innovative about your approach, and why you're likely to be successful when others have not been.

Understand Your Reviewer

Sometimes you really do need to convince the reviewer that your project goal is worth pursuing. In those cases, you should devote considerable effort to convincing the reviewer that, for example, it really is important to develop a better way to read fingerprints. But if the benefits of your ultimate goal are likely to be obvious to the reviewer, it's a waste of valuable space to belabor the obvious. This highlights the importance of understanding the likely backgrounds and knowledge of your reviewers. To take the previous example, if your reviewer will probably be a law enforcement expert with considerable background in the vagaries of reading fingerprints, it may be obvious to her why we need a better way to read fingerprints. On the other hand, if your reviewer will be a computer scientist who specializes in image analysis and has no background in fingerprints, you may need to make the case that this research is worth pursuing.

Effectively Communicating Impact and Significance

This is not to say that you don't need to communicate the impact and significance of your proposed research. However, that's usually best accomplished by connecting your particular research objectives and outcomes to the overall goal we've been discussing. So, for example, if you're proposing to conduct research to improve the efficiency of a photovoltaic cell, rather than spending a page discussing the importance of energy independence and improving solar technology, quickly move from one or two sentences making those points to explicitly describing how much improvement in efficiency you expect to attain if your project is successful and how that efficiency improvement would impact solar energy technology and our energy independence, with specific numbers and statistics.

Many researchers are by nature cautious and may be reluctant to make specific claims about the expected outcomes and impact of their project. As a result, they hedge their bets by using vague or tepid terms. For example, PIs often say that their research will "improve" performance, efficiency, etc. of a system, material, or method without ever stating by how much. For example, if your research is expected to improve efficiency of a photovoltaic cell, will it be a 50% improvement? A 5% improvement? A 0.0002% improvement? How will this improvement help to achieve the stated goal of improving the performance of solar technology? The reviewer is just left to wonder. As a result, the PI has stated a broadly laudable goal but then failed to convincingly connect the proposed project and its outcomes to that goal. No amount of exposition on the importance of the broad goal will convince the reviewer to fund the project because the PI is not answering the central question in the reviewer's mind: How are you going to achieve that goal?

Clearly, you don't want to make outlandish claims that invite the reviewers to question your honesty or competence, but you need to make the case that, if your project is successful, the payoff will be worth the $500K or whatever amount of taxpayer dollars you're requesting. To make that case, you may need to include calculations, refer to preliminary data, or in other ways rigorously justify the potential

impact of your research. Use your limited space to do this rather than expound on the broadly understood benefits of reducing our dependence on foreign oil.

Placing Your Project in the Context of the State of the Art

Similarly, when you describe the current state of the art, it's important to focus on what others have done to address your particular research questions or problem rather than continuing to focus on motivation. In other words, if you're proposing to develop an invisibility cloak, don't discuss all the ways that people have tried to make themselves hard to see. Instead talk about other researchers' efforts to make invisibility cloaks and previous work to address particular research questions that must be answered in order to make an invisibility cloak. One NSF reviewer described this section, not as a "Literature Review" or "State of the Art" section, but as a "What the Literature Brings to this Project" section.

To do this, you must identify the key research questions or critical problems that your proposed research will address. If a key problem in making an invisibility cloak is incorporating Pixie dust in the fibers so that all the particles are facing with the magic side out, then you would discuss at length what others have done related to incorporating dust in textiles and orienting dust particles, what is not known, and what you will build on from that previous work. If the key problem is that the Pixie dust won't stay in the cloak but instead falls out, you'd discuss what others have done to adhere dust to textiles.

A basic rule of thumb when writing these sections of your proposal is to put yourself in the place of the reviewer and think, "If I were reading this, what questions would I want answered?" Often, those questions are more focused on the "how" of your project rather than the "why."