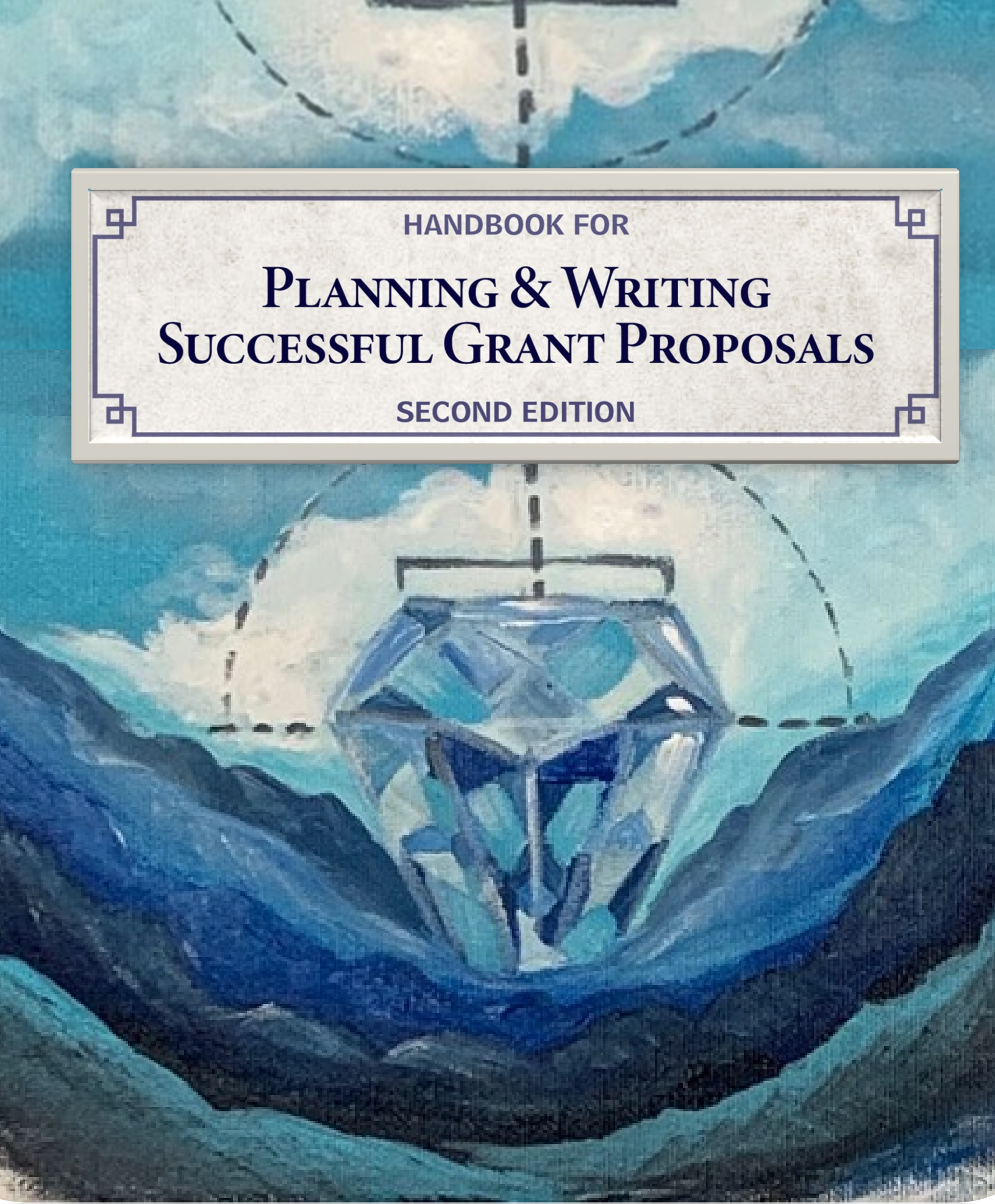

HANDBOOK FOR

PLANNING & WRITING SUCCESSFUL GRANT PROPOSALS

SECOND EDITION

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Zakyia S. Watkins
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Second Edition

Note for STEM applicants: You will find a focus on the NIH and the NSF specifics in this book because those are the two biggest funders I encounter when working with faculty on their proposals. That said, most of the book is couched as general advice, based on my experience with, yes, the NIH & NSF, but also with USDA, DOE, IES, USAID, and foundations, among others.

Note for Social and behavioral science applicants: I hope the general advice is useful, and you will also find specific information for applications you might write. Where the examples are seem to focused on hard science, please look for underlying structures.

Note for Humanities and Arts applicants: Where possible, I have tried to add information on elements specific for writing proposals for the kind of work you do. Where I have not, please try to read beyond the science and do what you do best: a meta-analysis of the underlying structures. Apply both the specifics and the general to your proposals.

I have tried very much to give the why under the how, and hope anyone reading finds this book useful.

Introduction

In NASA's 2017 Guidebook for Proposers, it states:

> "Experience has consistently shown that the characteristics of successful proposals are that they are technically meritorious, logical, complete, convincing, easily read, affordable, and responsive to the advertised NASA program…"[1]

In one sentence, they define what you need for good grant-writing skills, regardless of the proposal type or target funding agency. To unpack the sentence in the opposite direction, a successful proposal must:

- Be responsive to the priorities of the potential funder

This is first and foremost.

- Have a budget within the funding range of the potential funder, and one that matches the proposed activities

I think of the grant you receive as a box bounded by money and time. Would your proposed project fit in the box of available funds and duration of the grant?

- Be written and organized so that the information is easy to read and easy to find

Grantsmanship is often defined as the packaging and presentation of the idea.

- Present a clear argument, based on facts

Grant proposals are sales documents, but you are selling a solid idea with a firm foundation.

- Include all required parts of the proposal

Follow the directions. Follow the directions. Find more directions and follow those.

- Show demonstrable logic between what has been done, what needs to be done, and how you plan to provide solutions

[1] National Aeronautics and Space Administration. (2017). Guidebook for Proposers responding to NRAs and CANs. Retrieved September 13, 2021, from https://www.hq.nasa.gov/office/procurement/nraguidebook/proposer2017.pdf. The list is in the 2021 Guidebook, but the "Experience has consistently shown…" has been edited out.

You may know you have a logical foundation, but you must show those connections to the reviewers in a clear way. Show your thought process.

- Demonstrate that the approach(es) proposed have a sound technical basis and address an important problem

The best way to show that you have a sound technical basis is to describe it clearly, showing proof of feasibility and the underlying rigor.

It doesn't matter how good your research plan is, however, if you don't solve the first bullet: the problem must be seen as important to your potential funder.

All the concepts interrelate.[2]

The writing and organization of a grant proposal should reflect the logic of the project. In the chapters to follow, we will pull apart the components of a grant proposal and talk about the purpose of each part of the proposal, what you need to accomplish in that component, and very concrete tips for how to accomplish it. You will find

- suggested rubrics for specific paragraphs within the proposal
- outlines for key areas
- suggested approaches to wording
- links to other material

There is no one way to write a successful proposal, but my goal in this book is to provide you with some concrete skills and approaches to find the way that works for you.

There are many good books on writing grant proposals. I hope this one adds to your toolbox.

NOTES:

Where URLs are included as footnotes, please note that working copies move. It's often best to just search the document title to find an active link.

This is the second edition. Any suggestions on what works and what doesn't are welcome (even spotting remaining typographical errors) to peg@atkissontraininggroup.com.

Federal requirements can change! Please always check the current instructions from your sponsor.

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[2] See also the Heilmeier Catechism on proposals and projects. "What are you trying to do? Articulate your objectives using absolutely no jargon. How is it done today, and what are the limits of current practice? What is new in your approach and why do you think it will be successful? Who cares? If you are successful, what difference will it make? What are the risks? How much will it cost? How long will it take? What are the mid-term and final "exams" to check for success?" Retrieved September 13, 2021, from https://www.darpa.mil/work-with-us/heilmeier-catechism

Acknowledgements

I owe quite a bit to the implicit knowledge on grant proposals and sound logic imparted to me by my dissertation advisor, Dr. Kathleen Dunlap.

I owe Peggy Newell, JD, MBA, the best boss I ever had, for the opportunity to practice, practice, practice for eight years as a grant writer and research developer for Tufts University.

I owe Drs. Stephen Russell and David Morrison for mentoring and eight years of the opportunity to hone my skills in dissection of other people's proposals to a broad array of funders. It was one hell of a post-doc.

I owe Dr. C. Savio Chan for his generous and constructive comments on the first edition this book.

I owe many people on Twitter, too many to name you all, but most particularly @drugmonkeyblog.

I owe Dr. Joel White for support, believing in me, and telling me to quit my job, even if I had to hear it >10X to act. You're a great captain, great dad, and great partner, not necessarily in that order.

My thanks are owed to these folks, and to so many others. I had quite a bit of luck, support, and sponsorship. I hope to have honored that faith in me, or at least not embarrassed you all.

Added for version 2.0

The ATG team has grown over the past years, supported the core mission, and grown our capacity to provide faculty members with training to help them succeed in their research mission. In order of appearance: Dr. Amanda Welch, Mary Hensel, Jet LeBlanc, Sarah James, and Sydney Morris, who herds all the cats. Thank you all.

Dr. Fungai Chanetsa offered comments from the perspective of a former NIH Scientific Review Officer, which has helped improve this version. She provided helpful comments on the new chapter on Resubmissions.

My pandemic support squad was full of scientists who helped through both hilarity and serious discussions of surviving the academy: Dr. Melissa Bates, Dr. Rebecca Z. German, Dr. Valerie Wheat, Dr. Dana Miller, Dr. Rebecca Shansky, Dr. Michael Hulström, Dr. Michael Tomasson, and sometimes additional Michaels. The Socially Distanced Non-Essential Academics Happy Hour helped save my sanity.

Grant Proposal Outlines

Generic proposal outline	NSF proposal outline	NIH proposal outline
OVERVIEW ~1 page **IMPACT OF THE WORK** **BACKGROUND** **PRELIMINARY WORK** **PROJECT PLAN** **Aim/Objective 1** • ***Rationale*** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **Aim/Objective 2** • ***Rationale*** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **TIMETABLE** **SUMMARY AND FUTURE DIRECTIONS**	**OVERVIEW** ~1 page **Significance*** **Results from Prior NSF Support** **BACKGROUND** • Include **Results from Prior NSF Support** and **Relationship to Other Work in Progress** **PRELIMINARY WORK** **RESEARCH PLAN** **Aim/Objective 1** • ***Rationale*** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **Aim/Objective 2** • ***Rationale*** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **TIMETABLE** **BROADER IMPACTS*** **SUMMARY AND FUTURE DIRECTIONS** The Significance section can serve for Broader Impacts. For CAREER proposals, a longer Broader Impacts at the end can be used to integrate impacts of proposed research and education activities.	**SPECIFIC AIMS** 1 page **RESEARCH STRATEGY** **SIGNIFICANCE** • Include **Rigor of the prior work** • Include **Impact of the work** **INNOVATION** **APPROACH** **Aim 1** • ***Rationale*** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **Aim 2** • ***Rationale*** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **Timetable** **Summary and Future Directions**

USDA proposal outline	DOE proposal outline	NEH fellowship outline
INTRODUCTION **OVERVIEW ~**1 page **BACKGROUND** **PRELIMINARY DATA** **RATIONALE AND SIGNIFICANCE** **RESEARCH PLAN** **OBJECTIVE 1** • ***Rationale*** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches**** **OBJECTIVE 2** • ***Rationale*** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **OBJECTIVE 3** • ***Rationale*** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **Timetable** **Summary and Future Directions** *Suggested language instead of "Pitfalls and Limitations". Remember also many USDA proposals require a 2-page Logic Model.	**OVERVIEW ~**1 page **RATIONALE AND SIGNIFICANCE** **BACKGROUND** **PRELIMINARY DATA** **RESEARCH PLAN** **OBJECTIVE 1** • ***Justification and Feasibility**** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **OBJECTIVE 2** • ***Justification and Feasibility**** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **OBJECTIVE 3** • ***Justification and Feasibility*** • ***Specific activities*** • ***Expected outcomes*** • ***Potential problems and alternative approaches*** **Timetable** **Summary and Future Directions** *Supporting data go in Preliminary Data. Feasibility data go in Justification and Feasibility (see Chapter 8).	*Outline is by paragraph* Create a research space, using outline for Paragraph 1 of the Overview (see Chapter 4 and Chapter 5) Provide your long-term goals, objective and research question. Establish why you are the right person to do this work. Use outline for paragraph 2 of the Overview (see Chapter 4 and Chapter 5) State the significance of the work using model for second paragraph of Significance (see Chapter 6) Describe the process you will use to carry out the work. (For a book completion proposal, give the chapters and discuss what remains to be done, whether research or writing.) End with a statement on the expected deliverables and dissemination plan. State the impact.

Outlines can vary depending upon the specific funding opportunity. Always *read the instructions* and use the outline you can derive from the funding opportunity announcement (see Chapter 1).

Chapter 1: Getting Started

The blank page or computer screen can be intimidating, but there is work you need to do before beginning to write. A well-targeted grant proposal has three parts perfectly in line: the target funding agency, the type of grant (or grant mechanism), and the writer's awareness of the evaluators—who they are and how they evaluate the application. In this section, we will outline some of the work that needs to be done to create these alignments before you begin to write. As you advance in your career, many of these steps will become second nature. When first starting out, it may not be obvious why these steps are needed. We will discuss identifying potential funders, identifying the right grant type, and talking with the program officers—both the how and the why.

Many of the most successful researchers will say that they love to write grant applications. The statement often baffles their peers and colleagues. But if you ask them why they like writing grant proposals, you will get many variations of a similar answer. They consider it "intellectual playtime".[3] This is where they imagine new possibilities and hone their ideas. *For any kind of application, the clarity of the central idea drives the specific ideas for how to carry out the project.* The ideas drive a compelling proposal.

This sense of play and planning can also be important in writing applications for programs or facilities improvement grants as much as for research grant proposals.

Your proposal is a marketing document

Many academics feel uncomfortable with the thought of a sales pitch, but to develop good grant writing skills, you need to understand the purpose of the proposal. Your grant application serves to market your idea to your funder and reviewers. Don't think this makes you a salesperson trying to convince someone to buy something they don't need. Marketing and sales are intertwined, but consider the definition of marketing by astrophysicist Dr. Marc Kuchner:

> Marketing is the craft of seeing things from other people's perspectives, understanding their wants and needs, and finding ways to meet them.[4]

The "other people's perspectives" you must take into account are the wants and needs of your funder and of your reviewers. The needs of your funder are generally spelled out in

[3] The NIH National Center for Biotechnology Information's NCBI Style Guide says to place quotations inside of punctuation. See Chapter 5, "Style Points and Conventions" Accessed Sept. 14, 2021

[4] Kuchner, M. J. (2012). *Marketing for scientists: How to shine in tough times*. Washington: Island Press. Page 13. *I strongly recommend this book!*

their mission statements and explicitly in the documents they publish soliciting grant applications (see Jargon Box, next page). But you have another audience for most proposals written in academia: peer reviewers. What do your reviewers need from you?

- A good idea,
- packaged so that it is easy to understand,
- addressing a problem they care about.

Many of the principles we will discuss in this book come from marketing, although after this chapter we will not frame them as such.

Simon Sinek, in his TEDx talk, "Start with Why", notes that we usually start with the *What* and the *How*, but people respond to *Why*. In talking about marketing, Sinek says:

> People don't buy what you do. They buy why you do it.[5]

In the context of a proposal, that means explaining why you want to do the project in the first place, why you propose the specific activities to achieve your goal, and what you think the findings will mean. In terms of common grant review criteria, this maps to Significance and Approach (see review criteria discussion in Chapter 2). Most proposals contain a lot of detail about *what* the writer plans to do, often without context as to *why* it needs to be done. ***Always, at every part of the proposal, start with the why***. This point is so important that in her book 4 Steps to Funding, Dr. Morgan Giddings has an entire chapter on how important it is to get your reviewer to care about your project.

To get to the point of actually writing, though, there are many steps to take. The list may seem daunting, but these steps will rapidly become second nature.

Any marketing campaign requires a plan

No one likes to think of the grant proposal as a marketing document, but you are not selling soap. Your goal is to convey an important idea that has a strong intellectual foundation. The concepts from marketing can provide a useful framework to prepare you to convey that idea in a compelling grant proposal. Most of the elements of a marketing plan reflect what you already do to develop a project, but you may not have thought about it in this way. The Small Business Administration provides resources to small businesses on marketing, and they give the following headers for your marketing plan (not the marketing itself, but the plan for creating and executing the marketing):[6]

Target market
Competitive advantage
Sales plan
Marketing and sales calls
Marketing action plan
Budget

[5] Sinek, S. (2009). Start with why -- how great leaders inspire action | TEDxPugetSound. Retrieved September 17, 2021.
[6] Marketing and Sales. (n.d.). Retrieved September 13, 2021, from https://www.sba.gov/business-guide/manage-your-business/marketing-sales

These marketing concepts do not represent a linear process. For example, when we talk about identifying "target market," it should be clear the program officer is an important part of your target market, but I have put details on how to find and call your program officer under Marketing and Sales Calls. Also, elements of defining the target market cannot completely be separated from defining your competitive advantage. You may have a competitive advantage for one funder and grant type, but not be competitive for another.

In the following sections, certain subsections are designated as more relevant for research proposals, as compared to proposals to support a program or activity.

Target market: Funding agency, grant type, peers

Always remember that you have two target markets, if not three, for any proposal. One is the funding agency, represented by the Program Officer, and the second is the reviewers. You may have two separate markets among the reviewers—the primary reviewers that will read the entire proposal, and the other members of the review panel who may never read more than the first page or abstract yet likely have an equal vote or strong influence in the final rankings of proposals under review. All of these "markets" need to be satisfied in the writing process. Here, in terms of planning your proposal, let us first discuss the funding agency.

Funding Agency

Funders, whether the federal government or private foundation, have a purpose when they give grant funds. The purpose of the grant application is to allow the funder to decide among competing ideas. All funders have a mission that they are trying to accomplish. You are the proxy by which they achieve that mission. Part of good grant writing is understanding how your idea fits into the mission of your target funder, and then clearly positioning your idea so that the relationship of your goals and the funder's goals is clear and obvious. *Always read the mission statement.*

The relationship of your goals to funder goals plays out differently for different kinds of proposals.

- For agencies like the NIH and the NSF that often support fundamental research, it can be very easy to make the relationship to the mission clear. If you do cardiovascular research and apply to the National Heart Lung and Blood Institute, the positioning of idea to

Jargon Box: Funders may award grants in different ways, such as fellowships, research grants, grants for program development, and so on. All federal grant applications are written in response to some kind of announced funding opportunity. Federal Funding Opportunity Announcements (FOAs) can come as Program Announcements, Program Solicitations, Requests for Proposals (RFPs), Requests for Applications (RFAs), or Broad Agency Announcements (BAAs). These terms are sometimes used interchangeably, but different agencies use them differently. Usually both RFP and RFA will refer to one-time, very specific funding opportunities, and Program Solicitations or Program Announcements often indicate more open-ended solicitations with rolling submissions.

funder seems obvious.

- For example, if you apply for a Department of Defense Multidisciplinary University Research Initiatives (MURI) Program grant, the funding opportunities will list specific areas of research interest for each branch of the military that funds MURI awards. Your proposed project must align with one or more of the stated program goals. You should explicitly state in the proposal and abstract which of the priority areas stated in the solicitation that your project aligns with.
- For foundations, a careful reading of the mission statement will help you. Many foundations follow their mission statements with a paragraph that begins with words like *We achieve this mission by*…. The descriptions that follow tell you what kinds of projects they fund and how they fund them.

Even for the NIH, find and read the strategic plan for your target Institute or Center. That helps you understand the current priority areas.

It is not difficult to find information about funders. All it takes a little time and some good search skills. Almost every federal agency has web pages on open funding opportunities, and you can always start with Grants.gov. State agencies also have this information online. For foundations and other private funders, the most efficient database to search is the proprietary Foundation Center database. If your institution has access, there may only be one or two "seats"—specific computers authorized for searching the Foundation Center. Check with the development office and with your library. Your university may also subscribe to a proprietary database such as PIVOT, GrantForward, or FoundationCenter. Search your university website. You may also have an office with helpful research development staff.

Searching through Google or another engine can also be effective. Honing your search skills with combinations of keywords and Boolean logic can help narrow down the potential grants or funders that match your idea. Whichever approach you take (Grants.gov, Foundation Center, Google or other search engine), make looking for funding part of your weekly routine. Also look for email listserves that will deliver information to your inbox. And read the email. It can be very frustrating to find a perfect funding opportunity, only to find the proposal is due in a week.

Boolean logic: AND, OR, NOT
When you search more than one key word (Utah watershed), most search engines rank results first by AND, meaning pages that have all the key words (Utah AND watershed). Next it will rank those that have either word (Utah OR watershed). What many people do not realize is that you can also use a key word to filter out results containing that word, the NOT of Boolean logic. For Google, you can simply put a minus sign in front of the word you want eliminated. Searching with the terms *Utah watershed -Montezuma* will give you all results except those contain a reference to the Montezuma Creek watershed.

As noted above, the Program Officers represent the funding agency. An important step in establishing priority is the discussion with your program officer. (See Sales and Marketing Calls, below.) These conversations can be critical. You do not want to waste time on a proposal for a project that is not important to the targeted funder. The program officers can give you information that is not on the web and they have a perspective that

includes every proposal they've seen, awarded and declined. If you do not get a positive response from the program officer, you may want to consider other funders. Remember, a lack of enthusiasm from the program officer doesn't mean your project is not important. It means that you have to find a funder that agrees that your project is a priority and has a way to fund it.

Grant Mechanisms

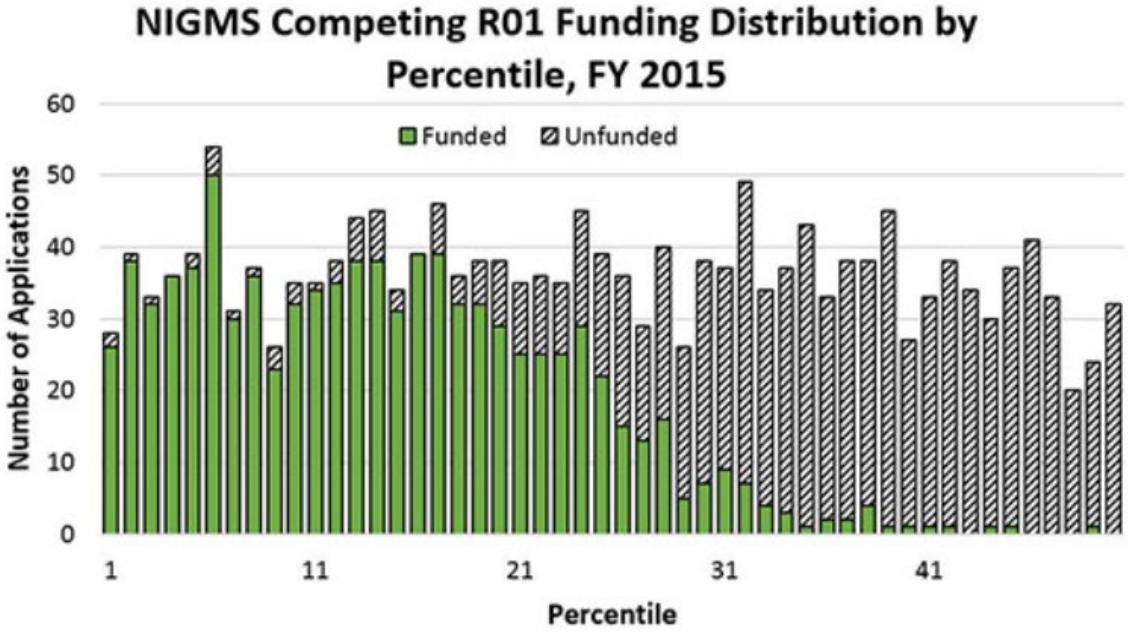
You will need to scale your project to the available funds and to the interests of your potential funder. This means spending time investigating how they fund grants. The different kinds of grants are often referred to as grant mechanisms. Examples include NSF or DOE Standard Grants, which differ from their early career awards. What funding opportunities can you find published on the web? What grants has that funder given in the past? How does your idea fit both their mission statement and the way that they give grant funds? If they only give $10,000 grants and you have a $50,000 project, it would be a waste of time to apply for $50,000. If you describe the larger project and only ask for $10,000, the project will be seen as "ambitious"—not fitting into the constraints of available money and time. In such a case, can you break out a piece of the project and apply for the smaller grant? The answers to these questions can drive you toward, or away from, a potential funding opportunity. (See the further discussion of grant mechanisms under *Sales Plan*, below.)

Peer Review

Your proposed project must also be seen as important to your peers and colleagues. Most research proposals undergo review by experts in the general area, but not likely by experts in your narrow field. Try to identify the reviewers—or at least the kinds of reviewers you can expect to read your proposal—and write your grant applications for that target audience. *Remember always that peer review is considered advisory to program*. Just because a proposal scores well, does not mean that it will be funded. The usual reason for not funding a proposal with good reviewer scores is *programmatic relevance*. Reviewers may find a project to be meritorious, but it may not be important to the funding agency at that point in time. The data shown in the figure on the next page reveals the relationship between the number of grants that scored at a certain percentile, and the number of grants with that score that were funded for the National Institute for General Medical Sciences for 2015. The figure was published by Dr. Jon Lorsch in the Feedback Loop blog in 2016.[7]

Many people are shocked to see proposals that scored so well, even in the 1st percentile, not funded. They were not funded likely because they were not relevant to the current programmatic interests of that part of NIGMS. Either there were other grants already funded that were too close to the same research area, or the research area was not considered a priority. Similarly, the proposals that did not score well but did get funded would have been highly relevant to current programmatic interests. In a later section, we discuss

[7] Lorsch, J. (2016, March 16). Application and Funding Trends – NIGMS Feedback Loop Blog. Retrieved September 13, 2021, from https://loop.nigms.nih.gov/2016/03/application-and-funding-trends/



2015 data from NIGMS showing the funding distribution by percentile demonstrates that proposals in the 1st percentile may not be funded and those at the 49th percentile may be funded. The deciding factor is usually agency priorities.

the "sales call" to your program officer. This is a critical step in making sure what you propose to do matches the goals and priorities of your target funder.

Competitive advantage: Idea development

It should be obvious that the purpose of peer review is to choose among the most meritorious of proposals. But as noted above, research proposals to most federal agencies have two target audiences, your scholar peers, and the funding agency as represented by the program officer. They have to be excited by the project, and what will usually excite them is a well-conceived project in an important area. Thus, idea development should be a conscious part of your planning process. It may seem axiomatic, but every competitive grant proposal starts with an outstanding idea. As Shore and Carfora put it:

> "The better developed the idea, the easier it is to more fully develop a proposal that anticipates, informs, and contributes to a quality project."[8]

When we talk about planning, we'll discuss developing the first page of your proposal, the Overview or Specific Aims page, starting months ahead of when you plan to submit the proposal. The process of creating this page goes through many iterations, but the page

[8] Shore, A. R., & Carfora, J. M. (2011). *The art of funding and implementing ideas: A guide to proposal development and project management*. London: SAGE. They have excellent recommendations for steps for idea development. They also emphasize that the subsequent project will be better if the idea is fully developed before writing the proposal. See also footnote 40.

serves as the solidification of the idea—what you want to do, and *why*. If you can solidify the idea clearly enough, it will help you convey it to your reader.

The process of idea generation can be somewhat formalized. One definition of creativity is that ***creativity consists of putting known things together in new ways***. That should bring you to the next clear axiom: the more you know, the more you creative you can be.

Maria Popova of the excellent website Brain Pickings has a very interesting post on the idea of networked knowledge and combinatorial creativity.[9] Many important discoveries have been made by "connecting the dots" between seemingly unrelated systems, or by looking at the system from a completely different perspective. We bring all our experience and knowledge to idea generation.

The development and refinement of good ideas requires time. In an article I read in an airline magazine many years ago, they interviewed the top five creatives in the advertising industry of the time, including the person behind the Nike swoosh. These creative professionals each described idiosyncrasies around their process. But all five identified an essential element, and one that you probably have in very low abundance: solitude.

I strongly recommend that you carve time out of your day and put on the calendar. No single approach works for everyone, but one of most successful and creative administrators I know has a 30-minute walk on her calendar every day, both for exercise and solitude. Many people say that they get their best ideas when they are actively not trying to generate ideas. Scientists who are also musicians, Albert Einstein famously among them, report flashes of inspiration while playing their instrument. Other people report their ideas solidifying during physical activity. Find what works for you and carve out the time to read, write, and, most importantly, think.

Ideas Require Input

For Research proposals: Given the sheer volume of literature in any field, it can seem impossible to keep up with our own narrow scholarly area, much less read more broadly. Here are the steps and tricks that I recommend to help broaden your knowledge base.

- Go to departmental seminars. Go to other departments' seminars.
- Read the short paragraphs in the beginning of each issue of Nature or Science or even Scientific American.
- Use an aggregator/search service appropriate to your field, such as Highwire out of Stanford for biomedicine. Do not simply look at literature generated by your specific keywords. If the service will also email you the tables of content for major journals in your field make sure to sign up for those. Skimming the table of contents takes very little time and can serve as an excellent method for serendipitously finding papers of interest that may spark a new idea.

[9] Popova, M. (2015, September 18). How Creativity Works. Retrieved September 13, 2021, from https://www.brainpickings.org/2012/03/20/jonah-lehrer-imagine-how-creativity-works/

- If you read a paper online, consider having some physical record. Print out the first page of the PDF and take notes on the back as to what you thought were the key points and take-home messages from the paper. Looking back through these pages later can also help you spark connections.
- Read reviews of the literature, but do not trust them. Chase down interesting papers referred to in the review. You may find that you interpret the data differently, or that the person who wrote the review did not include elements of the paper that have bearing on your work.

The idea for your research grant proposal will generally rest upon two key elements: the literature and your preliminary data. As you examine both of these to generate ideas, look for areas where there are key gaps in the knowledge base and particular problems that require novel solutions. Look for what makes you think, "Huh, that's weird."

Your first ideas may not be your best ideas. They may not even be original. Many other investigators have access to the same literature that you do and may be thinking about similar problems. Once you have an idea, make certain that it will be unique.

- Double check the literature.
- ***Search the databases of funded grants.*** Most federal agency websites have a robust search capability.
    - Funded proposals give you insight into what your potential competitors are doing now, not what they were doing during last year that led to the paper that came out yesterday.
    - Look beyond the database of your targeted funder. You may find relevant grants funded by the National Science Foundation, the Department of Defense, the Department of Energy, the USDA, the Institute for Education Sciences, or even the CDC. Try Science.gov or other aggregators.

If you find a funded proposal based upon something very similar to your idea, your choices are to compete (which no one would recommend), collaborate, or change. If you find that someone has already received a grant for work that essentially mirrors your idea, consider contacting the grantee to discuss possible areas of collaboration. Or consider creating a new collaboration that will allow you to address the problem from a unique angle. As with any such conversation, be prepared to bring something to the table.

For Program Proposals: Your idea likely relates to a clear *need* that you have identified—support for students, improved classroom technology, art installation, public policy development, and the like. In these cases, the refinement of the idea relates to the proposed solution. Do you have a compelling approach to meeting the identified need? Can you find any support in the literature that your proposed solution meets best practices? Or do you have the opportunity to put an interesting new twist on a known solution? Also, program plans can have unintended consequences. Input from peers, colleagues, and members of your target communities will be essential to refine the idea.

You must review the funding history of your target funder. You may notice trends in the types of grants they fund or the organizations they support. If they have never supported

a university-based application, then your proposal may not fare well regardless of the quality. Sometimes you may note that there is no consistency in what they fund. If you can communicate with a program officer for clarification, by email or phone, do so.

Seek Advice from Colleagues: The Banana Bread Principle

If your idea is original, your next critical step is to obtain feedback from your peers and colleagues. One of my colleagues says he goes through 50 drafts of his NIH Specific Aims page. The second or third draft, however, is created on a whiteboard in a room with two or three colleagues he trusts. He doesn't worry that they will steal his ideas; he trusts that they will tell him the truth and give him their complete criticisms. If you think you can't convince your colleagues to donate an hour of their time, provide baked goods. If you offer academics food and the opportunity to criticize something, they will come.

Feedback will serve you well at every point in this process. Not only should you have your ideas critiqued at the earliest stages, but when you write your Overview page you should obtain comments from anyone who will read it. One of the most effective things you can do is create a culture of mutual and honest feedback. Consider creating a group of 6 to 8 colleagues that meet weekly or every other week for a grant development lunch. Give the meeting a name. Have a roster like a journal club and whoever is on deck for the day brings their proposal, and perhaps banana bread.

> Bring Food – Food energizes and motivates people more effectively than any other meeting tactic.[10]

It does not matter how complete the proposal may be—early-stages of idea development, rejected proposal they plan to resubmit, or partway through writing the research plan. Everyone in the group offers their honest and straightforward commentary, and the group operates under the "Vegas rule": what happens in grant development lunch stays in grant development lunch. Several benefits may come from this approach, including better collaborations among participants and, especially, better proposals going out the door.

Assess Yourself and Your Resources

When you decide to write a grant application, you need to undertake a somewhat ruthless self-assessment. Do you have the skills needed to carry out your project? Do you have the personnel? Are you positioned to compete with your peers?

For Research Proposals: Do you have sufficient preliminary data for reviewers to see the project as viable? Do you a have a sufficient track record of publication to be seen as credible? Does your environment have the physical and intellectual resources to support the work that you propose to do?

[10] Rebori, M.K. "How to Organize and Run an Effective Meeting." University of Nevada – Reno Extension Fact Sheet 97-29 https://cyfar.org/sites/default/files/Rebori.pdf Retrieved September 17, 2021

For Program Proposals: What do you have? What do you need? What can you employ to help you get there? Do you have a clear vision of what you want to accomplish? Often, a successful proposal will have support from several sectors—administrative, community, and so on. You will need to garner and document such support with good letters from people who can promise resources. These take time, especially if the relationships are new.

For any developing project, the self-assessment should result in plans to mitigate any deficiencies that you may find.

The self-assessment and mitigation steps are necessary. In the proposal, you must convince the reviewers that you can do what you say you will do. Providing all the proof that you have the capacity will keep any doubt from arising in the readers' minds.

For example, if you do not have demonstrated mastery of the skills needed for the project, look for a collaborator or consultant who does. If you do not have a demonstrated track record with something you plan to do, try to get a paper out using the techniques, or find a consultant who will support you. A letter from a well-known expert in a particular approach agreeing to provide consultation to you can mitigate the concerns reviewers might have.

For Research Proposals: Preliminary data can be thought of in two ways: supporting and truly preliminary. Supporting data has been rigorously produced and would be publishable (Dr. John Christman).[11] You can include preliminary data to show feasibility of the proposed project in your hands. If you begin thinking about your specific aims early, you can identify the critical supporting and preliminary data you will need to include in your application to convince the reviewers of the feasibility both of your hypotheses and of the techniques in your hands.

When it comes to the environment, very few institutions would be considered completely inadequate. At the NIH, where applicants receive both individual review criterion scores and an overall impact score, an analysis by Matthew Eblen and colleagues revealed that the score for the Environment review criterion (the concrete question of whether the applicant facilities and equipment to do the work, not some vague "institutional quality" measure) correlated least to the Overall Impact score.[12] That said, sometimes you need equipment that may not exist at your institution. Establish a collaboration with someone who has access to such equipment or find a fee-for-service laboratory. If you consider that your intellectual environment may be perceived as lacking, consider changing that. Create group meetings or brownbag lunch sessions to promote the exchange of ideas among investigators. If you have such meetings, describe them under Other in your Facilities and Other Resources page. (See Chapter 13.)

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[11] OhioStateCCTS. (2015, December 03). Inside NIH Study Sections and Common Mis-takes Seen on Applications. Retrieved September 14, 2021, from https://www.youtube.com/watch?v=p3WQsC1S0TA

[12] Eblen, M. K., Wagner, R. M., RoyChowdhury, D., Patel, K. C., & Pearson, K. (2016, June 1). How Criterion Scores Predict the Overall Impact Score and Funding Outcomes for National Institutes of Health Peer-Reviewed Applications. Retrieved September 14, 2021, from https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0155060

For Program Proposals: Think of this part of the assessment not as holding up a mirror, but as having someone record you on video and you watching the recording later. Looking at your situation through "outsider" eyes can help you identify both strengths and weaknesses that you may have overlooked. Remember also that your needs assessments are the equivalent of what a research proposal would have as preliminary or supporting data. Your previous successes on other projects provide proof of feasibility, as do your documented relationships with your community institutions. What do you need to have in place, or write into the proposal, to show feasibility of your program?

For both research and program proposals, in almost every case where I have seen a low score for environment, the investigator had done an inadequate job of describing the capacity of their institution or organization. Be thorough.

Sales Plan

Match Your Idea to the Right Funding Opportunity

This concept is so fundamental to successful proposal writing that it bears repeating right away: Match your idea to the right funding opportunity. Implicit in that statement also is to match it to the right funder. Any applicant needs to understand this: funders have specific interests and limited resources. This is true from the smallest foundation to the largest federal agency.

Grant mechanisms: Once you have identified the appropriate target funder, the next step is to identify the right kind of grant to apply for. Most funders have awards for different purposes, often delineated as different mechanisms, or types of awards. Think of this as the formalized ways that funders award grants. Different mechanisms usually have a name ("Young Investigator Awards") or a designating number (R01), and each type serves a different purpose—early career support, training support, large project funding. Any federal grant proposal can only be submitted in response to a published Funding Opportunity Announcement, or FOA. Each announcement has its own identifying number, which must be on the application form.

For many agencies, proposals will be submitted only in response to specific announcements, but some agencies have broader programs. In this book, we will not review all the potential grant mechanisms. The NIH alone has well over 300 discrete types of awards. For example, the NIH R01 equates to the NSF or USDA Standard Grant—an investigator-initiated, relatively large-scale project ($200,000–$1,000,000 in research costs, three to five years). NIH also has mechanisms called the R21 (originally to support high risk/high payoff projects) and R03 (to support gathering preliminary data). The USDA has Exploratory grants and the NSF has EAGER grants, similar in many ways to the purpose of the R21. But neither agency has anything quite like the NIH R03. Foundations that support work in your field may have some kind of pilot mechanism, and it is worth looking for those opportunities.

To take the example of the NSF, two of their main types of grants for individual investigators are the standard grant and the CAREER award. The standard grant is used for most investigator-initiated proposals and generally supports basic research. The CAREER program was created in response to an identified need to encourage a young investigator to develop a career as a teacher–scholar, someone who integrates education and outreach into their approach to research. The NSF also supports Research Experiences for Undergraduates, Major Research Instrumentation, and other grants. Note that some of their specific grants will make mention of using the Standard Grant format.

A note for applicants to the NIH: Grants under the R01 (not RO1) mechanism comprise the majority of investigator-initiated research funded by the NIH, but there are many other kinds of awards. The two least understood grant mechanisms are the R03 and the R21. The R03 is meant for preliminary data but can sometimes be used for a complete project in secondary data analysis. The R21 was created to support high risk/high payoff projects. Neither were created to serve as "starter grants" for young faculty. Once a grant mechanism exists, though, an Institute or Center may use the designation for other purposes. For example, there are a few three-year R03 awards specifically for postdocs from historically excluded groups. There is a three-year R21 at one Institute intended for early-stage faculty.

One should never write an R21, R03, or any other pilot grant without a clear plan for the R01 that you hope to follow up with.

There are 329 activity codes at the NIH, including many career development (K) awards and several training fellowships (F). The NIH has many tutorials and even a decision tool for training and fellowship awards to help you choose the appropriate grant mechanism.

Many agencies have some sort of early-stage career development award, but they can vary. The NSF CAREER Award requires an education plan because it is designed to launch the grantee as a faculty member who integrates education and research. The Early Career Awards from the Department of Energy (DOE), by contrast, should not include anything about education because their purpose is to help launch promising researchers doing work relevant to DOE. These examples make the following point: When agencies have different grant types, each type exists for a different purpose. Understanding what the agency wants to accomplish with any particular grant type helps you match yourself to the right one.

The NIH uses numbers, or activity codes, for their award types: R01, R21, R15, F31, and so on. Descriptions are available on the NIH web sites.[13] Parent Announcements are broad funding opportunity announcements allowing applicants to submit investigator-initiated applications for specific activity codes. They are open for up to 3 years and use standard due dates. Not all NIH Institutes and Centers participate on all parent announcements, therefore check to make sure that NIH Institute or Center that might be interested in your research is listed as a participating organization in the announcement before submitting your application.

[13] https://grants.nih.gov/grants/funding/funding_program.htm Retrieved September 14, 2021.

For the USDA, every proposal must be submitted in response to a specific Request for Proposals, or RFP, accessible through USDA web pages.[14] These are often published within weeks of the proposal submission deadline, so search for funding opportunities often, and open the announcement emails.

Many agencies will issue solicitations or Funding Opportunity Announcements (FOAs), or Requests for Applications (RFAs). There are many agency-specific words or categories, but if you understand why these categories exist, it can be easier to navigate through and determine which mechanism is most appropriate for you.

Several of the agencies, such as the NSF and the NIH, have some form of "parent announcement" with a set of deadlines for the next few years, written to cover many proposals that could be submitted by any investigator. Many agencies, as noted above, only accept grant proposals in response to specific requests for proposals (FOAs, RFAs, RFPs, PAs, etc.). If you want to target a particular agency, take the time to learn about how their granting system operates. Most of the federal agencies have information available on the web, and the NIH and NSF both have regional grants conferences twice a year. Foundations have also learned that transparent information for potential applicants can be very useful, because if applicants know what the foundation wants, it can help reduce the number of very inappropriate applications. Take the time to identify what kinds of grants your target funder gives and which of these might be appropriate for the project you propose. For a proposal to fare well, it has to be seen as appropriate to the kind of grant award the funder wants to make.

Marketing and Sales Calls: Contact the Program Officer

For most federal research grants, peer review is the major driver, but many applicants forget that peer review is *advisory* to program. At foundations, sometimes the program officer simply makes the funding decisions. Within the various federal agencies, program officers play distinct roles that are far beyond the "mere administrators" that some applicants assume them to be. Certainly, they administer scientific programs and oversee grant portfolios, but they also set priorities for federal funds and act as advocates within a scientific area. If you read any federal FOA or foundation grant information, it was written by one or more program officers.

Always do your homework before you contact the program officer. Read everything available on the web and prepare questions. Make sure you do not ask them anything that is in the FAQ. Ask for specific, not blanket, advice. Send a short summary, no more than one page, of your idea. "This is my idea; is it relevant?" is a better question than just asking, "What's fundable these days?

Program officers at federal agencies, such as the NIH, NSF, DOE, or USDA are scientists first. For some, their prime responsibility is to monitor and understand a particular scientific area, and to promote advances in the field through funding. Thus, when you talk to them about your research idea, you

[14] https://nifa.usda.gov/page/search-grant Retrieved September 14, 2021.

can generally trust that the person on the other end of the phone has a very solid grasp of the field.

For applications to state agencies or foundations, the program officer plays a key role. As noted, they may make final funding decisions. At minimum, they will likely choose the reviewers and make recommendations for funding. They can help you understand how the proposal will be reviewed or give you key insights into any potential underlying politics.

You have one major purpose in contacting the program officer: to determine if they find your idea interesting and relevant to their current programmatic interests.

Remember that most program officers have a portfolio of grants that they administer, and quite often have an agenda related to that constellation of projects. Certainly, peer review primarily drives funding in most cases, but for grants "on the line" for funding, one in a high priority area is more likely to be funded, and the program officer is usually instrumental in those decisions. For foundations, the program officer may make the decisions in the form of recommendations to the board.

Contact your program officers early, 6 to 8 months before you plan to submit. If you learn early that your original idea would not be of interest, then you have time to shift directions and further refine your ideas, or to look for another potential funder.

You will not find it difficult to identify the program officer with a little digging. Most federal agencies will have a list of program officers and their specialty areas on their websites. For particular FOAs, the relevant program officers are listed in the solicitation, usually under the heading Agency Contacts. State agencies or foundations may list a blind email, which will give you a place to start.

How do you contact your Program Officer?

- Start by sending them an email. It should be short and be very clear. Request a short conversation. I recommend you even say "brief" or "15-minute" conversation. Be clear you want to talk with them about the project you are currently developing and plan to propose.
- Either include a paragraph in the body of the email giving the gist of your project or append a very solid draft of your Overview/Specific Aims page (See Chapters 4 and 5). This lets them know what the project would be about. In your conversation with them, do not spend time explaining your research unless they ask specific questions. Ask your

From a former NIH program officer: "If your application score does not make the payline cut and is close, be your own advocate. Send the program officer an impact statement—why your research is compelling and therefore considered for funding—and follow-up with a phone call. The advocacy should be strictly on the science. Sometimes, especially at the end of the fiscal year, there are excess funds to be spent at the discretion of the Director; and your application that was close could be one that gets funded."
Note: This kind of contact will go easier if the program officer already interacted with you at the application stage.

questions and spend more time listening to your Program Officer's advice and comments.

- Ask the most important questions.
    - Does your idea fit the agency's or foundation's (or program officer's) current interests?
    - Have you chosen the appropriate grant mechanism? (See discussion above.)
    - Can they explain specific points you may find confusing in a particular FOA or proposal solicitation?
    - [If the review process is not transparent] Can they let you know how the proposal would be reviewed? (How do they select reviewers? Is there a panel discussion or only written reviews?)
    - [If you have started to develop a professional relationship] Are there areas of your research direction they find particularly interesting that could potentially be developed to further the PO's program goals?

- Follow up on their instructions and advice. I cannot stress this enough. If a program officer takes time to give you specific advice and you decide to ignore it, they will notice that you ignored them when your proposal lands on their desk.
- Program officers are human, and they may or may not get back to you. If you send your email to a program officer while review groups are meeting, they will likely be focused on the grants currently under review. If you do not get an answer, try again in a few weeks. If you still do not get an answer, try another Program Officer. Never complain about unresponsiveness. Sometimes program officers leave but the website or directory is not revised for several months.

For many **NEH** programs, program officers will read a draft of your proposal and provide feedback if you get it to them in a timely fashion. They do not have time to read all the fellowship proposals, but if you apply for a Collaborative grant or similar larger program, look for a note about whether they will read advance copies. Usually, you need to provide a draft within six weeks of the application deadline. Program officer input is invaluable.

Marketing action plan

Proposal structure: In the chapters that follow, we will discuss specific information that needs to be in every part of a grant proposal. You should be aware, however, that some funders provide a specific outline that they expect you to use. Other funders may not provide a strong outline, but cultures have grown up around applications to the point that reviewers come to expect particular structures and logical flows. (See the suggested outlines on pages 8 and 9) Part of your planning process should include identifying the proposal structure. My favorite way to start any proposal, particularly if writing to a funder with whom I am unfamiliar, is to create an outline based on the requirements described in the solicitation or request for proposals. Then, I find the review criteria. As discussed in Chapter 2, many funders express the review criteria in the form of questions the reviewer is meant to answer. I copy and paste each question into the outline everywhere it

would be reasonable to provide the reviewer with answers to that question. Sometimes elements of review can be found in other parts of the solicitation, beyond the “review criteria” section. Reread the solicitation to find phrases and sentences that indicate what the funder values and their goals for the grant program. Paste those in the outline as well, so that you can incorporate them in your own text. Search for phrases like “successful proposers will”, “should”, “must”, "expect", and "encourage".

The proposal outline provides the structure of the information. Where does this project fit in your larger arc? How does it fit in with the funders’ priorities? In the discussions on the Specific Aims/Overview page (Chapters 4 and 5) and writing about Significance (Chapter 6), we will discuss ways to structure the information so that the reader can find it and follow clearly what you want to do and why.

Budget

In the context of a marketing plan, a business owner would decide the kinds of resources necessary to carry out the plan. In the context of planning your grant proposal, the biggest resource you need is time. In Chapter 3, we suggest a timeline for writing your proposal that includes identifying and generating the preliminary data you need, applying for pilot funds, and other activities that will help you produce your most competitive proposal.

Of course, you need personnel and materiel if you have to gather preliminary data, but thinking consciously about the time required will help you in budgeting your most scarce resource—time.

(For information on proposal budgets and justifications, see Chapter 12.)

Chapter 2: Review Criteria and Review Process

> A proposal's overt function is to persuade a committee of scholars that the project shines...[15]

Almost everyone who teaches anything to do with grant writing will, if they are any good, remind you to stay conscious of your audience. The quote above, from a booklet published by the Social Science Research Council, starts with the target audience—a committee of scholars. Peer review.

The overall score that your grant proposal receives is based upon the reviewers' perception of the potential for the work to have an impact—to achieve something important and relevant to your funder's interests. The score is based on the reviewers' assessment that the problem is important and that the plan is likely to succeed. In other words, *what is the anticipated return on the investment of grant funds?* Most reviewers have a bit of the same mind set as a venture capitalist: Why should I invest in this?

No grant gets a high score without a champion in the room. You have to get your reviewer excited about the project so that they will use strong, positive language in their written comments and use superlative descriptions in an excited, positive tone of voice during the discussion of your proposal.

"This is an excellent proposal from an outstanding young investigator," or something similar, needs to be the first thing a reviewer says about your proposal in a panel discussion. "This is a good proposal," or something similar in a neutral voice heralds a poor score.

Every proposal should answer the review criteria

In most cases, funders explicitly state the criteria that reviewers should use to evaluate proposals to that agency, often in the form of a question. The reviewer is meant to answer these questions as they evaluate the proposal. One key element of good grant writing is to hand the reviewer answers to the questions so that it is easy for them to review your proposal. The purpose of this chapter is not to list the review criteria for every agency, but to help you understand how to use the review criteria to write a reviewer-friendly proposal.

Reviewers are supposed to apply the review criteria stated by the funder. In general, they do. Often, however, they depend more on their own intellectual assessments than on the

[15] Pzreworski, A. and Salomon, F., On the Art of Writing Proposals: Some Candid Suggestions for Applicants to Social Science Research Council Competitions, Retrieved September 17, 2021 https://s3.amazonaws.com/ssrc-cdn1/crmuploads/new_publication_3/%7B7A9CB4F4-815F-DE11-BD80-001CC477EC70%7D.pdf ***If you are in social sciences, this is very useful.*** See also note 48.

stated criteria. Several agencies, particularly the NIH, actively train reviewers and provide review templates to make sure reviewers address the stated criteria. Some funders do not supply training, and the review formats will be inconsistent.

Reviewers will also have visceral responses to your proposal before they engage their critical thinking skills.

> Do I know this person? Is this close to my area? Do I want to read this?

Many factors weigh into the last question. One gut-level factor is the subject area—is it something the reviewer is generally interested in, or close enough that they won't have to work at understanding? Other factors may not even form consciously in the reader's mind and come from the layout of your proposal and the density of your prose. Which leads us to the next point.

Make it easy for the reviewers to review your proposal

The best way to help your reviewer is to hand them the answers to the review criteria. As noted under the Marketing Action Plan in Chapter 1, these are always my recommended first steps.

- Read the grant solicitation and the review criteria.
- Read any instructions to reviewers that you can find.
- Use the solicitation, RFP or parent announcement to identify the required sections of the proposal.
    - Make an outline in a document.
    - Paste in the review criteria everywhere they should be addressed in the proposal. (I've learned the hard way to paste in the review criteria and reviewer instructions in a colored font, so that you can remove them later. You can also use Word's Comment function.)
    - Add in anything gleaned from the instructions to reviewers.
    - Paste in any additional information from the solicitation ("should", "must", "encouraged" phrases).
    - Write the proposal to answer the review criteria and provide answers for all the proposal requirements.

This kind of approach will help you respond thoroughly and completely to the instructions from your target funder. Many program officers will tell you the one thing they wish applicants would do is to read and follow the instructions. In fact, the first bullet in the USDA's "General Grant Writing Tips for Success"[16] is the following:

> - Read the RFA

[16] https://nifa.usda.gov/sites/default/files/resource/General-Grant-Writing-Tips-for-Success.pdf Retrieved September 14, 2021

Know what the solicitation is about, beyond reading the title. Look for phrases like *successful proposals will* and for the words *should* and *must* so you don't miss any of the requirements. And of course, read the review criteria.

Respond to the review criteria to create content

In 2015, Falk-Krzesinski and Tomin analyzed the review criteria for the major federal agencies They dissected the common review criteria and compared them, organized by common terms. They observed:

> "… while there are differences in the language used to describe each core review criterion across the various grant mechanisms, the concepts being reviewed—what is being done, why it is being done, how it is new, who is doing the work, and where it was done—are essentially the same across each mechanism."[17]

The common five review criteria map to the one-word review criteria for the NIH:

> **Approach**
> **Significance**
> **Innovation**
> **Investigator(s)**
> **Environment**

You will find these review criteria for almost every other agency, sometimes with different wording. We will use them as the basis for our discussion here. The specific review criteria are often posed as questions. Sometimes they are posed as statements. Take for example the full NIH criteria for Investigator.

> **Investigator(s)**
> Are the PD(s)/PI(s), collaborators, and other researchers well suited to the project? If Early Stage Investigators or New Investigators, or in the early stages of independent careers, do they have appropriate experience and training? If established, have they demonstrated an ongoing record of accomplishments that have advanced their field(s)? If the project is collaborative or multi-PD/PI, do the investigators have complementary and integrated expertise; are their leadership approach, governance and organizational structure appropriate for the project?

The NSF criterion on Investigator is phrased as a more succinct question.

> How well qualified is the individual, team, or organization to conduct the proposed activities?

[17] Falk-Krzesinski, H. & Tobin, S. C. (2015). How Do I Review Thee? Let Me Count the Ways: A Comparison of Research Grant Proposal Review Criteria Across US Federal Funding Agencies. The Journal of Research Administration. 46. 79-94.

You can easily see how a reviewer could write the review by answering the questions. If you hand them the answers, you help them write the review.

For the National Endowment for the Arts (NEA) ART WORKS solicitation, the criterion for assessing the personnel is folded into a sentence fragment that also includes the organization and the works of art.

> Quality of the artists, arts organizations, arts education providers, works of art, or services that the project will involve, as appropriate.

The review criterion above tells you that you will need to explicitly discuss the organization, the individuals providing education, etc. In fact, you can use this list to create specific subheadings to make it easier for the reviewer (Artists, Organizations, Art Education Providers, etc., as appropriate). For the NEH's Collaborative Grants, reviewers are instructed to look not just at expertise, but also at time commitment and the collaborative partnerships.

> The qualifications, expertise, and levels of commitment of the project director and collaborators, and the appropriateness and value of the collaboration.

For one of the NEH or NSF collaborative grants, you should have a section explicitly describing the collaboration. How stable is it? How did it come about? What can you do with this collaboration that you could not do as individuals? The reviewers will be instructed to assess these issues. Make it easy for them.

Other agencies have explicit criteria on the reasonableness of the budget (e.g., NASA, the NEA). Many agencies, especially those funding programs and activities more than research, include explicit requests for an evaluation plan. Even the NSF, which primarily funds research, expects evaluation plans for activities related to the Broader Impacts criterion or the education plan for NSF CAREER proposals.

Take for example, the NSF review criterion:

> 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?

The NSF has two major review criteria: Intellectual Merit and Broader Impacts. The five review questions applied to each of those criteria map to the NIH criteria. The first question, above, clearly maps to the NIH review criterion of Approach. The second question refers to an evaluation plan. If you were new to writing NSF applications and did not read the review criteria, you might miss the implied instruction to include an evaluation plan for your Broader Impacts activities, or a timeline with milestones for your research. (For a brief discussion of evaluation plans, and of Broader Impacts, see Chapter 9.)

Some agencies state additional requirements to evaluate the question of return on investment. For example, if you respond to a request for proposals from a mission-driven agency like Department of Defense, Department of Energy, NASA or the USDA, your proposal must clearly be responsive to the priority areas indicated in the RFP. In fact, in the NASA Guidebook for Proposers Responding to a Funding Announcement, the first reason stated for rejecting a proposal without review is: "*The proposal is clearly nonresponsive to the objectives and/or provisions of the FA.*"

> You might think it obvious that you should use explicit statements of relevance to the funder's interests in a proposal, but I once reviewed a proposal in response to an RFP on nanotechnology that did not include the letters N, A, N, and O, in that order.

Taking the time to understand the review criteria will pay off for you in writing a competitive proposal. The review criteria tell you what to put in the proposal. If the reviewers have to answer the question, "Does the applicant do X?" make sure X is clear in the proposal. Do not hesitate to use the language of the solicitation and review criteria.

- The feasibility of this approach is demonstrated by…
- The outcome of these experiments will be…
- The innovation of this project is defined by…
- The potential for transformation by this research is evident by…
- Our team is especially well-qualified to undertake this project because…
- Our environment contributes significantly to the aims of this project in that…
- This proposal will advance knowledge/have a broader impact by…

Process

The process of peer review generally begins with the assignment of reviewers. At many agencies, the relevant program officer assigns reviewers and assembles panels. The number of assigned reviewers for any one proposal can vary widely depending upon the funding agency and the grant mechanism. Most typically, three people read the proposal, with one reviewer serving as the primary reviewer. This person will write the most in-depth review and start the panel discussion. The second reviewer generally also writes a fairly in-depth review. In many cases the third reviewer is referred to as a "reader", and their comments do not typically have the same level of detail.

For most of the major federal agencies, some form of review panel will be convened. Many agencies have experimented with virtual panels conducted entirely by text. Others have used tele- and video-conferences. Most reviewers and program officers of my acquaintance agree that the best review usually comes from an in-person panel, but opinions vary widely on this point. When a panel meets, the three reviewers present their comments, beginning with the primary reader. Panel members can ask questions, but the discussion is usually brief. In some cases, reviewers may consider five to six proposals per hour. This can be an intellectually grueling process for the reviewers. Your job is to make their job easy.

The NIH stands out in the congressionally mandated separation between review and program, with the Center for Scientific Review managing the peer review process for scientific merit. For the NSF and many federal agencies, the Program Officer manages the review process, selecting the reviewers and running the panel meeting. At USDA, the panels are co-led by the program officer, called the National Program Leader, and a Panel Manager who is a scientist. They can provide feedback on technical issues, but POs do not provide their opinion on scores.

For many panels, anywhere from 2 to 5 reviewers will read the entire proposal, but every member of the panel has an equal vote on the score or final ranking. Quite often, particularly at NIH, Reviewers are assigned numbers 1, 2 and 3, with the number connoting the order of presentation at discussion. All reviewers are expected to write a full critique. The only difference is that reviewer 1 presents a summary of what the application is about to orient the rest of the panel, and every reviewer will provide comments. The remainder of the panel will likely read the Specific Aims/Overview page (the critical first page of your proposal) while the primary reviewers are talking. (See Chapter 4.) Rarely do panel scores deviate far from the initial scores suggested by the primary reviewers, but each reviewer wants to come to their own intellectual conclusions about the project. If a discussion becomes lengthy, it usually means that the score will get worse.

There is a trust relationship among panel members. Those who have not read the full proposal will trust that your primary readers will bring up any technical issues. Even if the primary readers are enthusiastic, though, the other panel members will not simply follow along. They will want to make their own determination about the significance of the project. To make this determination, they will read your Specific Aims/Overview page during the discussion. (A few panels, to my knowledge, have a very brief, perhaps three-minute, reading period at the beginning of each discussion, but that is by no means universal across review panels.) Thus, you have two audiences for this key page. For the primary reviewers, you need to write a Specific Aims/Overview page that raises their enthusiasm and desire to read the rest of the proposal. They will have made their gut-level decision by the end of this page. For the panelists, you have to write in such a way that they can easily read this first page under non-ideal circumstances, including when someone else is talking during the panel meeting.

To get a sense of the tone of the review panel, I recommend that you watch the NSF mock review panel for CAREER awards available to watch online, linked below and easily searchable on the NSF web site.[18] Nothing, however, is as helpful to understanding the process as serving as a reviewer yourself. You can send your CV to NSF program officers to volunteer, sign up to be a reviewer for NEH (see link on the NEH grants page), or apply to the NIH Early Career Reviewer program (look up “early career reviewer” on the NIH web page search box).

[18] National Science Foundation - Where Discoveries Begin. (2016, September 23). Retrieved September 14, 2021, from https://www.nsf.gov/news/mmg/mmg_disp.jsp?med_id=81278 (or search "career panel video" on the NSF web site)

Scoring

Both the NIH and the NSF have undertaken self-study about the effectiveness of their review process and sought over the years to refine and improve peer review. You may think such studies do not affect applicants, but quite often these efforts often result in changes to the process. The following is from an NSF policy document on Merit Review.

> Reviewers are asked to consider what the proposers want to do, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful.[19]

Regardless of scoring method, the score you receive generally reflects their impression of the importance of the problem and whether they think the project plan will succeed. In some cases, an applicant only receives a single score indicating the reviewers' evaluation; in others they see the individual reviewer's scores. Different agencies use different names for their rankings, such as "Overall Impact" at the NIH, and "score" or simply "rank" at other agencies. Some agencies use numerical scores (1 to 9 for the NIH, with 1 meaning exceptional and 9 meaning poor) and others use adjectives for rankings such as "Outstanding", "Excellent", "Good", "Fair", or "Poor".

Two agencies, the NIH and the Institute for Education Sciences (IES), give individual numerical scores for each review criterion in addition to an overall impact score.

Other agencies use a points system. This is most common with programmatic proposals, such as those from the Department of Education and a subset of USDA and military programs. Each section of the proposal has a point value, usually adding up to a total of 100. For proposals scored on a points system, the distribution of points tells you how much attention to pay to each section. If 50 points are allocated to scoring the project plan and only 10 to the project team, consider that an indicator of space allocation in the text. If you have five pages about the project plan, you should have only one page about the project team.

Reviewers generally do their best to be fair. Applicants who have never served on a review panel sometimes carry deep misconceptions about how scores are assigned. Some programmatic grants, particularly those that have a point total, are scored with a severe rubric that seemingly leaves little to the reader's discretion. Even with a points-based rubric, reviewers make gut-level decisions about the importance of the project. The number or adjective score reflects their opinions of both the proposed project *and the proposal itself*. Consider the impression made by every aspect of your proposal—clarity of writing, attention to formatting, presence or absence of typographical or grammatical errors. A clear, error-free proposal does not guarantee a good score, but an unclear and messy proposal can get in the way of the reviewers understanding your idea.

[19] https://www.nsf.gov/bfa/dias/policy/merit_review/mrfaqs.jsp Retrieved September 18, 2021

Reviewers

Who reviews your proposal? For the most part, research proposals are reviewed by peers, but the exact definition of a peer varies widely among funders. Almost every description of review panel composition, from the NEA to the NIH, explicitly states that the panels will be made up of individuals with a variety of backgrounds. Here is a sample of panel descriptions:

> ***NEA:*** To review the applications, we assemble different panels every year, each diverse with regard to geography, race and ethnicity, and artistic points of view.[20]
>
> ***USDA:*** The program leader and panel manager aim to assemble a diverse panel active in research, education, and/or extension (as appropriate for the program) related to the subject matter in question.[21]
>
> ***NSF:*** Diversity of the reviewer pool is an important feature of the merit review system. Reviewers from diverse backgrounds help ensure that a wide range of perspectives is taken into consideration in the review process.[22]

Note that all three of the agencies stress diversity, this means diversity in a number of dimensions. The USDA information goes on to clarify:

> The goal is to create a balanced panel with the necessary expertise to cover the range of the proposals, while also maintaining diversity in geographical location, institution size and type, professional rank, gender, and ethnicity.[21]

Because there will be a range of proposals, one panel member may have been recruited based on how well they know your particular area. Others will have been recruited as a reader for their expertise related to a different proposal but could be assigned as second or third reviewer on your proposal. These reviewers will be less familiar with your research area. Some of these other panelists may be assigned as the third or fourth reviewer for your proposal. On top of that, many of the rest of the panel members

I once read a blog entry of a scientist scornfully dissecting the review of their proposal. Several times they wrote the phrase, "…an expert in the field would have known…" No wonder the score was low. The person had made the cardinal error. You cannot assume you will have reviewers who know your field as intimately as you do. They will come from a variety of backgrounds. ***You must write for the reviewer and not yourself.***

[20] Grant Review Process Retrieved September 18, 2021 from https://www.arts.gov/grants/grant-review-process

[21] The NIFA Peer Review Process for Competitive Grant Applications. (2015). Retrieved September 15, 2021, from https://nifa.usda.gov/sites/default/files/resource/The%20NIFA%20Peer%20Review%20Process%20for%20Competitive%20Grant%20Applications%2004062015....pdf

[22] Report to the NSB on the NSF's Merit Review System FY 2000. Retrieved September 15, 2021, from https://www.nsf.gov/nsb/documents/2001/nsb0136/nsb0136_3.pdf

will read your abstract or first page during the discussion. You have to write your application so that it can be read and understood by everyone on the panel.

Unlike most of the other agencies, proposals at the NIH[23] are usually reviewed by standing panels, often referred to as "Study Sections". These are organized by general areas of research, such as tumor metastasis or bacterial pathogenesis. Scientific Review Officers manage the process of review, but the meetings are run by a Chair who is a scientific member of the Study Section. I urge you to explore the NIH Center for Scientific Review website. The identities of standing panelists are listed, although the panel that reviews your proposal will also have *ad hoc* reviewers to fill in gaps in expertise. CSR also provides resources for applicants. You can suggest assignment to the specific review group that seems to best match your idea, but the assignment will be determined by staff at the Center for Scientific Review. Start with the NIH Assisted Referral Tool, which will take text from your title and abstract (or more) and suggest the best match for a Study Section.[24] Keep in mind any standing review group at the NIH will be made up of mixed groups of investigators generally with expertise in the area. Few will have specific expertise in your sub-field.

When you identify a potential NIH review panel, take the time to look up panel members to identify their research expertise. You might also want to read one or more of their papers that might have bearing on your research area. If they are at all relevant, cite the papers as appropriate in your proposal. While this may seem somewhat self-serving, this approach also helps introduce you to areas of your field that you may not have previously encountered. The more you know, the more dots you can potentially connect, and the better your project will be.

[23] The NIH does not permit its logo to be used. For your convenience, I have reversed it so that it is not the official logo and used the mirrored version to point out the NIH-specific sections.
[24] https://art.csr.nih.gov/ART/

Chapter 3: Strategic Planning and Timelines

Writing a proposal is primarily a thought process. If you view writing proposals as an imposition on your time, it shows in the proposal. If you view writing proposals as a way to think through your project, it will force you to think through all the potential implications of what you plan to do. That thought process helps you to write the description so that any doubts that may start to arise in the reviewers' minds are answered before they have a chance to solidify. *If you view the grant writing process as a tool for thinking through the project, both your proposals and your projects will improve.*

In the pages that follow, we will present two ideal timelines for grant development. They focus on the steps for a grant application, and they cannot include something that may be one of the key drivers of long-term success or failure: Seeing how the proposal fits into your longer-term goals and into your overriding goal.

Keeping the proposal in context

In the business literature, discussions of strategic planning and best practices go back decades. The value of planning for individual people has also been studied as it pertains to employee performance and career development. People who set realistic goals and milestones and revisit them regularly are more likely to succeed, even if they don't hit every milestone on the planned date, or even if the plan changes completely.

Some of you will push back on this concept, claiming that you do not know where the research will lead you and therefore it would be foolish to over-plan. True, you can never tell how the project will go, and sticking to a plan because it is the plan, especially in the face of evidence, would be foolish. Some people survive quite well with a seat-of-the-pants approach. However, there is a great deal of research to suggest that most of us will have more successes with at least a little bit of thoughtfulness about short- and long-term goals.

In the context of planning grant proposals, this notion of longer-scale planning takes two shapes. One is the planning of any particular proposal, detailed below. The second is planning your overall strategy for funding. In the discussion of planning larger-scale proposals, we also discuss the idea of applying for preliminary or pilot funding early in the process. This discussion shows one small potential piece of what it looks like to have a larger funding strategy.

In this current climate, there is no guarantee you will win funding. I have heard various statistics on the number of proposals submitted per applicant per eventual funded grant. At one point the number at the NSF was quoted as 3.6 proposals per applicant per funded grant. In general, the statistics across agencies that allow grant resubmission show that

Life cycle of the NIH grants process shows how long it takes from submission to decision, much less to funding (or resubmission). This cycle looks similar for other funders, including NSF and NEH. (graphic from the NIH)

the second submission is about twice as likely to be funded as the first submission. Taken together, this means planning for resubmission in your longer-term funding strategy.

If you win a pilot award, when should you plan to submit the larger proposal? Should you only start working on a new proposal only after you have depleted the pilot funding? Absolutely not. You should start the larger proposal, at least a framework on a whiteboard (see Chapter 4), as part of writing the application for pilot funding. You should start planning the follow-on proposal the day the funding starts. If you have a grant, plan to submit the renewal application, or the proposal for the next project, more than a year before your grant funding will end. You will likely have to resubmit the proposal and should try to strategically submit proposals to minimize the chance of a large gap in funding.

Because you will likely have to resubmit, account for the lifecycle of the funding process. The example above is from the NIH,[25] but the timing is relatively similar across many potential funders. You will note at the bottom of the circle that receipt and referral to review takes place over three months. The review of the application and return of your scores takes an additional three to four months. Thus, you wait six to nine months before you even know if a submitted proposal will be funded. What are you doing during that time? Probably working on your project. Thus, for pilot work, you have likely made some substantial progress while simply waiting for a pilot award application to be reviewed, much less funded. Will you resubmit an unfunded pilot award application, or have you progressed enough to be competitive for the larger grant you really want? The answer depends upon your progress. For larger research projects, that ongoing work should position you to have better preliminary data and a stronger resubmission.

For project-based grants, the time between submission and resubmission can allow you to solidify your partner relationships. In either case, producing some sort of publication

[25] https://grants.nih.gov/grants/grants_process.htm, and https://www.nsf.gov/bfa/dias/policy/merit_review/ Retrieved September 14, 2021

or presentation, an exhibition or an article, during the lag between submission and learning the results of the review will help establish you as "the person" in this area. Such publications or activities (depending on your field) will help your resubmission. (See the chapter on developing a brand in Dr. Marc Kutchner's book Marketing for Scientists.)

Try to think of your grant proposal as a multipurpose document. It is not plagiarism to use text from a proposal in a publication. It is not plagiarism to adapt a proposal originally submitted to one funder to target another. Try to make each piece of writing work for you in multiple ways.

Dr. Karen Kelsky, who blogs as The Professor is In, has two absolutely perennial posts on having a five-year plan. These posts focus on graduate students, but as she notes, anyone on the tenure-track should probably have a concrete plan to achieve an excellent tenure packet. Big-picture planning is almost always a very useful enterprise. The plan has more details in the short term and is more sketched out in the long term, but one of the most important things that she notes is the inclusion of deadlines.

> Staying on top of deadlines is exactly what allows a person to achieve huge life goals.[26]

For example, she suggests putting deadlines for meeting abstracts into your calendar with a one-month alert. You can use this strategy for deadlines for grant proposals, target dates for submitting papers, teaching obligations, and so on. It is always easier to deal with what is right in front of us, but we can sometimes use our time more strategically when we think about the overall context. What is important, but not urgent? Important tasks and goals get sidelined by urgent, but often unimportant, tasks.

I would also recommend that you consider taking some time, even only five minutes, to see if you can articulate your larger goal. A personal mission statement can provide context for integrating professional and personal goals. Then the steps in the five-year plan can be designed to provide structure and framework for the incremental steps toward that larger goal. And breaking big tasks into incremental steps is, of course, one of the best ways to get things done.

In the pages that follow, I include a timeline for proposal writing adapted from Dr. Jacob Kraicer's monograph *The Art of Grantsmanship*.[27] (His timeline was adapted from Dr. Tutis Vilis's Survival Skills[28] for graduate students and postdocs, and I have further adapted it here.)

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[26] Kelsky, K. (2020, June 12). In Response to Popular Demand, More on the 5-Year Plan. Retrieved September 15, 2021, from https://theprofessorisin.com/2014/05/09/in-response-to-popular-demand-more-on-the-5-year-plan/

[27] Kracier, J. (1997). The Art of Grantsmanship. Retrieved September 15, 2021, from https://www.hfsp.org/sites/default/files/webfm/Communications/The Art of Grantsmanship.pdf

[28] Vilis, T. (n.d.). Survival Skills for Graduate Students and Post Docs. Retrieved September 15, 2021, from http://www.tutis.ca/SurvivalWeb/frame.htm (Also available on Amazon Kindle.)

These timetables focus on the steps for a grant application. While helpful, they do not include key drivers of long-term success or failure: Seeing how the proposal fits into your longer-term goals. Identifying your primary aim—your Big Why—can help you figure out where to put your efforts and keep yourself "on mission".

Planning a single proposal—smaller projects

Most of the steps needed for planning a large project are needed for planning a small project, but the timeframe is, of course, compressed. Small projects do not require the same amount of preliminary data or other proof of feasibility, but the development of the proposal can take a fair amount of time, largely due to the administrative requirements. These tend to remain the same regardless of the size of the proposal.

Pilot projects

Before writing a proposal for a pilot project *sit down and sketch out the aims of the larger project that you want to have*. Identify where you have deficits that would prohibit an application for a larger project from being competitive. Once you know what gaps you need to fill, write the application for the smaller grant with a clear eye toward how the proposed work will position you to be competitive at the larger level. It will both help you clarify your aims and help you set long-term goals for your program. This approach generally shows reviewers that you have such a plan and are more likely to use the grant to advance the work in a strategic way.

Planning a single proposal—larger research projects

About one year ahead of your planned submission date, for a large-scale grant such as an NIH R01, NSF Standard Grant, or NEH Collaborative Grant, you should start to think about the big question you plan to tackle next and the explicit steps it will take to address that question. In the next chapter, we will discuss the creation of a theoretical or conceptual framework for your proposal that provides the basis for the first page: the Overview (most agencies) or Specific Aims (NIH). If you begin this process very early, you can refine your idea, think critically about the current state of the relevant project(s) in your group, and identify papers in the pipeline. Ask yourself the key questions:

- What is the question we want to pursue in the project?

For a young research group, there may be only one major question. However, as the research group matures, several strands of research questions may develop. Each proposal would focus on one of those strands.

- What will it take to answer that question?

The answer to this question helps you to develop the specific aims or specific goals and objectives.

- What preliminary work do we have up to this point?

There should be some indication of proof of feasibility (see Chapter 6). Often proposals have great proof of feasibility for the first aim, some indication from the second, and almost no support from the third aim. If you have a sense of what your aims will be, then you know where to focus your work to demonstrate proof of feasibility for all parts of the proposed project.

- What "stories" are almost ready for publication?

Papers are the measurable products of research productivity, and recent publication is often used as an easy metric for reviewers. If you have anything in the pipeline, start moving it out. One of the best ways to find out what you need to complete a publication is to start writing. As Dr. Prachee Avasthi said on Twitter:

> PI broken record: you only know what experiments are left to do (and even how to prioritize them) once you start writing. Write now. BEFORE you think you're done collecting data.[29]

As you ask yourself the questions, you may identify smaller parts of the project where you could apply for preliminary support. Apply for pilot funds or smaller grants (see notes above), especially if you need support to generate that preliminary data for your third objective. Even if you do not succeed in winning pilot funds, parts of that proposal can be used in the larger application, or even spun into part of a publication.

Garner feedback about your ideas as early as possible. As discussed in the next chapter, you can start the first page of your proposal on a whiteboard with a few colleagues who will give you honest feedback. About six months before the proposal is due, polish your Specific Aims/Overview page and send it to the Program Officer (see discussion in Chapter 2). If your ideas do not excite your colleagues or find favor with the program you plan to target, it would be good to revisit your central ideas and specific objectives.

If you do have positive feedback, then continue forward with the rest of the proposal. Everything follows from the Specific Aims/Overview page. The aims provide the organization for the research plan. The process of thinking through your aims contributes to the design of your research plan.

It will take time to get letters of support from the upper administration. This is especially true for letters promising material support, such as matching funds, support for graduate students, and so on. A faculty member once asked their Provost, while walking in the streets of Boston's Chinatown, for a $1,000,000 match for proposal that was due the next day. As you can imagine, the conversation did not go well. Don't be that person.

[29] Avasthi, P. (2018, January 29). Pi broken record...Twitter. Retrieved September 15, 2021, from https://twitter.com/pracheeac/status/958038593053843456.

Planning a single proposal—Programmatic projects

Projects designed to carry out a program can often be written in a shorter time frame, but you still need to plan. For example, if you plan to work with a school system, you will need to have concrete letters of support. These can be difficult to obtain. Similar to research proposals, there are a few things you need to consider.

- What do we want to achieve?

The objectives should reflect measurable outcomes. When crafting the overall objective, give thought to how you would know you completed it. Many program proposals require evaluation plans, and it helps to include input from the evaluator early.

- What will it take to achieve that goal?

The answer to this question helps you to develop the specific activities you will propose.

- What do we bring to bear?

A clear sense of what you already have helps to define what you need. This is the first step to creating a Logic Model, which many program grants require.[30]

Getting Organized

Make a list of everything that goes into the proposal, from Abstract to Facilities & Other Resources page, and make a plan to pull everything together. You can make a checklist in Excel or a table in Word and track your progress. Some days you may have time on your calendar to work in your proposal (see time management, below), but may not feel tremendously productive that day. Use that time to polish your Facilities & Other Resources page, or to pull together biographical sketches from your collaborators or letters from your community partners. Several months before the project is due, begin to get quotes for equipment, work on budgets, and solicit letters from your collaborators.

About one month ahead of the due date, start to put together all the pieces that you need. If you personally upload grant forms to your target funder's electronic grants management system, open a proposal and learn how it operates. Federal agencies have their own, such as ASSIST (NIH), Workspace (the Grants.gov portal), or Research.gov (NSF replacement for FastLane). Some NEA solicitations have required a Grants.gov form on one due date, and a proposal uploaded through their own website at a later date.

[30] Logic models can serve as great tools for planning out what you need to do the project and clearly articulating what the expected outcomes would be. Some USDA proposals require a 2-page logic model. Do it first, not last! Here is a great resource: W.K. Kellogg Foundation. (2004, January). *Logic Model Development Guide*. Wkkf.Org. Retrieved September 14 at https://www.aacu.org/sites/dfault/files/LogicModel.pdf

If you ask a program officer what one thing they wish applicants would do, the answer is usually, "Read the solicitation. Read the instructions." If you teach undergraduates and find yourself repeating, "It's in the syllabus," consider that program officers often feel the same.

Read the instructions! Find everything that you will need to upload. Also, touch base with the staff in your sponsored programs office. Let them know at least a month ahead of time that you are planning to submit, the deadline, the link to the funding opportunity to which you are responding and anything else they ask for. Make sure you know what internal paperwork you need and what internal deadlines you must meet. Every federal grant comes with strings attached. There are specific rules on budgets and cost sharing, for example, and did you know that with every federal grant submission, the institution certifies that it is a Drug Free Workplace? The administrators know those details so you don't have to. Their job is to keep you and the institution out of trouble. Be nice to them. Give them what they need and don't be the person with the 4:45 submission for a 5:00 pm deadline, expecting the sponsored programs staff to just press Submit without a compliance review. If you give them what they ask for by their internal deadlines (or sooner), they usually will bend over backward to help you when you have a real problem.

Try to get an early and complete draft done at least two weeks ahead of the deadline so that you can have it read by at least two other people. While they review your proposal, make sure that you have all your administrative forms, budgets, etc. together. Then, integrate your readers' comments as much as you can. Elements that may make sense to you may not make sense to your outside readers because you are close to your subject and they are not. Remember that these readers represent your potential peer reviewers in a real sense. If they do not understand your project, the peer reviewers will not, either. Also make sure someone reads it purely for grammar and typographical errors. As I often tell people, do no trust the spell-checker.

A colleague of mine learned the hard way to check the proposal image before submission. In her case, every single β had turned into ■ in the conversion to PDF. Note that copying and pasting from Word into web forms can create problems with special characters. Word may automatically change a straight apostrophe to a curved quote, but the web form may only use basic ASCII characters. That curved quote mark will turn into a question mark, as in don?t.

If you do not have to upload documents or fill out all the forms and yourself, make sure you get them to your sponsored programs office as early as possible. Before they press the Submit button, make sure everything has been uploaded and then look at the proposal image on the grant submission portal, if you can. This is the version that will be made available to the reviewers. Be sure that everything looks the way you wanted it to and that the conversion from web form to proposal image has not created a problem. If you can do this a day or two before the final due date, then you have time to fix any errors.

As noted above, the timelines that follow are adapted initially from Dr. Jacob Kraicer's monograph *The Art of Grantsmanship*.

Ideal Grant Writing Timeline – Larger research grant

Start

Preliminary Data

Preliminary Draft

feedback

regulatory issues

details, details

mock deadline

1 Year

9 Months

6 months

4 months

2 months

1 month

- Draft preliminary aims/objectives on a white board
- Critically look at field, your data
- Get papers in pipeline
- Seek preliminary/pilot support (see shorter/pilot timeline)

Polish your Overview/ Specific Aims!
From there, all else follows.

- Block off time
- 1 to 4 hours in a day for writing and reading, more near deadline
- Put it in your calendar
- Do not look at or answer email during set-aside time

- Start filling out protocol forms for Animals, Human Subjects, Authentication of Key Biological and Chemical Resources, etc., etc.
- Gather Biosketches and Letters

Contact your Program Officer

mock deadline

final version

grant package

DONE

Touch base with Sponsored Programs; start Checklist

1 month

Get someone you trust to tell you the truth

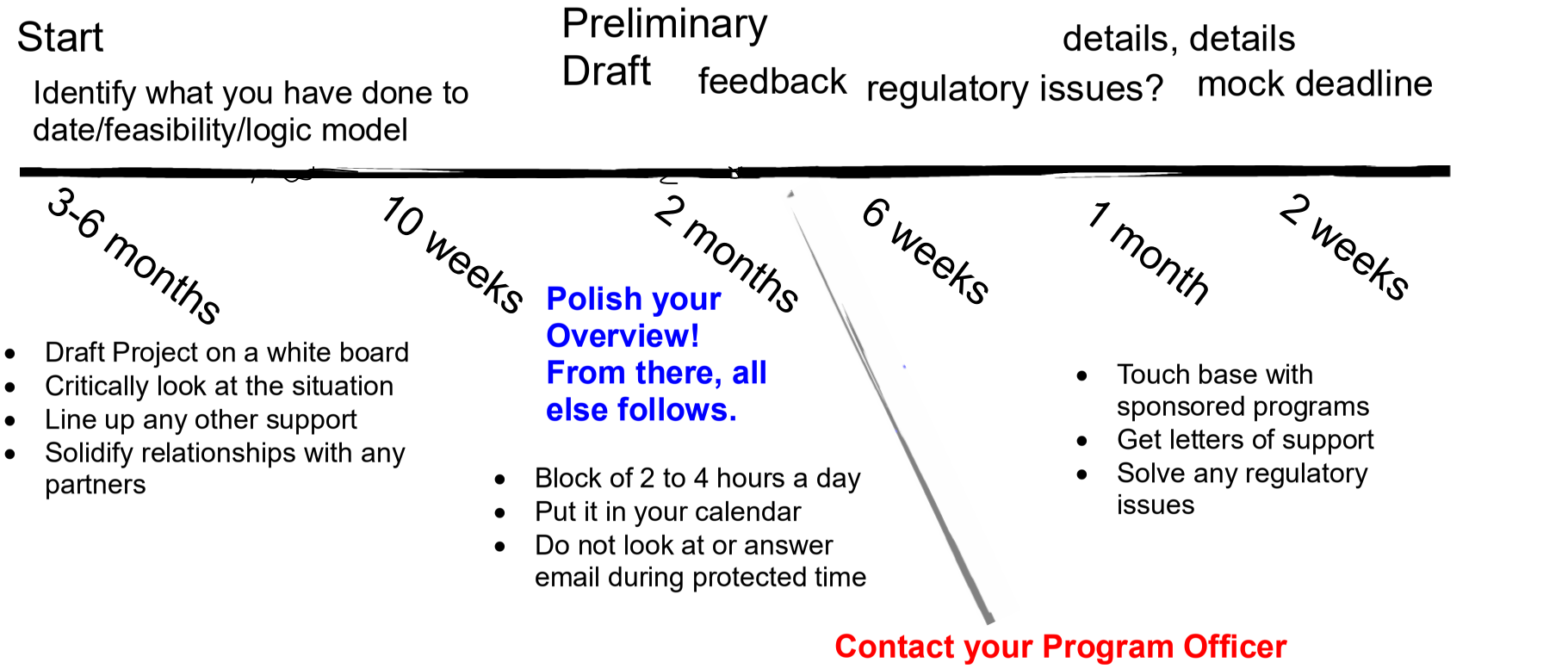
2 weeks

- Print it out and proof read
- Do no trust spellcheck

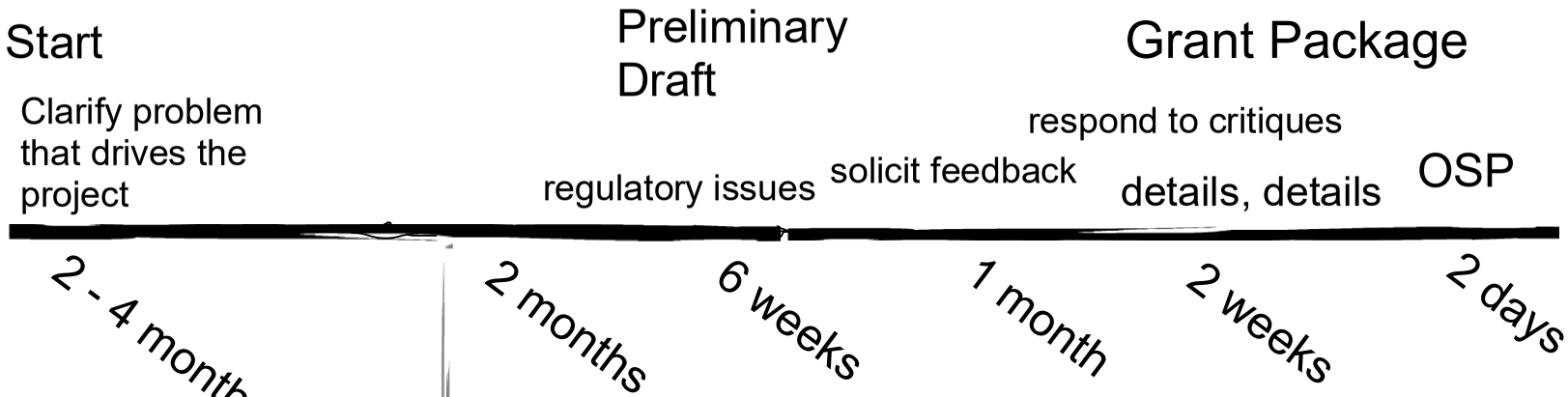
1 week

Look at PDF image on sponsors sub mission portal, fix problems

Ideal Grant Writing Timeline – program grant



Ideal Grant Writing Timeline – shorter/pilot proposals



For pilot funds:

- identify why you are not competitive for the larger proposal
- craft aims/objectives based on what is needed to position you for the larger project

For all smaller grants:

- solidify any partner relationships
- identify clear endpoints

For all:

- block out time!
- what will this small grant allow you to do?

- solicit letters of support
- work on the budget
- get familiar with sponsor grant portal
- gather additional documentation

Contact your Program Officer

Time management

I've seen a few techniques for time management work particularly well for academics.

- Keep office hours as office hours. Can you really be available to students all the time? Should you? Have them make appointments for meetings outside of office hours. Tools like Calendly.com can help you set when meetings can be scheduled.

- Put time on your calendar for reading and for writing and *show up*. You wouldn't go to a room full of students ready for class, stand up in front of them and check Facebook or Slack on your phone, would you? Be as courteous to yourself when you show up for reading or writing time. Pick a time that works for you.

- During your set-aside time, exit your email program so you won't see any alerts. Even if you do not open the email, the alert will disrupt your thinking. There are now many apps to support you in focusing, including one built into Microsoft Teams.

- Turn off your cell phone and other messaging apps if you can, or use Do Not Disturb settings. Many phones have a way to identify numbers allowed to ring through Do Not Disturb, a useful way to be available for emergencies but quiet all the other notifications.

- If you need to look up something on the web, write it on a sticky note and put it on your monitor. Look it up after writing time. As soon as the web browser is open, it is too easy to check on social media or the news.

- Consider a sign for your door that says you're not available, perhaps something both humorous and direct. ("Is it bleeding or on fire? If not, please go away. #AmWriting.")

- Find the time of day and method that works for you. Some people like the Pomodoro method (named after a tomato-shaped kitchen timer), to break workflow into 20 to 25-minute increments. You needn't buy a physical timer; there are many equivalent apps. I use a timer as a lead-in to a sustained 90 minutes, which I prefer because many of us take about 15 to 20 minutes to get into the flow of the work. The discipline of the timer helps me initiate my 90-minute writing session to start the focus, but when it goes off, I usually ignore it and keep working. But no one method or time of day works for all people. Find yours.

Chapter 4: Specific Aims/Overview: the Framework

Your grant proposal is a sales document, and all the principles of marketing apply. If the thought of "selling" your idea doesn't sit comfortably, think of it as an argument. You need to make a solid, cogent, and compelling argument for the work you want to do. This first page gives the reviewer a condensed prospectus. The NIH has a required, separate Specific Aims page, but NASA and the NSF do not. However, if you read the solicitation for almost every grant proposal, you will find instructions to give a concise overview at some point. See the following three sets of instructions.

> **NIH Specific Aims:** State concisely the goals of the proposed research and summarize the expected outcome(s), including the impact that the results of the proposed research will have on the research field(s) involved.
>
> List succinctly the specific objectives of the research proposed (e.g., to test a stated hypothesis, create a novel design, solve a specific problem, challenge an existing paradigm or clinical practice, address a critical barrier to progress in the field, or develop new technology).[31]
>
> **NASA:** The goals and expected significance of the proposed research, especially as related to the objectives given in the NOFO [Notice of Funding Opportunity]…[32]
>
> **USDA/NIFA:** Include a clear statement of the long-term goal(s) and supporting objectives of the proposed project.[33]

Many NEH proposals require a first section called "Intellectual Rationale", with very similar instructions. For any potential funder, the importance of this page cannot be overstated.

Readers either turn to Specific Aims page / Overview section first, or they start with the Abstract/Project Summary, which should be created out of the Overview (see Chapter 10). Almost all reviewers will tell you that by the end of the first page, they have made their

[31] General Instructions For NIH And Other PHS Agencies. October 16, 2020. Retrieved September 23, 2021 from: https://grants.nih.gov/grants/how-to-apply-application-guide/forms-e/research-forms-e.pdf
[32] Guidebook For Proposers Responding 5o A Nasa Notice Of Funding Opportunity (NOFO). NASA. 2021. Retrieved September 19, 2021 at https://www.nasa.gov/sites/default/files/atoms/files/2021_ed._nasa_guidebook_for_proposers.pdf
[33] Agriculture and Food Research Initiative Competitive Grants Program April 4, 2021. Retrieved September 23, 2021 from https://nifa.usda.gov/sites/default/files/rfa/FY-2021-2022-AFRI-FAS-MOD2-V2-RFA-508-F.pdf

gut-level decision. What do you need to make a positive first impression? First, you need a good layout and information that is easy to find and digest.[34] The substance within the layout needs:

- Clear flow of ideas
- Connections between the ideas

Reviewers want to come away from your first page with a clear flow of what you plan to do, why it is important, and how you plan to accomplish the work. It also helps if they have a sense of you and of your capabilities. There are several ways to convey this information effectively, and in fact, there is no magic bullet or perfect outline. If you read successful proposals, you may notice they can differ wildly in form and format, but the order of information tends to follow a pattern. You have to frame a problem that your reader will care about and then convince the reader that you have the right solution. The pattern of ***problem: solution*** describes the overall structure of the page, structures within paragraphs and the structure of each specific aim/objective.

Some of the discussion in this chapter owes a great debt to two Northwestern University CLIMB program videos on YouTube. They are titled "The Patterns of Introductions in AIMS Pages" and "Specific Aims and Conclusions in Aims Pages". You can find them on YouTube by searching the titles. In the first video, the unnamed speaker dissects the rhetorical patterns commonly found in the first paragraphs of a successful proposal to the NIH. In the second video, he discusses how to present the specific aims or objectives of the proposal and what information should be included in a closing paragraph. They use examples from proposals to the NIH, but I highly recommend anyone to watch the discussions.
https://www.youtube.com/watch?v=5XFbo_2IdYE
https://www.youtube.com/watch?v=aum4Nurz4uM

The following information needs to be on the first page:

- General scope of the problem
- The state of the art (or current circumstance, for programs)
- The gap in knowledge or barrier to progress (or need, for programs)
- The longer-term goals of the [research] program
- Relationship to funder priorities
- A clear statement of the objective
- A central hypothesis or research question (as and if appropriate)
- Proof that the applicant can carry out the work
- The specific objectives
- The expected outcomes
- The impact

These elements of information have also been described as rhetorical moves. The specific rhetorical structure can vary, but it does not vary widely. Many of the elements of the first page will be reflected in the rest of the proposal. For example, the "state of the art" will be

[34] Do not underestimate the negative impact of a Wall of Text.

expanded in the Background section. The "impact" will be further nailed down in the Significance section.

In an analysis of grant proposals across disciplines, Dr. Ulla Connor expanded on her previous work and suggested the following rhetorical moves: [35]

1. territory
2. reporting previous research
3. gap
4. goals
5. hypothesis or research question
6. means
7. achievements
8. benefits
9. competence claims
10. compliance claims
11. importance claims

These essentially map to the bullets above.[36] "Compliance claims" maps in part on to the relationship to the funder's goals, but can also include explicit statements, such as, "This is responsive to Goal 3 stated in the solicitation because…" In the formulations we discuss below, I recommend stating a long-term goal that is clearly in line with the funder's priorities, combining several of the rhetorical moves (compliance claim, territory, and importance) into a single sentence (see Chapter 5 for examples).

Understanding these structures can help you write a grant proposal that accomplishes what you need to accomplish: communicating to your reviewer what you want to do and why it is important. Simply checking boxes ("Got that rhetorical move!") doesn't work. There is no magic bullet, and writing style ultimately matters so that the clear flow of the information pulls the reviewer along. The framework here is a thinking tool. The rhetorical moves can only succeed if there is substance behind them.

These opening sections may have different names for different funders. As noted, the NIH has a one-page Specific Aims as part of the application. For the NSF I recommend an Overview section as the first part of the 15-page narrative. For proposals to the USDA, the Introduction, which includes background and significance, should begin with an Overview section. Unless there is a cultural expectation for a specific section title or one given in the solicitation (e.g. Specific Aims for the NIH, or Intellectual Rationale for NEH Humanities Connections), title this key opening section Overview.

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[35] Conner, U. (2000). Variation in rhetorical moves in grant proposals of US humanists and scientists*. Indiana University in Indianapolis, 1–28. http://www.users.miamioh.edu/simmonwm/Connor_rhetorical_grants.pdf I added Central Hypothesis or Research question to her list, based on her comments in the article.

[36] As part of the analysis of US proposals, Dr. Connor noted that US proposals were more likely than EU proposals to include a hypothesis or research question.

Writing this page is a process more of thinking than of wordsmithing

Some successful grant writers will tell you that they spend about 50% of total proposal development time on this page. That time estimation includes all the work needed to write the research plan, craft the budget, get the biosketches together, and so on. They do not spend all that time changing wording or moving commas; they spend time thinking.[37]

The aims or objectives you articulate on this critical first page provide the basis for everything in the proposal. All the review criteria will be reflected here: significance of the idea, appropriateness of the plan, conceptual or technical innovation, and strength of the team and environment. Before perfecting the wording, you need to think through the plan. This is why I suggest first using a framework to establish the major ideas and the connections among them.

Start writing this page well in advance of submission

The ideal grant timeline given in Chapter 3 shows that you should begin drafting the Overview/Specific Aims a full year ahead of the planned submission date for a larger investigator-initiated proposal. That's no joke. Here are five reasons:

I should also note that my mentor and former colleague Dr. Stephen Russell observed that when he began to write the NIH Specific Aims page a year ahead of his targeted submission date, not only did his success in funding double, but his publication rate doubled as well.

1. The first step for any research proposal is to think about the state of the field (literature) and of the current progress in your group (preliminary data). As part of the process, you may identify papers from your group that are either ready to be written, or that could be completed with just a bit more work. Reviewers look at productivity and writing the paper(s) will also help you think about important next steps that you want to propose.
2. Many research proposals with 3 aims/objectives[38] will, as noted earlier, often have uneven preliminary data for each aim/objective. If you start your Overview/Specific Aims well before submission, you have time to think about the supporting data you would need and can make sure the work gets done.
3. Attention to the supporting work needed for the aims/objectives can help you look at the incoming results in a critical way. When we read or write a paper, we have a linear narrative, but the work almost never progresses that way. Thinking about the data in context of the proposal can help provide some focus. Is this a rabbit

[37] "No one should write a grant proposal without thinking first." Quoting from Bev Browning, Grant Writing for Dummies, Hungry Minds, Inc., 2001.

[38] We use aim and objective interchangeably in this context. The word you use in the proposal will depend on the culture of your funder.

trail and you need to get back on track? Or is this a new and unexpected direction you should explore?

4. New collaborations can take time to solidify. When you start clarifying your plans for the project, you may identify parts where a collaborator would add strength. If you've published a paper, or even co-presented a poster with a collaborator, the reviewers will see evidence that you can work together productively and that the proposed project will likely succeed. Also, when you engage a collaborator early in the process, they may be more engaged and will give you better input.
5. The earlier you start, the earlier you can get the input from peers and colleagues to hone your ideas. In the section on idea development in Chapter 1, you'll find mention of someone whose second or third draft of the Aims/Overview page is on a whiteboard with two or three colleagues who provide critical input (see "the banana bread principle"). It would be better to invest your time in an idea that your colleagues find exciting, but you won't know what they think until you ask.

Create a theoretical or conceptual framework for your proposal

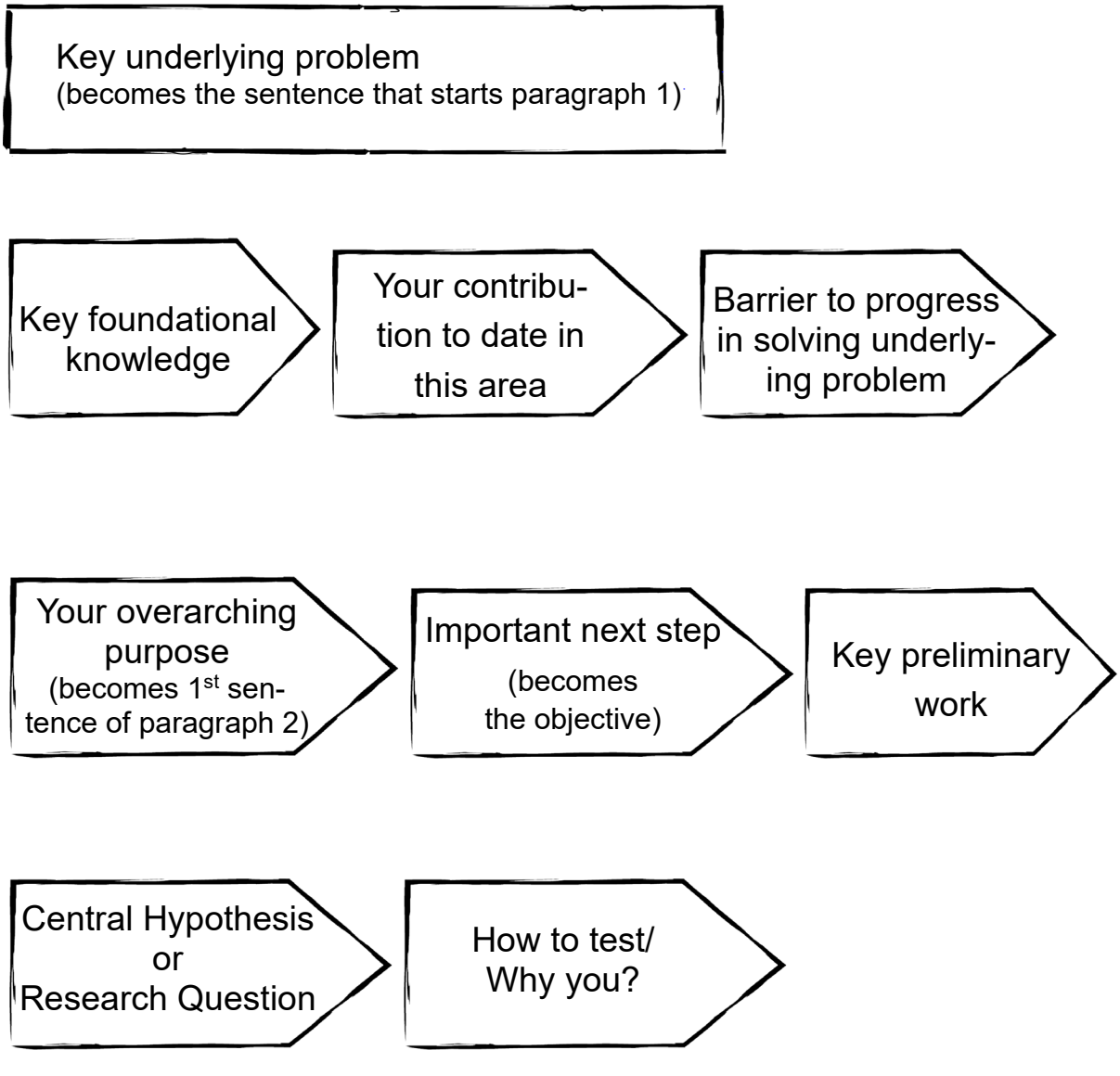
The phrase "theoretical framework" may be more familiar to researchers in social sciences or those outside of other STEM fields. The theoretical framework or conceptual model is the structure that guides your research. In some fields, people create explicit theoretical frameworks. In others, they are implicit. If the phrase is new to you, you're probably in the latter group.

Theoretical frameworks always start with the literature, from which you identify a research problem, the important gap in knowledge. The framework also helps to identify effective ways of doing the research—what you will measure, what statistical approaches you will need, or what elements a program will need to succeed. Most preliminary work could be used to support more than one project, depending on the starting place for the framework.

In the following pages, you will find one approach to creating a framework, and how the framework can translate to the outline of your Overview/Specific Aims. The framework is laid out as a worksheet or whiteboard guide. You can start to build your framework from almost any point within the frame. It may be easier to construct the page in a non-linear way. Sometimes I don't craft a central hypothesis until after clarifying the specific aims. Sometimes I start with the objective, and then think about why that objective would be important, which helps me to frame the key barrier to progress.

As the page develops (and your framework develops), expect parts to change. In creating the aims/goals/objectives, you may realize that the project as it stands would be considered overly ambitious for the amount of money and time the funded grant would afford you. Perhaps you could pull out part of the project and turn it into yet another proposal.

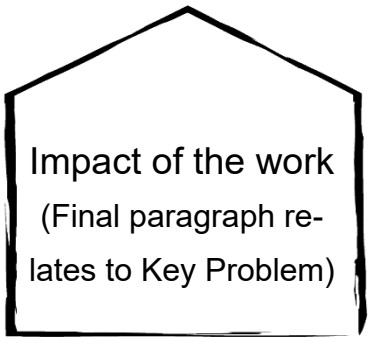
Tool to create a conceptual Framework



Aim/Objective 1: Problem: Solution

Aim/Objective 2: Problem: Solution

Aim/Objective 3: Problem: Solution



Regardless of the specific subject, the framework is designed to help you create a clear flow of ideas and connections between the ideas.

- The first sentences of each of the first two paragraphs and the last sentence of the Overview/Specific Aims should all relate to each other.
- The places where you indicate what you have contributed, the preliminary data and "why you" all relate to each other, showing your trajectory and capabilities.
- The overall objective relates to the key barrier to progress.
- The specific aims/goals/objectives together test the hypothesis or allow you to achieve the overall objective.

The logic of your overview needs to be linear, so that it is easy to read, reflective, and creates a coherent whole.

As noted above, *the specific order of information can vary depending upon the best way to communicate your ideas*. The most mobile element is the *key preliminary data*. The default outline places *key preliminary data* in the second paragraph, before the hypothesis or research question, to set up the basis for the hypothesis. The information might be better in the opening paragraph to help frame the barrier to progress. Your own published work may need to be mixed with the key foundational knowledge to create a clear flow for your argument and framework. You may need to include different specific points of preliminary work in different places. The point here is to think about the kind of information your reader needs, why they need to know it, and when they need to see it. In the sections below, we will discuss the purpose of each part of the Overview/Specific Aims framework and how to best harness them to make your argument and sell your story.

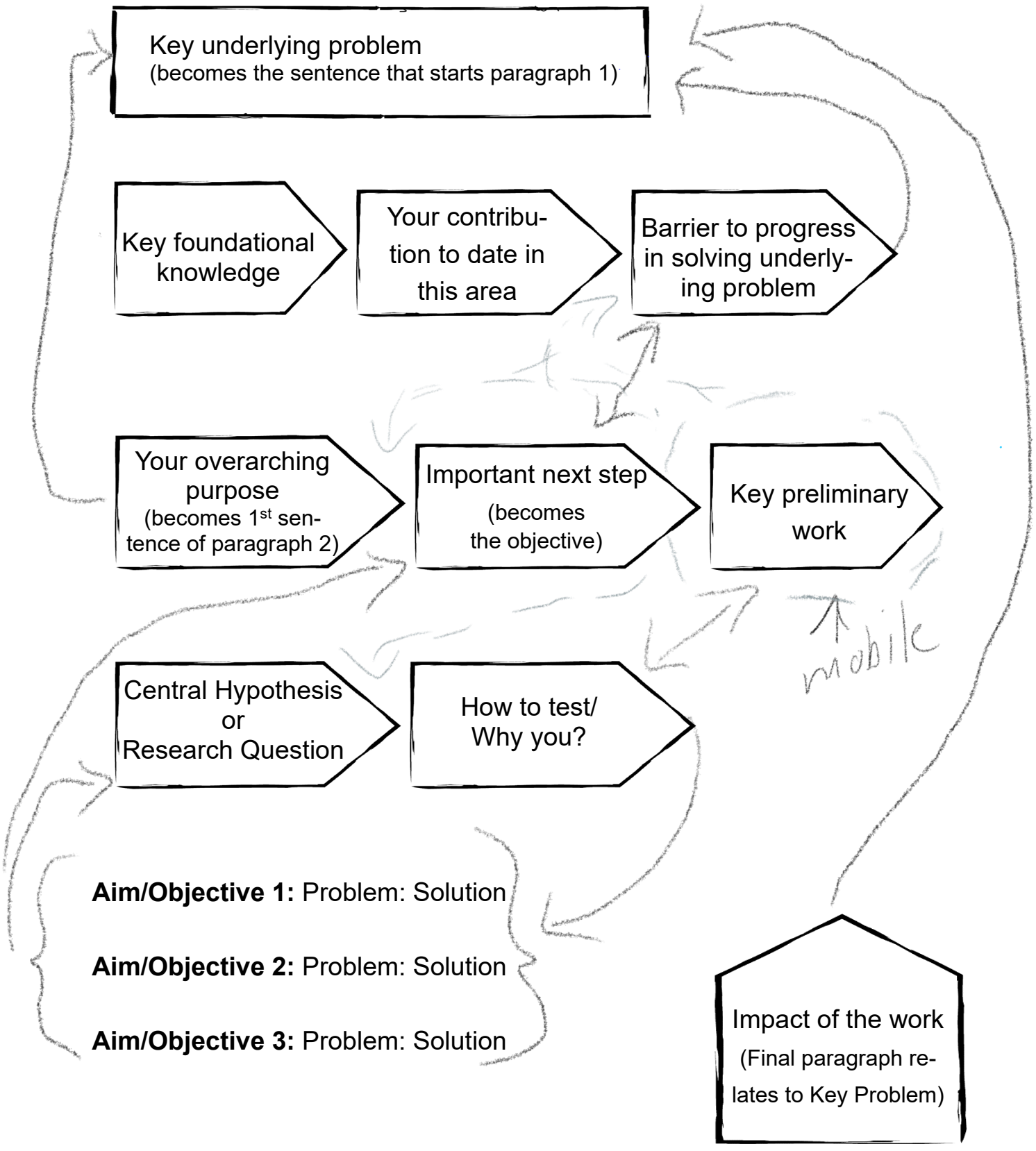
For arts and humanities and program proposals, or for some mathematics proposals, you may not need every piece of the theoretical framework. For example, the central hypothesis or research question may not be appropriate for a proposal to complete a book or create an artwork. It might not make sense to delineate specific aims/goals/objectives for some mathematics proposals or for NEH fellowship proposals.

Respect the norms of your field for elements such as central hypotheses or research questions and think consciously about how someone else will read this page. They are not you and do not share your assumptions or knowledge base. Tell them what they need to know in an order that builds your argument, your story.

Flexibility in the framework

On the following page you will find the framework with a lot of lines scrawled on it to show the relationships among the ideas and some flexibility in the structure. Black lines show how the ideas you present relate to each other—which ones must connect. Gray lines show flexibility in where the preliminary work can be placed. What you choose, in terms of the final order of the information, translated from framework to prose, depends on what your reader needs to know and when they need to know it.

Relationships among the parts of the framework

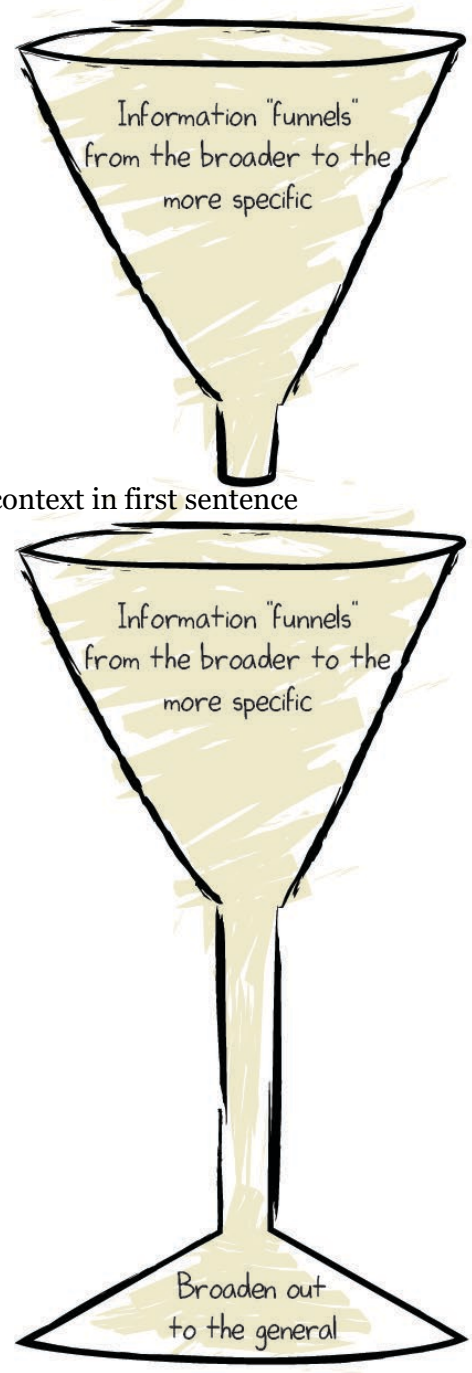


You may also note that the rhetorical moves listed on page 41map onto the framework, such as how “territory” is defined in the opening sentence as the key underlying problem, and the “gap” in the problem statement as the key barrier to progress. The "compliance claim" generally shows up in the long-term goal. Some moves show up in more than one place. The “means” rhetorical move (how the goal will be achieved) can show up implicitly in the discussion of the preliminary work and explicitly in both the “How to test/Why you?” box and in the specific aims/objectives. The "competence claim" shows up implicitly and explicitly in both "Your Contributions to Date" and in the "How to test/Why you?" box.

Dr. Connor analyzed full proposals to identify the common rhetorical moves[35], but the this first page contains the microcosm of your full proposal. This single page, known as the Specific Aims page for NIH, and the Overview for many other funders, serves as the entry point for your reviewers. Most of them will form their first opinion based on this page, and you must give them clarity as to what you want to do, how, and why.

Chapter 5: Turning the framework into a Specific Aims or Overview Page

The framework can result in the following outline for a research proposal (see additional outlines at the end of the chapter):



Paragraph 1: The problem

What is the context? Why is this important?

What key information does the reader need?

How have you contributed so far?

What is the key unresolved problem?

Paragraph 2: The solution

Provide a framework for your arc – a long-term goal that relates to context in first sentence

What is the objective (relates to solving the unresolved problem)?

What preliminary work do you have?

[What is your central hypothesis?]

What is the general approach to solving this problem/ testing the hypothesis?

Show that you can undertake this approach

P**aragraph 3: Specific Objectives (What, exactly, do you plan to do?)**

1 Problem: Solution

2 Problem: Solution

3 Problem: Solution

Paragraph 4: Impact

What impact will the work have? (relates to opening sentence)

The top funnel and martini glass in the outline version indicate how these paragraphs start with the more general and move to the specific. The base of the martini glass indicates that you should end by placing the proposed work back in the broader context by describing the impact that you expect it to have. At the end of this chapter, you will find three versions of the outline corresponding to research projects, program projects, and arts projects.

It is much easier to teach a static outline. But in my experience across many potential funders, one size does not fit all. Every funder needs the same information from their perspective: *Why this project? Why should it be done now? Why should we fund it? Why is this the right person to do the work?* In this chapter, in the entire Handbook, I hope to share tools, such as the rhetorical moves in the last chapter, that you can use. The goal is to actively think about the process of communicating with your target audiences, the reviewer and the funder.

Let us pull that outline apart and talk in more detail about what goes in each part of it.

Key underlying problem

> "Your goal as a grant writer is to pull your readers forward through your text in a way that entices them to want to find out more about the project."

The quote is from Dr. Morgan Giddings' book 4 Steps to Funding.[39] You need to "hook" your reviewer from the very first sentence. Each sentence that follows has to flow logically from the one before. As you work through the Aims/Overview Page, you add detail. It may seem that you circle back to concepts, but every time you revisit an idea, you add depth and complexity. Everything starts, though, with the first sentence.

The first sentence does not contain the specific problem that you plan to address, but rather a bigger picture of the important area within which your specific project sits—the territory. The computer screen is blank. You have to start somewhere. Many writers start with a "throat-clearing" sentence.

> Cardiovascular disease is a leading cause of death in the United States.

Would a proposal starting from this sentence be about population behaviors, exercise intervention, or molecular cardiology?

> Children in under-resourced schools have lower graduation rates.

Would a proposal starting from second example be about systemic issues with school funding or individual student impacts?

[39] Giddings, M., 4 Steps to funding, 2011. ISBN 978-0-615-50558-9, Page 74

> The arts provide an enriched experience in our shared humanity.

What is this proposal about? Would a reviewer know whether this proposal was for a Fulbright Scholar to travel to Nepal or a project for a local middle school?

The answer to all these questions is that you can't know without more context. As with journalism, "Don't bury the lede."[40] Also, don't mislead. Take for example the following opening sentences:

> Breast cancer is a leading cause of death in post-menopausal women. While the etiology of such cancers is quite broad, there is a strong influence of genetics in pre-menopausal breast cancer.

The first sentence tells you nothing new, and in fact misleads the reader. This proposal isn't about cancer in post-menopausal women. It's about genetics in early-onset breast cancer. Many writers try to set up a contrast, but instead set up an expectation that they won't fulfill.

It's fine to write a "throat-clearing" sentence, but do not leave it there. If you use a theoretical or conceptual framework ahead of sitting down to write, it will help to clarify the overarching or underlying problem wherein your specific research questions fit. It can help you get to a good "lede" faster.

We can take the "throat-clearing" examples from above and get to the point. For a more general scientific audience, you might write something like the following.

> The obesity-related risk factors known as metabolic syndrome can have implications at the level of the cells that line the blood vessels.

This narrows the project to cellular metabolism. If the target audience is broad, such as the reviewers for a university-wide internal pilot award or for a foundation, a sentence like this would tell them the area of research. On the other hand, if the target reviewers are the NIH study section, you can dive in even deeper.

> Patients with metabolic syndrome often have cardiovascular co-morbidities, but the impact of changes in insulin metabolism on vascular endothelial function is not clear.

Let's look at a revision of the second example.

> Lack of school resources correlates to lower graduation rates, and there are several theories as to the specific causal relationships.

[40] See lede vs lead, journalism jargon. Duffy, M. J. (2018, June 14). Lede vs. Lead - Matt J. Duffy. Medium. Retrieved September 23, 2021 from https://medium.com/@mattjduffy/lede-vs-lead-69d4e82c1ae1

This project would likely be about determining which theories most correlate to reality in student retention rates.

> Building empathy is a critical step in decreasing bullying behavior, and there has been speculation that group musical activities promote empathy.

This project could be about using music for an anti-bullying program, or it could be centered around a research question on the relationship of group musical activities on the individual students or climate of the school.

"Every grant application must answer the question, ***So what?***"[41] You can start delivering the answer to the question in the opening sentence. Where does your idea sit in the grander scheme of things? What direction do you plan to take the project? Why should the reader care about it?

Why not begin with the objective? For those applying to mission-driven agencies, such as the Department of Energy or NASA, reviewers have a strong cultural expectation that the proposal will begin with something like, "The objective of this proposal is…" I do not typically recommend beginning proposals with the specific objective because the reviewer does not yet have any context as to why they should care about the very specific thing you propose to do. For such proposals, I use the first sentence in the same way that I describe here but phrased as a larger objective to frame the larger area or problem in which the specific proposed project sits. Then, when I state the specific objective later in the first page, I frame it as the specific part of the larger problem addressed in the proposed project. You could consider having an opening sentence framed as, "The overall objective is to address a critical element in the efficiency of argon-based lasers." In the second paragraph, as noted below, you would state the specific part of the problem you propose to solve to help improve laser efficiency. "Our objective here is to improve the power and temperature requirements."

Key foundational knowledge

Any framework you create should have a solid foundation in the previous work, but you cannot give a complete literature review in a single paragraph. What are the most important concepts or data? The purpose here is to give the reviewer the information they need, so that when you frame the problem, they understand why that problem is important.

The story you tell is critical in keeping your reviewer's attention. I recommend you draft these two or three sentences with no regard to citation. It will change the way you write. Your reviewer may already know some of this information, but they may not know the connections you have made. Your job is to show the context for the work you propose, not try to cram a full literature review into the paragraph. When you do include citations, give only key citations, those without which a sentence would not be believed. If you're tempted to include two to five citations after a sentence, don't. Give them later.

[41] Dr. Beatrice Rogers, Tufts University Friedman School of Nutrition Science and Policy, personal communication over lunch, approximately 2005.

Your contributions to date

For those writing program proposals, the "previous research" means the current situation. If you have information on a target audience for an outreach program that helps convey why they need the program you propose, that information goes in the first paragraph. Also, some information about your relationship with the group helps to establish you as the right person to identify the problem and the potential solution and demonstrates credibility with your target audience so that they would participate in the program.

The work of others gives only part of the context. If you propose a project in a specific area, typically you already have some experience in the field. What have you contributed to the field so far? By including your relevant published work here, you demonstrate that you have already contributed to the field and, thus, are well versed in the gaps. These sentences should lead up to identifying the barrier to progress. As with the foundational knowledge, write this section first without citation and put in the key references after you have the story in place.

As noted above, the suggested order of information here is not absolute. Information about your contributions may flow more logically if mixed in with the work of others. Keep in mind why the reader needs the information and when they need to know it. It may seem odd to think about it this way, but a good proposal builds a story in the reviewers' minds. They may already know the facts you write here, but not framed the way you will structure the information to make your argument. Your goal is to build an argument that there is an important problem.

The additional goal here is to demonstrate that you already have a presence in the field. If you have already published in the field, that provides evidence that you are well positioned to identify the key barrier(s).

These two boxes in the framework, the foundational knowledge and your contributions to date, do not have to be linear. Don't just give facts. I advise above that you draft this without citation so that you will build a narrative. You may need to go back and include key citations—those without which the statement would not be believed, or your own newest work—*but tell the story first*.[42]

Key barrier to progress

What needs to happen next? What is the gap in knowledge or barrier?

> It is important in a proposal that the problem stand out—that the reader can easily recognize it. Sometimes, obscure and poorly formulated problems

[42] ***Human brains love stories.*** See: Zak, P. (2014, November 10). *Why Your Brain Loves Good Storytelling*. Harvard Business Review. Retrieved September 23, 2021 from https://hbr.org/2014/10/why-your-brain-loves-good-storytelling Also https://www.americanscientist.org/article/the-science-of-narrative

> are masked in an extended discussion. In such cases, reviewers and/or committee members will have difficulty recognizing the problem.[43]

This quote from Prof. Frank Pajares's excellent monograph, "The Elements of a Proposal", summarizes one of the most common mistakes in proposal writing: the lack of a clear statement of the problem you propose to solve. In a proposal, you have very little space for an extended discussion, hence the recommendation that you limit the discussion of foundational knowledge and work to date to a few sentences. These framing sentences should be carefully crafted so that you can next present the problem, the barrier to progress, and the reviewers will have enough information to understand why the problem is important.

Every part of a grant proposal needs to answer the *So what?* question, not just in the opening sentence. The proposal also must answer the *Who cares?* and *Why you?* questions.[44] It is not enough to simply state the gap or the barrier; the reader has to understand why that gap is important. Sometimes stating the gap or barrier alone will convey the urgency. Sometimes an additional sentence or two explicitly stating what needs to happen to overcome the barrier will help convey the urgency. In creating your framework, think about three questions:

1. What important information is not known, or what thing is lacking, that creates the barrier to progress?

This question helps you frame the problem statement. You should additionally think about this question in the context of your reviewer and potential funder. "Who cares?" You can often look at a problem from many directions, and the framework you create needs to tell the story that your audience cares about.

2. What needs to happen to overcome this barrier?

This question helps you frame two elements: the need (stated in the first paragraph) and the objective (stated in the second paragraph). The objective should be to overcome the barrier, so what do you need to do? For some proposals, you may want to state a critical or urgent need as part of the first paragraph.

3. Why is it bad if this barrier remains in place?

This question brings you again to the impact of the work. If circumstances stay as they are, what are the consequences? You may want to state this in the opening paragraph, or you can put the information in the discussion of Significance. Wherever it ends up in the proposal, thinking through the "So what?" aspect will help you improve your argument.

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[43] Pajares, F. (2007). *The Elements of a ProposaL*. Emory University. Retrieved September 27, 2021 from http://www.uky.edu/~eushe2/Pajares/ElementsOfaProposal.pdf *Strongly recommended for those in social science and humanities.*

[44] See Wendy Kennedy's "So what? Who cares? Why you?" design methodology. WKI. (2021, January 21). *Entrepreneurial training and coaching program using design thinking tools*. Wendykennedy.Com Inc. https://wendykennedy.com/the-methodology/ Retrieved September 27, 2021

Turn the question around. If you overcome the barrier, what will become possible? If you do not, what are the consequences?

The first and third questions frame the problem, and the second one creates the Objective (see below). Using these questions will help you craft an ending to the opening paragraph. Make sure your reviewer (and your funder) understands why this work needs to be done. Phrases like, "Without this knowledge we cannot..." can be useful for you as starting places for the third question.

I do not recommend ending this paragraph with the statement of what you plan to do. End with the problem so that they will want to read the next paragraph to discover your solution. Remember also that this statement relates to the opening sentence because it defines the barrier to progress for that key underlying problem, the overall territory laid out in the first sentence.[45]

The problem statement also must be relevant to your potential funder.

Your overarching purpose

What is the arc of your research program? How does it relate to the key underlying problem you identify in the first sentence? The second paragraph should begin with a statement on the long-term goals of your research program to begin to answer the question of *Why you?* Write this to reflect a sustained interest in both the key underlying problem identified in the first sentence and to reflect the goals and values of your potential funder. Reread their mission statement and see if you find some language or sentiment you could incorporate in the sentence. A good long-term goal ties back to the opening sentence without repeating it, explaining what you plan to contribute to this research area over the course of your career.

Take a very simple example from a proposal to the NIH:

> A good long-term goal is important particularly for pilot grants or career development proposals. Pilot projects are initial investments. Can you tell them what the investment will bring? For any career development award, you are as much a product of the grant as the research you propose to do. What will the agency enable by investing in you?

[45] Months after initially writing this section, I learned in reading Helen Sword's book that this pattern to the opening paragraph essentially follows the Creating a Research Space (CARS) pattern: "a four-step rhetorical sequence identified by John Swales." The steps of the pattern are: 1) Establish that the research area is significant. 2) Summarize the relevant previous work. 3) Show the gap. 4) Turn the gap into research space…" (Sword, H.. Stylish Academic Writing. Harvard University Press, 2012, p. 77. I have not read the original 1990 Swales book, Genre Analysis: English in Academic and Research Settings, where CARS was described.) I added to step 2 the explicit notion of referring to your own work.

Both Sword and Swales are discussing academic papers, but the pattern was quite familiar when I saw it in Sword's book. It seems to have worked its way into the grant writing canon, with good reason. It is also reflected in Connors's rhetorical moves, territory, prior work, and gap.

Opening sentence: Patients with metabolic disease often have cardiovascular co-morbidities, but the impact of changes in insulin metabolism on vascular endothelial function is not clear.

Our long-term goal is to identify novel molecular points of intervention in cardiovascular consequences of metabolic disease to develop therapeutic approaches to decrease the development of co-morbidities.

Developing effective therapeutic approaches clearly relates to both the opening sentence and to one of the goals of the NIH, the reduction of disease or disease burden.

Let us take an example from one of the other opening sentence examples:

Opening sentence: Lack of school resources correlates to lower graduation rates, and there are several theories as to the specific causal relationships.

The long-term purpose of this research program is to identify tractable and low-cost points of intervention in under-resourced schools to improve student retention and graduation rates.

Remember that the long-term goal should also be shaped to reflect the values of your potential funder. The example opening sentence on empathy and music could be written several ways, depending on the goals of the funder.

Opening sentence: Building empathy is a critical step in decreasing bullying behavior, and there has been speculation that group musical activities promote empathy.

If your funder has an interest in reducing bullying behavior, you might write something like the following:

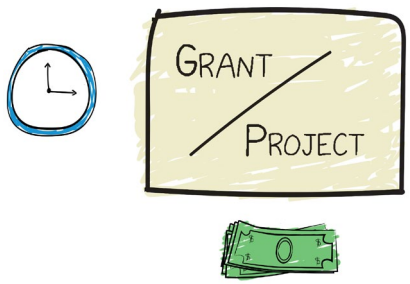
Our overarching goal is to identify methods to improve empathy in middle school children outside of formal “anti-bullying” curricula.

If your funder is interested in increasing music education or even just exposure to music, you might start the second paragraph with something like the following:

Our long-term goal is to increase the use of music in schools by demonstrating specific additional benefits that will advance the districts’ competing priorities.

None of these examples is perfect, but I hope they provide some indication of how your first sentence of the proposal and the sentence on your long-term goal should tie together.

Key next step



The "shape" of the grant is delineated by the resources (mostly money) and time. If you apply for a 3-year grant for $125,000 per year, the proposed project must be accomplishable within the constraints of money and time. The statement of the key next step, your objective, describes the contents of the box.

What needs to happen to overcome the barrier or fill the gap? If you have defined a barrier to progress, then the key next step would obviously be to overcome that barrier. Overcoming the barrier would, of course, be the objective of the proposed project. However, when you write a sentence, you cannot simply take a statement of need and flip it around to say that your objective is to meet that need. That doesn't add any information.

I often described a grant as a box, bounded by a length and width that corresponds to resources and time. Whatever you propose to do has to fit in that box. Funders give you a certain amount of support over a certain amount of time. At the end of the award period, what will you have accomplished with those resources? Proposals that do not fit in the box are considered "ambitious". If you see that word in the reviewers' comments, it means nothing good.

Matching the proposed project to the available resources is a general problem in grant writing, and specifically relevant in this context because the statement of your objective needs to show a clear endpoint. There should be strong verbs that indicate an endpoint, such as *identify, determine,* or *quantify*. Avoid words like *study* or *investigate* that indicate activity.

Often, your first draft of the objective may be written to describe an activity—a description of what you want to do. Take the example of the project concerned with high school graduation rates. What if a researcher said the objective was to study the impact of physical facilities on student perception of teaching quality? What is the endpoint of "study"? As my former colleague and mentor Dr. David Morrison said, "… the objective *to study* clearly defines an activity; namely, what you plan to do, but not why you plan to do it."[46] If your first draft of an objective describes what you plan to do, ask yourself why you plan to do it. Thinking about the purpose of the activities you propose will lead you to a more concrete objective, one with an endpoint. Why would the researcher want to study the impact of physical facilities on student perception? They want to identify the impact of the physical environment on student perception of the quality of instruction.

If you have a central hypothesis or research question for your project, the objective should not be to test the hypothesis or answer the question. Instead, the objective should be stated so that it could be achievable regardless of how your hypothesis tests.

[46] Morrison, D. Hints: Writing Your Objectives September 23, 2016 Retrieved September 23, 2021 from http://www.grantcentral.com/hints-writing-your-objectives/

These points—about concrete end points and the relationship of the aim or objective to the hypothesis—will apply also when we discuss the specific aims/goals/objectives. And keep in mind this part of the Heilmeier Catechism "What are you trying to do? Articulate your objectives using absolutely no jargon."[47]

Key preliminary data/Relevant unpublished work

What have you done most recently? The idea here is to provide one or two sentences that communicate a few important points to your reviewer:

- You have contributed to the field beyond what you have published.
- You are "ready to go".
- You have unique information about the problem.
- For programs, you have a needs assessment and partners in place.

As we noted above, for program proposals, your community or partner assessments are the equivalent of "supporting data". For Arts and Humanities grant applications, use the sentence to focus on something unique or innovative that you bring to the project you want to do.

For proposals with a central hypothesis, this preliminary work provides the basis for the hypothesis. For proposals driven by a research question, preliminary work provides the framing for the reviewer to understand why that particular question must be answered.

Central hypothesis/Research question

A hypothesis is a declarative statement about how you expect two or more variables to interact. I do not say this to be pedantic. Many proposals that cross my desk have sentences labeled as hypotheses that are not testable.

In the monograph referenced earlier, Prof. Pejares describes four ways of stating the hypothesis, two *null* and two *alternative*. In some fields, hypotheses may normally be expressed as the *null*, i.e., that there is no relationship between or among the variables. Unless it would constitute a complete violation of the norms and expectations of your field, I would never state a null hypothesis in the context of a grant proposal, because the null hypothesis is boring. More importantly, it does not tell the reviewer what you think.

Most research proposals include an *alternative* type of hypothesis, one that gives the basis of comparison and a sense of direction. These can be *literary*, stating the general relationships, or *operational,* indicating what you will measure. Prof. Pejaris gives examples, excerpted below:

> *Literary alternative*—a form that states the hypothesis you will accept if the null hypothesis is rejected, stated in terms of theoretical constructs. In other words, this is usually what you hope the results will show. For example,

[47] The Heilmeier Catechism. (n.d.). Retrieved September 16, 2021, from https://www.darpa.mil/work-with-us/heilmeier-catechism

> "The more that nontraditional-aged college women use support services, the more they will persist academically."
>
> *Operational alternative*—Similar to the literary alternative except that the operations are specified. For example, "The more that nontraditional-aged college women use the student union, the more they will persist at the college after their freshman year."[48]

In the first case, the literary alternative hypothesis gives no specificity as to what the writer means by "support services" or "academic persistence". In the second case, the writer indicates what will be measured, and the directional relationship of the two variables. A literary hypothesis can work as a central hypothesis, provided that the specific objectives or aims provide more details (and potentially contain operational hypotheses).

In many quantitative fields, reviewers expect a hypothesis. At the NIH, many reviewers express a strong bias toward hypothesis-driven research, even when program officers can see the importance of funding work such as non-biased screens. The lack of a focusing hypothesis can cause an NIH reviewer to assume that the proposed project is either "merely descriptive" or a "fishing expedition". The pejorative tone of those phrases is not accidental. Sometimes it works best to have a literary hypothesis as the central hypothesis, and operational hypotheses for each of the specific aims/objectives to show that this is not exploratory work.[49]

In some social science and humanities fields, reviewers generally expect a research question instead of a central hypothesis. A hypothesis is a declarative statement of how you expect two or more variables relate, but a research question simply poses the question, "How do they relate?" or even "Do they relate?" The latter serves more as a null hypothesis. Which of these approaches you take depends on what you have learned from your preliminary work and the norms of your field. Research questions can be written in the format described above, as literary or operational. As with hypothesis-driven work, any literary central research question will generally need to be followed by more operational specific research questions for each of the aims/objectives.

In engineering or mathematics, inclusion of a hypothesis might seem strange to your readers. Trying to pose a hypothesis about solving an engineering problem can result in a very trivial hypothesis: "We think our idea will work." If a hypothesis doesn't make sense to you in the context of your project, don't include one. Simply leave it out.

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[48] Pejaris, F. (2007) The Eléments of a Proposal. Emory University. pp4. Retreived September 19, 2021 from http://www.uky.edu/~eushe2/Pajares/ElementsOfaProposal.pdf, I take issue, however, with Prof. Pejaras's description of the hypothesis as, "…what you hope the results will show." A well-formulated hypothesis rests upon solid data and sound reasoning, not hope.

[49] In these days of "-omics" in biomedicine, reviewers seem to increasingly accept the relevance of non-hypothesis driven, unbiased screening. That said, if your project revolves around such an approach, have an extremely clear justification for why to do the screen on the Specific Aims page. Consider including a clear research question instead of a central hypothesis. In the Approach section you will need to include exquisitely clear criteria for identifying "hits", which can be alluded to on the Specific Aims page.

A hypothesis must be testable, meaning at least two potential outcomes. The definition of hypothesis is that it is a declarative statement. Most simple understanding of the scientific method centers around falsifying hypotheses, trying to prove the declarative statement to be wrong. Using conditional language (may, could, should, can) makes the statement no longer declarative, but conditional. You cannot test a conditional, so do not use those words.

Similarly, a sentence that contains "or" cannot work as a hypothesis. How do you falsify an "or" statement? You can use "and" in a hypothesis. This can sometimes help you to create a central hypothesis with components that will clearly be tested (and testable) in the specific aims/objectives.

Similarly, a research question must be well formulated to be answerable. Research questions can also be formulated as literary or operational, depending on the level of detail you think is appropriate in the Overview/Specific Aims page. Including a research question for research proposals helps further provide focus and detail, so that when the reader encounters the specific objectives, they have a sense of how those specific objectives would answer your central question.

For program proposals, or areas such as mathematics, which would generally not include testing a hypothesis or answering a research question, again simply skip this step.

General approach/Why you?

These sentences address two of the rhetorical moves: means, and competence claim. How do you plan to carry out the project, and why are you the right person to do it?[50]

Research proposals: How will you test the hypothesis or address the research question? What are the important approaches you will use? What unique resources do you bring to bear? Why are you qualified to undertake this work? What elements of your research team assure reviewers of your success?

The outline given earlier in the chapter contains one line about how you plan to test the hypothesis or carry out the plan, and one about why you and your group would be best suited to succeed. In practice, these two ideas are almost inextricably linked. For example, if you have a relationship with a community or patient group that is important for the project or program you propose, explaining that you have a relationship with the group speaks both to how you will carry out the project and why you are the best person to do it. You may have unique instrumentation or access to a core facility for materials testing that you will need to carry out the work. Providing such information here speaks both to the approach and to why you are the right person to carry out the proposed project. It also gives the reader a sense of how you will carry out the specific aims or objectives.

[50] In the chapter by Connor, referenced above (page 46), she notes that proposals written by women were less likely to contain the competence claim and the female researchers expressed in interviews that they were uncomfortable "…blowing their own horn." However, they framed the competence claim as needing to state that one was better than others. That is not the point! The point is to say why you (and your team) are highly qualified, perhaps uniquely so, to do the work that you propose.

I would start this section either with something like, "We plan to test our hypothesis by…" or "Our approach will be…" By describing your capabilities and your approach, you can segue into the specific aims/objectives.

Program proposals: Would you be prepared to start the moment the grant check arrives? What work have you done building relationships? Can you directly mention letters of support in the grant package showing that your community partners are fully engaged? The answers to these questions will help you craft these sentences.

For purposes of this discussion, the words aim, goal, and objective will be used as interchangeable. (You may have noticed the use of aims/objectives in the preceding text. Yes, these words have specific connotations and denotations in some fields, but in the context of a grant application, the word you use depends upon the culture of your funder. For the NIH and many parts of the NSF, the expectation would be for specific aims. For some parts of the NSF and for most of the mission-driven agencies (DOE, USDA, DOD), the expectation may be to state goals or objectives.

In both cases, do not be afraid to point toward where the reader might find more information showing that your assertions here have a solid basis. For a USDA proposal you might write, "We have a strong relationship with our producer board (see letters of support)."

Specific Aims/Goals/Objectives

What, exactly, do you plan to do?[51]

In the context of your overall objective, there may be specific concepts to be tested or tasks to undertake. The third part of Overview/Specific Aims page should not be given in paragraph form, but rather as a list with bolded headlines. Similar to the overall objective, each specific goal/objective/aim should not describe the task, but rather why the task needs to be undertaken.

As noted earlier, both the overall structure and the internal structure of the Specific Aims/Overview page follows a *problem: solution* approach. This plays out slightly differently depending upon whether the aim/goal/objective is driven by a hypothesis that relates to the overall objective and hypothesis or if the aim/goal objective describes some activity that needs to be completed to achieve the overall objective.

Writing good aims is not easy. Ideally, the aims/goals/objectives will focus on the concepts, the why underneath the what. Ideally, each aim or objective will be independent, so that each aim could potentially start on the first day of grant funding. Even though independent, the aims are also ideally interrelated. Together, successful completion of the aims would achieve the overall objective and test the central hypothesis or answer the research question.

Weak aims have verbs without endpoints and describe activities, or set up a domino effect, or contain surprises. The question of stating the aim/goal/objective with a clear endpoint

[51] You have no idea how often I say that when reviewing client proposals.

is the same as for the overall objective: what do you expect to have accomplished at the end of this aim?

Let us work with a few examples.

> **Objective 1: Survey students using a combination of electronic and in-person canvassing.**

This is a "what we plan to do" aim. It states activities, but not why the activities need to be undertaken. Why do you want to survey students?

> **Objective 1: Determine whether students think the current enrichment opportunities are engaging.**

This is a problematic aim largely due to one word: *whether*. The problem is the implied *or not*. The word *if* creates similar problems, as shown below.

> **Objective 1: Determine if students think the current enrichment opportunities are engaging.**

So what if they don't?

Why does this investigator want to survey students?

> **Objective 1: Identify student attitudes about current enrichment opportunities.**

This way they can learn what the students think, and it implies a bigger range of questions that might be on the survey beyond, "Engaging? Yes, or no?" You could include questions about engagement, timing, applicability, and more. You would then want to follow this with text on how you planned to undertake the survey.

> **Objective 1: Identify student attitudes about current enrichment opportunities.** To gather both immediate reactions and those reached on reflection, we will use both immediate in-person surveys and electronic follow-up surveys two weeks after each activity.

Now the reader knows what the applicant plans to do, and why, starting with why. Going back to the original formulation of the "what" objective, *Objective 1: Survey students using a combination of electronic and in-person canvassing*, see how the new formulation includes <u>why</u> the applicant would want to use both survey methods.

Now let us revisit the words "whether" and "if", which often show up when the objective masquerades as a hypothesis.

> **Objective 1: Determine whether student participation in enrichment opportunities correlates with improved outcomes**.

The "stealth hypothesis" here is that they do correlate. But what if they don't? It helps to frame specific aims/goals/objectives the same way that you frame the overall objective or key next step and think of each one as describing a sub-box within the overall box described in the overall objective. What else might you learn? Versions of aims/goals/objectives like those described above can limit your scope. What about the following?

> **Objective 1: Determine the relationship between student engagement with the course and student outcomes**. Our hypothesis is that students who participate in at least 65% of the enrichment activities will have higher scores on the final examination for the course than those that attend 50% or fewer.

Note that the objective can be achieved regardless of how the hypothesis tests. Note also that this is an operational hypothesis, not a literary one, and provides additional detail and direction. Clearly this example is highly simplified, but the Problem: Solution formula is clear. The implied problem is that the relationship of X to Y is unknown. The solution is the hypothesis that X relates to Y in a specific way. Going back to the idea of a bigger range of questions, consider that more things could be measured about these students than just attending enrichment activities. Would these investigators potentially also track class attendance, weekly quiz grades, class participation, self-report of study time, or other potential student activities? With that information, if the hypothesis is wrong, they would have the data to pose an alternative hypothesis.

In a highly simplified example such as this, the hypothesis may seem trivial. Or your field may expect a different formulation, such as a research question.

> **Research question 1: What aspects of student participation correlate with higher course grades?**

The question implies the problem. It is not known whether participation correlates with improved outcomes. Follow a research question with information on how it would be answered.

> **Research question 1: What aspects of student participation correlate with higher course grades?** We will compare individual student attendance rates in enrichment activities with scores on the final examination and overall class grade. We will also track class attendance, participation in regular class activities, quiz scores, and student self-report of study time and of attitudes about the engagement activities.

Problem: solution. We don't know what aspects of student participation correlate with higher course grades. The solution is to get data that we can analyze to potentially identify the correlations.

Avoid "Domino aims". If the second aim/goal/objective is not worth doing unless the first aim works as you hope, you set up a domino effect—like a line of dominoes standing

that will fall if you push the first one. Such dependent aims can make a reviewer's day because your proposal is fundamentally flawed, and they can easily put it on the bottom of the stack.

You can have linear and dependent aims in some fields or for some projects, especially for engineering projects that require a step-wise approach. However, in the proposal you must demonstrate that the risk of failure of the early steps is near zero. Even if the outcome is unknown, in the research plan you will need to clearly describe decision points so that the reader can assess your plan.

If an aim contains a surprise, then the problem usually does not lie with the aim but with the opening paragraphs. Sometimes I see proposals that contain discussions of data and experiments, and suddenly the third objective involves mathematical modeling. The modeling approach may be appropriate, but it should not be a surprise. Everything in the opening paragraphs should prepare the reader for the details to be given in the aims.

In a few fields, it may seem out of place to include specific aims/goals/objectives on this page. Although I strongly suggest you articulate clear aims or goals for the project, providing structure to the research plan, you can potentially leave them out of the introductory material. The outline changes only in removing the delineated specific aims/goals/objectives. The other three paragraphs remain intact.

Impact of the work

What will be the impact on the field? Almost all the instructions quoted at the beginning of the chapter include describing the impact. The final paragraph should relate to the opening sentence and to the objective. In a sentence or two, describe what you expect to have accomplished, and why that work is important. It may be tempting to leave out this paragraph because of space considerations, but that would be a mistake. The idea here is to close the cognitive loop. If you open the Overview/Specific Aims page by framing the key underlying problem, then you should end with how your proposed work would contribute to the solution. Write two or three sentences describing what you expect to have accomplished and what impact you expect the results would have. Do not overreach, however. A project for pilot funds will not likely give results that will change the world. Think realistically about what you will accomplish, but what could that work ultimately lead to? A grant to support the development of a new technology won't immediately lead to new manufacturing hubs. A new understanding of student needs won't immediately translate into 95% graduation rates. Determining the mechanism of a particular metabolic pathway in a cell will not immediately create new cancer cures. To give a sense of those longer-term impacts, the word "ultimately" is your friend.

See also the next chapter on Significance. For many funders it may be appropriate to expand this into a longer pair of paragraphs on the impact of the work.

If you plan to apply for any pilot or developmental grants, you need to be clear in the application what you plan for the next steps. Tell the reader what the pilot work will enable—data from which to generate hypotheses, proof of concept for an idea or technical

Proposals to the NIH traditionally have three aims, but you should not feel bound to that tradition. There are two reasons to consider having only two aims in an NIH R01 application: space in the application and budget. You only have 12 pages for the Research Strategy, which includes Significance and Innovation along with Approach. Given the requirements for rigor and reproducibility, you should plan to include more information on the details of your approach. You may not have enough room to develop three aims. As for budget, the "buying power" of the NIH modular budget has decreased significantly since it was introduced. It may only include enough resources to carry out two strong aims.

approach, etc. In fact, the USDA specifically says, "In order to be competitive, long-term goals and a statement describing how this Seed Grant will allow the applicant to become competitive for future funding must be included."[52] Like USDA Seed Grants, NIH R21 or R03 awards are meant to position you for future success. For career development awards, the purpose of the grant award is to develop you, so include that in your impact statement for NSF CAREER, NIH K or F, or other early-investigator grants.

How Many Aims, Goals, or Objectives?

For many questions about grant writing, the answers start with two words: "That depends." Typically, given the page limitations of most grant proposals, there is not enough room to develop more than three specific aims/goals/objectives. In fact, when I see four or five specific aims or objectives, I can usually condense them into two or three. Why? Because the objectives/aims were written as procedures and not concepts. Quite often, two different kinds of activities are aimed at the same underlying question or problem.

A very common mistake is to separate the aims by the kind of things you plan to do, rather than the underlying reason for doing them. Sometimes two very different experimental or observational approaches are aimed at answering aspects of the same underlying question. The aim should reflect the underlying question. In the discussion of the Research Strategy or Approach, you would describe the approaches and how they complement other to achieve that specific aim or objective.

The Specific Aims/Overview page provides the outline for the rest of the proposal

Every part of this opening page will be reflected in the rest of the proposal.

- The first paragraph sets up the argument for the key barrier to progress, and your Background section (Chapter 8) should provide the details.
- The second paragraph sets up the feasibility of the project, and your Preliminary Data or discussion of previous work (Chapter 8) should provide the details.

[52] https://nifa.usda.gov/sites/default/files/resource/AFRI-FAS-RFA-Additional-Information-for-Part-IV-C-04162021.pdf Retrieved September 18, 2021

- The specific aims or objectives give the steps to the plan, and you should use these as the headings to organize the project plan (Chapter 9)
- The fourth paragraph indicates the significance and potential impact of the work, and you should expand on this in your argument for the impact in the Significance section (Chapter 6).

The sections work together to tell the reader why this project is important—why the reviewer or program officer should care about it—and also what you will do and how you plan to do it. If they have made their gut-level decision in your favor, the rest of the proposal serves to support that decision.

Note for those writing NEH fellowships and other short proposals

If you read the examples of successful NEH fellowship proposals available on neh.gov, you will find that many follow a rhetorical pattern very similar to the conceptual framework described here. The first paragraph presents the problem, and the subsequent paragraphs lay out the solution. Even for those proposing support for writing a book, the "aims/objectives" can be laid out clearly to describe what you need to do to write the book chapters. If you plan to write a short fellowship application, I strongly urge you to read the examples provided by the NEH with an eye to the pattern of the information. See also the outlines given at the beginning of the book.

The Bottom Line

The Specific Aims/Overview page must convey everything that is important about your project but not overwhelm the reader with details. It needs to:

- Get your primary readers excited about the project so that they want to read the rest of the proposal.
- Provide other panelists, who will likely read this page under non-ideal circumstances, with enough clear and readable information that they can understand the importance of your project and agree with the enthusiastic recommendations of your primary readers.

Readers will judge the potential impact and whether they think your plan will work just from this page. So much rests on this page that you need to allow yourself sufficient time and attention to get it right. Fortunately, most of that time and attention is spent thinking through your project. This work will also pay off when you write your project plan and your abstract.

Sample pages, two more outlines

Following are several samples of first pages of proposals.

- ***Computational Bedazzling.*** The subject of this mock NSF Standard Grant is designed to be humorous so that you focus on the structure and not the content. The first

example shows a version of a scientific proposal with deep flaws in the grantsmanship—the packaging and presentation. The second shows a version of that same proposal reworked using the conceptual framework and outline suggested in Chapters 4 and 5.

- ***Book proposal.*** The second pair shows a proposal for a book, again with flawed and improved versions. The book proposal does not include specific objectives, but the rhetorical approach in the better version matches the framework. The proposal is based on a funded NEH grant, and our apologies to the original author.
- ***NIH R21.*** The third pair also uses mock text, in this case about toe cancer. The R21 grant mechanism was created for high-risk, high-payoff projects, but can now be used for developmental projects. Note that in the better example, the objective and the hypothesis are combined, and the text reminds the reviewer that this is a high risk/high payoff R21 proposal (not the more standard R01). It explicitly calls out the proof-of-concept nature of the project (a "compliance claim" in the rhetorical move list). The better example also proposes about 25% of the work badly described in the worse example.

All of the "better" examples are <u>not</u> perfect.

Following the sample pages are outlines showing how the framework adapts to proposals for program proposals, or artistic endeavors, courtesy of Mary Hensel.

Examples

NSF Standard Grant with deep flaws

Towards an accurate approach for identifying Esthetic Methods in Bedazzling

Overview:

More than ever, there is a great need to advance theoretical models and develop algorithms that effectively use modern computing systems. The tremendous growth in computational capabilities in recent years offers many opportunities for computational bedazzling. None of the existing legacy code takes advantage of massively parallel architecture. As outlined in the DOE Office of Basic Science report on extreme-scale computing, the development of advanced theoretical tools within chemistry, physics, and materials science (including bedazzling) — combined with the development of efficient computational techniques and algorithms — has the potential to revolutionize the discovery process for materials and molecules with desirable properties.1 Computational modeling and simulation are an essential complement to experimental studies.

The development of affordable ab initio methods that can provide an accurate description of potential bedazzled states continues to be a challenging problem in modern quantum chemistry. Another major challenge is the cost of the calculation which makes these high-accuracy methods impossible to large systems with thousands (or tens of thousands) of collocated plastic gems and decoration functions. Bedazzling Barrier (BB methods and its equation-of-color-match extension, EOCMBB, are regarded as the best methods for high accuracy calculations. However, the current implementation of BB methods is limited to about ten adjacent gem appliques and does not include solid-colored beads. Several linear scaling methods have been implemented. One promising approach is the fragment pattern prediction (FPP) methods which has demonstrated the capability of performing an all-bead-type calculation on over 20,000 beads by decomposing the system into fragments. Not only does this reduce the computational cost but it also enables the development of calculations that scale almost linearly with system size.

We are ideally positioned to develop predictive, highly-accurate, large-scale *ab initio* methods for bedazzling by integrating BB theory into FPP methodology to enable rigorous modeling of potential decorative patterns, having extensive experience in both BB method development and implementation as well as experience in applying and benchmarking large-scale FPP calculations in one of the top supercomputers. Our established track record includes formulating BB methods using diagrammatic and algebraic methods and many-body theory and efficiently implementing these equations through diagrammatic factorization techniques and recursively generated intermediates resulting in fully vectorized computer codes. We also demonstrated the scalability of FPP up to 262,144 cores.

We are proposing to accomplish this goal with the following specific objectives:

1. Develop and implement efficient parallel EOCMBB codes
2. Formulate new applique pattern method, FPP-EOCMBB, by combining EOCM variants with FPP methodology
3. Benchmark and validate the methods, algorithms, and parallel codes
4. Apply FPP-EOCM method to gain insights into the esthetic design processes and to design theoretical models of fashionable hats.

By developing novel highly-accurate methods as well as effectively using parallel computing strategies that would efficiently scale to medium-sized clusters and current leadership computing facilities, and potentially to exascale computing facilities, we expect to pave a way to rigorously model bedazzling processes to address important problems in high-fashion decoration of hats.

NSF Standard grant, better version

Computational Methods in Bedazzling: Improving predictability in the generation and structural integrity of esthetic decorations

OVERVIEW

Automatic predict and design for esthetic bead and gem patterns, accounting for the mechanical issues of bead/gem adjacencies, is a general problem in computational approaches to decoration. The two major challenges are the need for affordable *ab initio* methods for accurate descriptions of potential bedazzled states and adjacencies, and the cost of such calculation. The Bedazzling Barrier (BB) method and its equation-of-color-match extension, EOCM-BB, are regarded as the best methods for high accuracy calculations. Implementation of BB methods is limited to about ten adjacent gem appliques and does not include solid-colored beads. One promising approach for linear scaling is the fragment pattern prediction (FPP) method, which has demonstrated capability to perform an all-bead-type calculation on over 20,000 beads by decomposing the system into fragments. Not only does this reduce the computational cost but it also enables the development of calculations that scale almost linearly with garment and design size. However, FPP methods plot adjacencies without the high accuracy of BB methods for effects at the interfaces that can affect structure. At present, there are no methods to combine the accuracy of BB methods with the scalability of FPP methods. Without such tools, the generation of bedazzled decorations that are both structurally sound and esthetically pleasing will continue to rely on empirical, labor-intensive methods.

The long-term goal here is to identify tractable computational solutions to inform experimental approaches to appliqued garment decorations. The *objective* in this project is to develop predictive, highly accurate, large-scale, methods for rigorous, *ab initio* modeling of bedazzling processes. Our *central hypothesis* is that integrating FPP methodology with BB theory will result in the ability to calculate the bedazzled state processes for tens of thousands of gems and beads intermixed, as compared to the current BB limitation of 10 gems. Our preliminary work, using one of the top supercomputers and addressing the problem of colored beads only, has indicated that large-scale FPP calculations are feasible. The initial approach will include formulating BB methods using diagrammatic and algebraic methods and many-body theory. We have experience efficiently implementing and scaling these equations through diagrammatic factorization techniques and recursively generated intermediates resulting in fully vectorized computer codes. With this experience we are well prepared for an iterative design-test-redesign approach for the following objectives:

1. **Develop methods to identify adjacency interactions in gem/bead bedazzled decoration.** Our approach will be to apply a new bead patterning method, FPP-EOCM-BB, by combining EOCM variants with FPP methodology.
2. **Benchmark and validate the computational methods.** Our approach will be to implement algorithms and efficient parallel EOCMBB codes, and to benchmark computational efficiencies and accuracy and esthetic properties of outcomes of theoretical bedazzled pattern modeling.
3. **Test the methods in a real-world scenario.** We will apply FPP-EOCM method to create new empirical designs that satisfy all adjacency requirements. We will create pilot decorations first for fashionable hats, where the base material has more structural integrity, and then for lightweight denim, with feedback from designers as to the esthetic properties.

Completion of these aims will allow us to gain insights into the esthetic and structural bedazzling design processes and provide novel highly accurate methods that effectively use scalable parallel computing strategies. This will pave a way to rigorously model bedazzling processes to address important problems in high-fashion appliques for garments and other decorative fabrics.

NEH book proposal – worse version

Significance and contribution

Architecture is a pertinent subject for all of us—we live amidst it, whether we wish to or not—and Louis Kahn, perhaps above all other twentieth-century American architects, was a "public" architect who did not design shopping centers or fancy hotels or expensive condominium towers or corporate skyscrapers but instead focused on medical and educational research complexes, government centers, art museums, libraries, memorial parks, religious buildings, and other structures that would in some way serve the public good. I feel he is an exemplary subject for a general-interest biography. There is as yet no book that encompasses his complicated life and his powerful work in a way that makes its importance clear. My book, I hope, will do that.

The fact that I myself am neither an architect nor an architectural historian is of great assistancein this project. Coming at the subject from the outside, as my readers will, I need to fully understand the complexities in layman's language before I can transmit them to the page. I am now grappling with the writing phase. A schedule of fulltime writing, from October 2015 through July 2016, is whatI hope will be funded with the NEH Public Scholars grant. I have already written the opening sections of the book and have worked out the entire structure. The problems of writing a biography are very interesting ones, and I have already begun to immerse myself in them. Not only must I go back and forth between the life and the work, as all biographers of artists must—a complicated task, if onewants to avoid being either reductively causal or completely disjunctive but I will also have to ex- plain the complex procedures of modern architecture including, for instance, how concrete is poured,and what holds buildings up, and how a client and an architect interact, and how various people worktogether on a single commission, and many other subjects of this kind) in language that ordinary readers can comprehend.

My project will be the first full-length biography of the architect Louis Kahn, and the only book about him to be aimed at a wide general audience. There are dozens if not hundreds of works about his architecture, plus one book that calls itself "a life" (but which speaks in the language of professional architecture and leaves out a great deal of the personal information) and a few rather one-sided memoirs written by people who knew him. There is also one great documentary film, *My Architect*, made by his son Nathaniel Kahn. This is not an authorized biography in any way, and I amfree to come to whatever conclusions I wish. I hope my project will present the life of a pre-eminent architect to the general public.

By all accounts, Louis Kahn was a warm, captivating man, beloved by students and friends, admired by colleagues from all walks of the architectural profession, enduringly attractive to strangers and intimates alike. Born into a Jewish family in Estonia in 1901, Kahn was brought to America in 1906, grew up in poverty in Philadelphia, and by the end of the century was widely recognized as one of the greatest architects of his time. Jewishness, for Kahn, may have been as kind of mask, de- fining him in the eyes of WASP Philadelphia (not to mention the *echt*-Protestant architecture world), but less fully defining him to himself. If he received more commissions to build synagogues than churches or mosques, it is nonetheless the case that among his built masterpieces only a mosque and a church emerged triumphant; the synagogues, for the most part, foundered in the design phase. "I'm too religious to be religious," he once told a friend, after a major Philadelphia synagogue commissionhad disappointingly died on the drafting-board. Perhaps he partly meant that his religion was architecture and everyone who knew him sensed this about him, that he was, even by his own admission, aterrible businessman, but he was a great, public-spirited artist, and his architecture reflected that.

(Heavily edited from a successful proposal by Wendy Lesser of Threepenny Press, funded by NEH's Public Scholar Program in 2017)

NEH book proposal better version

Significance and contribution

Architecture is perhaps the most public of arts, and Louis Kahn was a "public" architect, perhapsabove all other twentieth-century American architects. His best buildings have a kind of inevitability to them, displaying a perfection of form that is almost mythic in its rightness. The arched line of vaults that make up the Kimball Art Museum in Ft. Worth Texas, and the concentric interior spaces of the library at Philips Exeter Academy in New Hampshire showcase the rhythms in his forms. He designed not commercial buildings but structures that would in some way serve thepublic good. Yet this man also had a personal life that was so complex and obscure (and some- times so unconventional) that it has remained largely unexplored in any of the works written about him. There are dozens if not hundreds of works about his architecture, and the one book referred to as "a life" speaks only in the language of professional architecture and leaves out a great deal of the personal information. What we do know about his life story possesses the allure,the pathos, and the shapeliness of a work of fiction. A few rather one-sided memoirs have been written by people who knew him and there is a documentary film made by his son Nathaniel Kahn. But there is as yet no book that encompasses both his complicated life and his revolutionary, powerful work in a way that makes its importance clear to the non-architect.

My goal is both to place the work of Louis Kahn in context both of the times and of his own re- markable life story. For this work, I have been given complete access not only to the Kahn papers at the Architectural Archives at Penn, but also to a vast number of private papers in the hands of Kahn's three children. I have also had extensive conversations with dozens of people who knew him, ranging from established architects and designers (Moshe Safdie, Richard Saul Wurman, Balkrishna Doshi) to the Kahn relatives in Philadelphia and California, the members ofKahn's office who are still alive. The research phase has been largely completed and the shape ofthe work has emerged (see chapter headings, below). I am the author of ten published books, andmy expertise as a writer lies in bridging the distance between the academic or specialized cultural world and the world of general readers. The book is also under contract at Farrar, Strauss and Giroux.

In writing a biography, one must go back and forth between the life and the work—a complicated task, if one wants to avoid being either reductively causal, on the one hand, or completely disjunctive, on the other. In Kahn's case, I will also have to explain the complex procedures of modern architecture (including, for instance, how concrete is poured, and what holds buildings up, and how a client and an architect interact, and how various people work together on a single commission, and many other subjects of this kind) in language that ordinary readers can comprehend. In this I am assisted by the fact that I myself am neither an architect nor an architectural historian. Coming at the subject from the outside, as my readers will, I need to fully understand the complexities in layman's language before I can transmit them to the page.

I expect this book will find an audience interested in the fascinating personality and life behind many medical and educational research complexes, government centers, art museums, libraries,memorial parks, religious buildings in the Philadelphia area and around the country.

(Heavily edited from a successful proposal by Wendy Lesser of Threepenny Press, funded by NEH's Public Scholar Program in 2017)

NIH R21, problems

SPECIFIC AIMS

Metastases are the leading cause of death in cancer. Toe cancer patients negative for expression of NR and CUT2, so-called double-negative toe cancer (DNTC), have no targeted therapy options. Once diagnosed with distant metastases, these patients suffer a dismal 35% 5-year survival rate. Notably, the combination of elbow metastasis and double-negative toe cancer lowers median overall survival drastically to less than 3 months. The two major contributors to mortality from DNTC are local recurrence of drug-resistant tumors and the establishment of distant metastasis and both of these are driven by the action of chemotherapy-resistant, invasive, and tumor-seeding, arch-like cells (ACs). Clinical evidence for the role of FACs comes from surgically removed residual toe cancers in patients that received neo-adjuvant chemotherapy. Profiling of the residual tumor tissue indicates enrichment for an AC associated gene expression signature. Experimental evidence shows that ACs can derive from toe-arch transition (TAT). Because TAT is one mechanism that can drive tumor cell invasion and metastasis, targeted arch-like cells will also impact the metastatic cascade. To discover novel inducers of AC-selective cell death, we examined a family of natural product-based inducers of cytotoxicity and tested their actions on models of AC activity *in vitro*. Our lead compound, Miraculin A (MiA), a secondary metabolite isolated from comb jellies, induces cell death through influencing epigenetics, and has been shown to cross the blood-elbow barrier (BEB).

Using a model of toe-to-arch transition (TAT)-induced ACs (TAT cells), our preliminary data show that TATs are more sensitive to MiA than differentiated cells. This finding is unexpected because TAT has been shown to decrease sensitivity to the majority of cytotoxic drugs. Remarkably, prolonged exposure to sub-lethal doses of MiA change TAT characteristics through the parent loss of archness. Long-term treatment leads to loss of anchorage-independent growth, reversion of gene expression towards a more differentiated state and re-sensitization to doxorubicin treatment. MiA only exerts these effects on TAT-induced ACs and has little significant impact on differentiated toe cancer cells.

ACs are well-established to be resistant to many inducers of cell death due to their relative quiescence, upregulation of this multidrug transporters and phenotypic plasticity. By contrast, our preliminary results show that induction of TAT sensitizes toe epithelial cells to the effects of MiA. Our objective in this R21 project is to test the hypothesis that MiA can serve as an AC-selective, sensitization-inducing DNTC therapeutic capable of blocking AC-driven tumor growth and progression and reversing chemotherapy-resistance through induction of miR-# expression,. We are well prepared to carry out this project because we have all the necessary skills for the initial medicinal chemistry, access to patient-derived elbow metastases from DNTC patients on which to test MiA and derivatives, and well-developed xenograft models for *in vivo* analysis.

Specific Aim 1. Identify all pathways affected by MiA treatment in FACs. We will build on this finding by using IC50 doses of MiA, selectively modified derivatives of MiA, which are predicted to have interediate activity or which serve as a negative control, to determine the mechanism of TAT-induced chemosensitivity. Secondly, we will utilize lentivirus-based expression of drivers and inhibitors of TAT to assess impact of specific pathways on sensitivity to these molecules. Finally, we will utilize patient-derived xenograft models of DNTC with varying degrees of TAT-induced FACs to assess the impact of MiA *in vivo*.

Specific Aim 2: Show the effect of MiA on TAT/AC-driven phenotypes of DNTC models. We have demonstrated that sustained treatment with MiA is sufficient to block the TAT/AC properties of an experimental model of TAT in transformed toe epithelial cells and DNTC cell lines with TAT/AC features. We will extend these findings by examining the effect of MiA on TAT and AC properties *in vitro* and *in vivo* through the use of the elbow-metastatic TAT-enriched DNTCs.

Specific Aim 3: Measure the methylome and acetylome of TAT cells treated with MiA. Because we believe that the primary action of MiA is through regulation of the epigenetic state of miRNA-#, but that it could have other avenues, we will identify other areas of modification that may have an effect on TAT or the maintenance of “archness.” Both treated and untreated cells will be studied in order to make comparisons of the metabolic responses and of the acetylation status of histones.

Impact: Patients with elbow-metastatic DNTC are faced with few treatment options and median survival on the order of months. Given the AC-enriched nature of DNTC, it is essential to pursue approaches that directly impact foot-arch cells. In this collaborative effort, we plan to establish a novel direction to deplete this subpopulation from aggressive tumors. This proposal focuses on elucidating the impact of MiA on elbow-metastatic DNTC with the long-term aim of rapidly translating these findings to the clinic, either as a single activity agent or a sensitizing agent that increases the efficiency of existing standard-of-care therapy for advanced DNTC.

NIH R21, improved

SPECIFIC AIMS

When toe cancer patients have tumors that lack two common drug targets, survival rates are much lower than for other subtypes of toe cancer. The two major contributors to mortality from this double-negative toe cancer (DNTC) type are local recurrence and distant metastasis due to the action of chemotherapy-resistant and tumor-seeding arch-like cells. Arch-like cells are produced by a toe-to-arch transition (TAT cells), and the state is known to be preserved by multiple layers of epigenetic regulation, including post-transcriptional suppression of gene expression by microRNAs. In prior work, we showed that microRNA-# is universally suppressed in TAT-enriched toe cancers as well as in TAT-rich DNTC cell lines. Strikingly, re-expression of miR-# alone was sufficient to block tumor initiation and metastatic seeding of DNTC cell lines in immunodeficient mice, indicating a reversal of TAT properties (Ourlab, et al., 2021). These results may seem promising, but a recent clinical trial involving miRNA delivery to cancer patients was halted due to adverse immune events. An alternative approach would be to induce re-expression of miR-# in TAT cells. We and others have shown that epigenetic mechanisms, particularly DNA methylation, suppress miR-# Prolonged exposure to very low (non-cytotoxic) doses of a DNA methyltransferase inhibitor *in vitro* reversed differentiation of TATs and restored chemosensitivity of DNTCs, suggesting a potential adjuvant co-treatment for toe cancer patients. However, the key barrier to advance our results into therapeutic strategies is the lack of mechanistic and efficacy proof-of-concept data in relevant pre-clinical, patient-derived xenograft-based studies.

Our *long-term goal* is to discover and advance TAT-targeting adjuvant therapies that will minimize the outgrowth of pre-metastatic tumor cells and increase the sensitivity of DNTCs to standard chemotherapy. Our *objective in this R21 proposal is to prove or refute the concept that a small molecule inhibitor* of DNA methyltransferase *reverses the silencing of miR-#, halts metastatic progression, and restores sensitivity of DNTC TATs to chemotherapy* in vivo*.* Our preliminary data in cell line models of DNTC indicate that inhibition of DNA methyltransferase (DNMT) increases miR-# expression and blocks TAT properties. The next step is to identify how the promising *in vitro* results carry through in a pre-clinical model using patient-derived tumors to assure maximum translational impact. We have already demonstrated that MiA is not toxic, and our collaboration with Dr. ToeSurgeon assures we will have access to patient samples for use in our established xenograft models. We are well prepared to conduct the *in vitro* assays, and to noninvasively track in animals the *in vivo* lung metastases that consistently form when DNTCs are transplanted into the foot pad of immunocompromised mice. With our collaborators Drs. Labwiz and Dataking, we also have the techniques and informatics capacity in place to reliably measure and analyze chromatin alterations and gene expression in the following specific aims:

Specific Aim 1: ***Determine the impact of low-dose inhibition of DNMTs on metastatic DNTC tumors.*** The hypothesis here, based on our preliminary data, is that inhibiting DNA methylation will reverse the repression of miR-#, leading to loss of metastatic capacity and re-sensitization to chemotherapy. To test for consistency and generalizability, we will test at least 5 independent tumors in 3 biological replicates in xenograft models of DNTC. This will allow for strong pre-clinical data to justify next steps.

Specific Aim 2: ***Determine the genome-wide chromatin and transcriptomic impacts of low-dose inhibition of DNMTs*.** We expect to identify changes in modification at the promotor of miR-# that correlate to changes in miR-# and cell phenotypes of tumors in xenograft models of DNTC. While miR-# may be solely responsible for regulating TATs maintenance of an arch-like state, we also will identify how inhibition of DNMTs by MiA specifically alters the DNA methylation epigenomic landscape and how such changes correlate to expression of genes related to the toe to arch cell transformation and maintenance of an arch-like state. These results will lead to a fuller picture of both the mechanism of action if MiA and the basic biology of these cancers.

Together, these approaches will allow us to definitively provide proof-of-concept and a mechanistic basis for a novel approach to DNTC treatment in our most high-risk toe cancer patients. We expect to demonstrate restoration of chemosensitivity and disruption of the metastatic cascade of DNTCs *in viv*o through induction of miR-# expression, and to identify additional potential targets of low-dose inhibition of major chromatin modification enzymes. These results would provide the basis for an R01-level project in collaboration with clinical trial specialists to robustly identify the longer-term impacts of MiA and the extensive trials needed ahead of clinical testing of miRNA expression-targeting compound

Program Proposal – one-page outline

Paragraph 1 – why this, why now, why you, why them

- In first sentence(s) provide context for the entire proposal and highlight significance
- In second portion narrow the context (2-3 sentences) by giving details about target population, partners if any, and goals for that population and this study
- Describe the key problem or need that is unresolved
- If appropriate relate answering this need directly to the funder's goals, echoing the language in their mission statement, RFP, or website
- Show where you have contributed to addressing this problem (2-3 sentences) and what remains to be done

Paragraph 2

- Provide a framework for the arc of the project—this relates to the first sentences of the first paragraph and shows where you fit in to that larger problem
- Elaborate on the statement of need
- Discuss existing approaches to solving the problem and their success (or lack of)
- Explain your approach to solving the problem
- Indicate how you will determine the extent to which need was addressed and program a success
- Relate your skills and resources to those needed to undertake the project
- Use this to segue into your specific aims/objectives

Specific objectives – Your solution

- Do not write this as a paragraph. Lay out objectives with clear numbering. A few sentences are sufficient to describe activities

Objective 1: Accomplish specific thing. Follow this with text about how you will accomplish it—people, places, achievements with numeric values if possible.

Objective 2: Accomplish specific thing. Follow this with text about how you will accomplish it—people, places, achievements with numeric values if possible.

Paragraph 4 - Close

- Close the cognitive loop—tell the reviewer how completing your aims will have an impact on the problem
- The final sentences can tie back to the opening sentence, the problem and wider context, and, importantly, the funder's priorities

Artistic Proposal – one-page outline

Paragraph 1: Why this, why now, why you, why them

- In first sentence(s) provide context for the entire proposal and highlight significance. Try to capture the passion in your work and its ability to engage, enlighten, encourage and improve lives
- Go wide and advocate for impact of all artistic expression
- Then, narrow the context (2-3 sentences) by giving details about your presentation, target audience (underserved population?), and venue(s)
- Describe the key outcome and impact of the presentation. If appropriate, relate this impact directly to the funder's goals, echoing the language in their mission statement, RFP, or website
- Show how your past work has led to the development of this presentation

Paragraph 2

- Detail where your work fits into creative expression in the area of funder's interest or meshes with wider goals, e.g., NEA's of creation, engagement, learning and community livability
- Briefly touch on resources, venues, collaborators, that support your work
- Demonstrate that you have the skills and resources to undertake the project
- Use this to segue into your specific aims/objectives

Paragraph 3: Specific objectives (might not be included)

- Do not write this as a paragraph. Lay out your objectives with clear numbering
- Products or performances may be one objective
- Others may include outreach and educational aims

Objective 1: Accomplish specific thing. e.g., aesthetic investigation. Follow this with text about how you will accomplish it.

Objective 2: Accomplish specific thing. e.g., community engagement. Follow this with text about how you will accomplish it. Give timeline

Paragraph 4

- Close the cognitive loop—tell the reviewer how completing your aims will have an impact on your field
- A sentence or two can tie back to the opening sentence, the problem, and the larger context

Chapter 6: Significance

Significance means impact. In the catechism of George Heilmeier, former head of DARPA, you find the question, “If you are successful, what difference will it make?”[53] This is the key question of significance. Different funders will view impact in slightly different ways. For a grant application, it always comes back to the mission of the funder.

For mission-driven agencies (NASA, USDA, the Department of Energy, any of the Defense agencies, and so on), the wording that translates to the Significance review criterion usually relates to mission relevance. The Funding Opportunity Announcements usually have a list of priority areas. Your proposal must directly link to one or more of the stated priority areas. The FOA may even have an explicit requirement that you quote the priority area. Use this section, perhaps as the final paragraph of the Overview, to describe how your project would advance the mission of your target funder.

For agencies that support more basic science, the significance of the work still must be clear and relevant to their general interests. As noted in our discussion of review criteria, Significance, in some way shape or form, always shows up. For applications to the NEA, the review criteria will refer to artistic significance. The NEH guidelines refer to intellectual significance. For any foundation funder, your projected impact must be in line with their mission. For the NIH and the NSF, Significance (impact) is the first review criterion. No matter where you apply, you will have to argue for the significance of the work. This section of the proposal provides the most explicit answer to the question, "*So what?*"

Even though it may not be a formal part of the outline of the proposal, it cannot hurt to subtitle a paragraph with a clear indicator, such as ***Significance*** or ***Significance of the Proposed Work*** or ***Impact***. I also recommend that you place this paragraph directly after the Overview unless the agency specifies otherwise. (It can substitute for the short Impact paragraph described in Chapter 5.) Proposals to the USDA have a Rationale and Significance section after the Background and Preliminary Data sections. Proposals to the NIH have three sections to the Research Strategy: Significance, Innovation, and Approach, and they should be given in that order. (See more on the specific requirements for proposals to the NIH at the end of the chapter.)

You can state the significance in one or two paragraphs. The first paragraph should provide clear documentation that there is a problem. Sometimes the “throat-clearing” sentence that you wrote on the blank computer screen when starting your Specific Aims/Overview can serve you as the opening sentence for Significance. If the opening paragraph of the Specific Aims/Overview tells the story, framing the general problem, the key literature, your contribution and the key barrier to progress, then the first paragraph under Significance solidifies that argument. You may recall from the last chapter that I recommend that you draft the opening paragraph of the Specific Aims/Overview without

[53] https://www.darpa.mil/work-with-us/heilmeier-catechism Retrieved September 16, 2021.

For fellowship applications, especially in the humanities, you may need to combine background and significance. The structure described here can work quite well, although the paragraphs may expand a bit with further discussion of the literature.

citation to help you focus on telling the story. Here you substantiate that story, provide citation and go into a bit more depth on the problem. For example, the USDA instructions include:

> Estimates of the magnitude of the issues and the relevance to stakeholders and ongoing state-federal food and agricultural research, education, and extension programs;[54]

This means you need include data about the economic impacts of your project in a USDA Rationale and Significance section. For NIH proposals, you may want to include data on the demographics and impacts of the relevant disease. For NSF, you may need citations on the need for the work and the potential broader impacts (see notes below). Put this information first, and then follow with more details (and citations) that demonstrate that you have identified a real problem. End the first paragraph not by restating the problem or the key barrier to progress. Instead, present what you plan to do as the clear and logical next step.

The second paragraph under Significance has three parts. The first part begins with what you expect the results to be from this next step. What will this work contribute to the field? The second part is a single sentence that clearly states the impact of having achieved that objective. Do not be afraid to use language like, "This is <u>significant</u> because…" or "*We expect these results to have an impact on the field by…*" You should not hesitate to italicize that sentence, underline the word "significant", or some other approach to draw reviewers' attention to your statement of significance. They may copy and paste it into their review.

Never simply say that your work "will add to the literature". The literature contains the knowledge-base, but papers are not ends in themselves. How will the results have an impact?

Sometimes the reviewer is asked to explicitly state why the work is significant during the review discussion. Ideally, you should write the significance sentence so that they could speak it as written and all the other reviewers would understand the meaning.

In some cases, you may have several points of significance that you want to highlight. I do not recommend making multiple statements of Significance because less important impacts may dilute the impression of the biggest impacts. The additional points become the 3rd part of the paragraph, sentences describing the potential benefits that follow the statement of significance—part 3 of the 3-part second paragraph. In the context of pilot work or proposals to foundations, you may want to make two points of significance. The first would be the impact of the work you propose, and the second would be future work enabled by successful completion of the pilot work.

[54] https://nifa.usda.gov/sites/default/files/resource/AFRI%20Foundational%20%26%20Applied%20Science%20RFA%20Additional%20Information%20for%20Part%20....pdf Retrieved September 18, 2021

See example text in the box below. As before, please ignore the Latin; the purpose here is to demonstrate the structure of the information. Follow the significance statement with real examples of the impacts you foresee.

SIGNIFICANCE

Student difficulties [with thing our training program is about] are well documented and have been shown to correlate with increased dropout rates (Department of Education, 2015). This appears to be particularly relevant in students with Factor 1 (Nevada, et al., 2014) Consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua (Reviewed by Whorfin and Lizardo, et al, 2016). Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat (Emdall, et al. 2000, Gomez and O'Connor, 2015). Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum (Carruthers, et al., 2017). Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat (Carruthers, et al., 2015, Carruthers and Nevada, 2017). Therefore, we plan to track over 2 years how students with Factor 1 are impacted by the program through measuring completion rates, perceptions and concrete learning outcomes as compared to other students.

The longitudinal approach in this proposed work will allow us to identify the key connections between Factor 1 and the student outcomes in our training program. *These results are expected to have an impact on identifying which students would benefit from intervention.* For students with Factor 1, we expect this will improve their retention in the training program by helping them overcome a barrier that causes frustration and disengagement. We expect positive impacts on student engagement, further leading to improved retention and graduation rates. For the programs, our results will allow for the creation of a more cost-effective approach to assigning resources.

One clear statement of significance usually serves best. Sometimes, particularly for pilot grants or career development grants, one point of significance should relate to the purpose of the award. A slight change in the example above would provide two points of significance, one for the research and one for the grant purpose. If the proposal were for a project to establish proof of concept or some kind of preliminary work, you could add a second bullet to that effect. The second paragraph would then look like the following.

The longitudinal approach in this proposed work will allow us to identify the key connections between Factor 1 and the student outcomes in our training program. These results will provide

1. *an impact on identifying which students would benefit from intervention; and*
2. *key foundational data for determining the mechanism of Factor 1 influence on poorer student outcomes.*

For students with Factor 1, we expect this will improve their retention in the training program by helping them overcome a barrier that causes frustration and disengagement. We expect positive impacts on student engagement, further leading to improved retention and graduation rates. With insights as to the mechanism, our results will also allow for the creation of a more effective interventions that have the potential to scale for application in other school systems.

For some proposals, you may not need or have room for a separate section titled Significance. In that case, extend the final paragraph of the Overview.

- For DOE, ED or NASA proposals, for example, you may choose to end the Overview with a longer impact statement than the one discussed in Chapter 5. In that case, use the structure of the second paragraph—contribution/outcome, impact statement, credible benefits—as the final paragraph of the Overview.

- For NSF, some applicants choose to put the Broader Impacts (see below) directly after the Overview. I do not recommend this approach, but if you choose to do so, you can use this format for Significance and call it Broader Impacts. In the last part of the second paragraph, you will need to include both the impacts of the proposed research and of other Broader Impact activities you might plan. Other activities would include training graduate and undergraduate students, incorporating your research in your teaching, or other outreach activities.

- For NEH or other very short fellowship proposals, title the section **Background and Significance** and make the first paragraph longer, or have two paragraphs, to incorporate more discussion of the literature.

Significance for applicants to the NIH (and impacts on the Approach section)

Significance and Innovation are two of the three sections required in the NIH Research Strategy. They should take up no more than two pages of the 12-page Research Strategy for an R01, leaving the remainder for the Approach. For an R03, keep it to about a page and a half of the six-page Research Strategy. For an R21, this could go as long as two pages because the Innovation section should not be given short shrift if you use the R21 in the original intent of a “high risk/high payoff” proposal (see Chapter 7).

Note that NIH goes to great lengths to differentiate between Significance vs Overall Impact. For Significance, reviewers generally consider that, if all the aims are successfully completed, whether the project would "address a problem or critical barrier to progress in the field or have the ability to improve knowledge, technical capability, or clinical practice." The Overall Impact score can be influenced by all 5 criteria (Significance, Investigator, Innovation, Approach, Environment), weighted based on reviewer’s judgment.

The NIH added a question under the Significance review criterion in 2016.

> Is there a strong scientific premise for the project?

This requirement changed in 2019 to a different phrasing

> Is the prior research that serves as the key support for the proposed project rigorous?

The history of Scientific Premise as a criterion, however, should guide you in addressing the new criterion. There was much discussion about what "scientific premise" meant. The Deputy Director for extramural research at the NIH, Dr. Michael Lauer, gave the following description in 2016:

> Therefore, as a part of the Significance section of the Research Strategy, the updated instructions clarify that applicants should: "Describe the scientific premise for the proposed project, including consideration of the strengths and weaknesses of published research or preliminary data crucial to the support of your application." Weaknesses in scientific rigor or gaps in transparency that preclude the assessment of scientific rigor should be acknowledged. If such weaknesses are identified, the applicant should consider whether or not to include this data in support of the application and how the proposed research will address the weaknesses.[55]

Note here the use of the word "transparent". *The entire goal of the Scientific Premise requirement was to ensure that if someone builds on existing data, whether published or their own preliminary work, the foundation is solid, rigorous, and reproducible.* Unless the methods are truly transparent, the work may not be reproducible based on the published literature.

NINDS director Dr. Story Landis was lead author on the paper in *Nature* in 2012, "A call for transparent reporting to optimize the predictive value of preclinical research."[56] The paper came in response to a clear question about failure in clinical trials due to basing the trial on pre-clinical work that was poorly done and/or poorly reported.

Despite the information from NIH, applicants (and reviewers, and sometimes even Scientific Review Officers) were not sure what was supposed to be in the Scientific Premise. For submissions in 2019, NIH changed the language to a question about the rigor of the prior work, quoted above, which makes it much more clear what NIH wants—an explicit discussion of the rigor of the prior work. But they provided no guidance on how to provide that discussion.

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[55] https://nexus.od.nih.gov/all/2016/01/28/scientific-premise-in-nih-grant-applications/ Retrieved September 18, 2021

[56] A call for transparent reporting to optimize the predictive value of preclinical research
Story C. Landis, Susan G. Amara, Khusru Asadullah, Chris P. Austin, Robi Blumenstein, Eileen W. Bradley, Ronald G. Crystal, Robert B. Darnell, Robert J. Ferrante, Howard Fillit, Robert Finkelstein, Marc Fisher, Howard E. Gendelman, Robert M. Golub, John L. Goudreau, Robert A. Gross, Amelie K. Gubitz, Sharon E. Hesterlee, David W. Howells, John Huguenard, Katrina Kelner, Walter Koroshetz, Dimitri Krainc, Stanley E. Lazic, Michael S. Levine et al. Nature 490, 187–191 (11 October 2012) doi:10.1038/nature11556

Following is my recommendation. This advice stems from the previous writing from NIH about Scientific Premise, quoted by Lauer above, including "published research or preliminary data crucial to the support of your application." The key word here is "crucial". To make sure that reviewers can see that you have addressed the criterion, include a section between the two paragraphs of Significance discussed earlier in the chapter and give it a bold title: **Rigor of the Prior Work**[57]. Start with a paragraph with full citation of the papers pretty much everyone agrees would form part of the foundation of your proposed work, and which are generally considered to be robust and reproducible. Be sure to cite those that reviewers in your field will expect to see. See also Chapter 8; this paragraph should tell a story. Do not treat this as a literature review, but more as perhaps setting the table.

Next select from two to five key papers that must be right for your project to be worth doing. To put it the opposite way, pick the key papers which, if they're not right, would mean your project will likely fail. You can also include one, or at most two, pieces of preliminary data, done to publishable quality. Pick crucial data, those where if your data are not right, the project will likely fail. By including data from your own group, done to the standards of the NIH Rigor and Reproducibility requirement (see Chapter 9), you demonstrate to the reader that the prior work on which you base the proposed project provides a solid foundation.

Note that the example on the next page includes a discussion of a potential deficiency of rigor. This is a requirement, if such deficits exist. Such discussions must be handled carefully, but you must have the intellectual honesty to include them. There may also be deficits in transparency, where the methods were not completely reported.

Also, as discussed in Chapter 9 on the Approach or Research Plan, the newer NIH criteria include the following: "Have the investigators included plans to address weaknesses in the rigor of prior research that serves as the key support for the proposed project?" In the example on the next page, I demonstrate a potential way to address this question and provide cues to your reviewer about what they will find in the Approach.

[57] Several clients have had reviewers state in their NIH reviews that they had not provided a discussion of the rigor of the prior work. The clients thought the discussion was implicit. Don't make the reviewer work. Give it a heading and let them check off the box.

RESEARCH STRATEGY

SIGNIFICANCE *(This is completely made-up science. Focus, please, on structure)*

Co-morbidity 1 (CM1), which affects nearly 50% of Imaginary Chronic Disease (ICD) patients, has consistently correlated with worse outcomes (McKay and Zelenka, 2016). The question of whether CM1 is specifically related to incidence of ICD is equivocal (reviewed in Kusanagi and Novak, 2018). More recently Caldwell, et al. (2019) demonstrated that one of the more promising potential treatments for CM1, imaginizab, showed high efficacy in animal models of the disease, but a subsequent trial in humans proved equivocal (Carter, et al., 2020). When the data were re-analyzed in a scatter plot, there appeared to be two relatively clear levels of response, but the nearly bimodal distribution did not correlate to sex or age. (Jackson, et al., 2020; O'Neill, et al., 2021). In the proposed longitudinal analysis, we will include analysis of additional biological markers that correlate with known co-morbidities to identify the underlying correlation of this unexplained distribution.

Rigor of the prior work: Our understanding of the biological basis of ICD has, over the decades, solidified from a constellation of symptoms to an understanding of the gene X environment interactions (reviewed in Kusanagi, et al, 2016). The initial discovery of the family of mutations in the SG1 genes (Kowalski, et al., 1994, Frasier, et al, 1997, Lee, et al., 1997) has guided the attempts to develop therapeutics to treat ICD beyond the standard of care of symptom management. This work revealed key correlations between patient exposure to GLD and the degree and extent to which mutation carriers developed ICD symptoms (Hammond, et al., 1999, Quinn, et al., 2001). A key finding of the connection between GLD exposure and symptom development indicated that GLD exposure induced exuberant expression of SGA (Murray, et al., 2005; Doran, et al., 2006), which would normally have been regulated by SG1 (Landry, et al., 2004). This *in vitro* finding was recapitulated in the well-understood animal model of the SG1 mutation pattern, C57bl6^{SG1like} (Harriman, et al., 2009; Lam, et al., 2011). In response to this finding, initial attempts at finding a therapeutic targeting SGA's mechanism of action were not effective (reviewed in Hailey, et al. 2018). New immunotherapy approaches were aimed at reducing excess SGA, ultimately resulting in, imaginizab, a monoclonal antibody targeting circulating SGA (Shang, et al., 2014; Ti, et al., 2016).

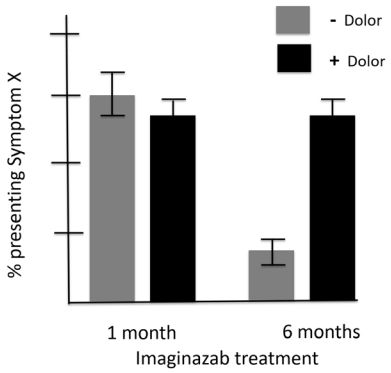

Figure 1: Patients with Dolor co-morbidity markers continue to present symptom X six months after treatment, whereas those without show significant benefit from imaginazab. We identified patients with and without Dolor comorbidity by biomarker analysis. We reviewed charts of 50 patients per group. This represents a re-analysis of the data originally published in O'Neill, et al., 2020. Error bars represent standard error of the mean.

Three key points underlie the proposed project. First is the original publication of pre-clinical testing of imaginizab. In a robust study that included blinding of treatment groups, imaginizab was found to reverse two ICD-like phenotypes of C57bl6^{SG1like}, specifically the disrupted stereotype pattern behaviors such as grooming and swimming, and the altered taste preferences seen in the animal model (Novak, et. al, 2017). Second is the results from the human studies, which showed equivocal success with imaginizab in a double-blinded trial (Carter, et al., 2019). While the study was powered to detect overall efficacy in several areas, the appearance of a potential group difference in responsiveness was unexpected. The original trial was not designed to assess comorbidities. We reanalyzed trial data and used qPCR (three replicates) for Dolor, the CM1 biomarker, on biobanked samples from the original study participants. Cross referencing the chart review and qPCR showed clearly that patients without dolor markers responded better to imaginizab treatment (Figure 1, O'Neill, et al., 2020). In a separate study, patients without biobanked tissue were coded for CM1 symptoms by two independent investigators and the blinded data analyzed

by our bioinformatics team. This analysis showed that approximately half of 1,730 diagnosed ICD patients, for whom biomarker analysis was not available, also have phenotypic indications CM1, further indicating the potential of co-morbidities to interact with potential treatments (McKay, et al., 2020) Together, these publications and supporting data provide a strong basis for the proposed work, and our approach will account for the potential impact of co-morbidities in potential treatments targeting SGA overexpression in ICD.

Expected impacts of the proposed work: The longitudinal approach in this proposed work will allow us to identify the key connections between CM1, ICD outcomes, and approaches to treatment. *These results are expected to have an impact on classifying ICD patients for the most appropriate treatment approach.* This classification would potentially change the standard of care for ICD patients. At the same time, the proposed work will provide key information on the mechanistic impacts of CM1 on ICD physiology and disease course. Our approach will also include testing for additional known markers for ICD co-morbidities (detailed in Approach), which we expect will allow us to refine the model of treatment interactions. Ultimately, this work would provide the basis for treatments for those with CM1, and the mechanistic insights could also yield tractable new points of intervention for all ICD patients. Through the development of targete1d therapeutic approaches, this work is expected to both impact the health of patients with ICD and result in more cost-effective approaches to patient care.

INNOVATION

….

Chapter 7: Innovation

Innovation shows up in the review criteria of almost all funding agencies, including the NEA. The Institute for Education Sciences (IES) does not include Innovation as a review criterion.[58]

The 2017 ART WORKS program at the NEA included the following in the review criteria:

> Be distinctive by offering fresh insights and new value for their field and/or the public through unconventional solutions;[59]

That sounds like innovation, and the criterion makes a key point about innovation—offering new value.[60] *Invention* is not necessarily *innovation* if the invention has no impact or value.[61] You might have an unconventional solution, but if it does not provide fresh insight or new value, what purpose does it have? Just stating you have invented something does not provide an argument for innovation. Yes, like all parts of the grant proposal, your discussion of innovation should contain a compelling argument.

Proposals to the NIH have a specific section titled Innovation. For proposals to places other than the NIH, you can discuss innovation in several places, including the Background, Preliminary work, or in the Research Strategy/Project plan. Use the buzzwords in the target agency's stated criteria to guide the reviewer

As a reference, here are the NIH review criteria for Innovation, the most explicitly developed description. The concepts can apply across the board.

- Does the application challenge and seek to shift current research or clinical practice paradigms by utilizing novel theoretical concepts, approaches or methodologies, instrumentation, or interventions?
- Are the concepts, approaches or methodologies, instrumentation, or interventions novel to one field of research or novel in a broad sense?
- Is a refinement, improvement, or new application of theoretical concepts, approaches or methodologies, instrumentation, or interventions proposed?

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[58] Procedures for Peer Review of Grant Applications. Retrieved September 19, 2021 from https://ies.ed.gov/director/pdf/SRO_grant_peerreview.pdf.

[59] The solicitation is longer available at the NEA web site (arts.gov). Archived copy retrieved September 18, 2021, from https://www.federalgrants.com/NEA-Art-Works-I-Application-FY2017-54872.html

[60] Current (September, 2021) NEA language for programs such as Our Town use the word "new" quite a bit, as in "Envisioning new possibilities…"

[61] Brown, J. S. , and Duguid, P. The Social Life of Information. Harvard Business School Press, 2000, chapter 6. I don't know if this distinction is original to them, but I found it helpful in determining what was truly innovative and what was simply inventive. It's inventive to make a contraption to take a goldfish for a walk, but do the fish need enrichment activities beyond the plastic castle in the tank?

The following words appear in two of the three bullets:

theoretical concepts	instrumentation
approaches or methodologies	interventions

One bullet in the NIH criteria has a question about paradigm shifts, and one asks about refinements, improvements, and new applications. Notice also that they list concepts or theoretical concepts first. The major mistake people make in writing about Innovation is to assume that it only means technical innovation. You can frame the innovation for the reader, starting with the current state-of-the-art and placing your innovation by contrast. The second bullet under the NIH instructions asks whether the innovation is novel to the specific field or in a broader sense. If your innovation would have impact beyond your narrow field, do not hesitate to make that argument in your discussion.

Innovation is the most subjective of all the review criteria and the one criterion where I have seen individual scores on proposals to the NIH vary the widest. The best way to present your innovation is to make an argument. Think about these two questions:

- How have people done this work or thought about this problem before?
- What will you do, or what concepts do you bring, that are different?

This can also be the most frustrating section to write, particularly if the most appropriate methods to use for your project are standard. In that case, I would focus on the *conceptual* innovations. How are you thinking about it differently? How are you applying a known technical approach to solve a different kind of problem?

Reviewers and applicants alike make the same mistake of assuming innovation means novel. Innovation can mean truly new, or it can mean new application of a known method to a field, or it could mean being creative in solving a problem. Reviewers are advised at NIH to put too much weigh on this criterion when thinking about the overall impact of the work. That said, some programs, such as to DARPA or for the military MURI programs, place a premium on the innovation of the proposed work.

Innovation is best appreciated by contrast. Start by framing the current conceptual or technical approach (with citation) and present your innovation as different from the past. The NIH requires a specific section, but I've seen the argument approach effectively used in the Background, where you can present your innovation relative to the literature. It can also be placed within the Preliminary Data, where a graphic presentation of the new approach can help to solidify the argument for your new technical approach.

Think of your argument for innovation as having four parts:

1. Past approaches or concepts
2. The limitations of those approaches or concepts
3. Your innovation
4. The impact of your innovation in overcoming the limitations of the past and the impact it will have on future work

Below, you will find examples of how to construct an NIH Innovation section, but the general approach of setting the stage applies across the board. Again, these examples are biomedical and I use Latin text because the point of the example is to show structure, not content.

INNOVATION

Previous approaches to orro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem (reviewed in McKay and Zelenka, 2019). More recently, the Shipman group has reported orro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia (MalDoran, et al., 2020). These approaches have laid important groundwork in the field, but translation to clinical practice has been somewhat limited by the lack of correlation of patient biomarkers with longer-term outcomes. *By contrast, our approach allows us to longitudinally track these factors using a unique combination of [thing] and [other thing].* This will allow us to use the results to create more patient-specific approaches to assigning treatment regimes based on patient biomarkers. The optimized treatment will reduce the cost and patient burden of undergoing expensive but ultimately ineffective treatments for a substantial portion of ICD sufferers.

Additional innovations in our approach will also improve both the efficiency of the work, and support the rigor of the study and will be detailed in the Approach section.

- We have an innovative approach to identification and recruitment of ICD patients with CM-1.
- The additional patient coding in our tissue bank allows us to more tightly correlate outcomes by integrating with patient visit reports, increasing our tracking of CM-1 symptoms.

Note the use of bullets in the text box. One successful NIH-funded scientist I know has a page for Innovation open as she writes the Approach. As innovations occur to her, she puts a bullet about it in the open Innovation page. That approach can work well or backfire. It backfires when the bullets are presented without context. This particular writer would curate the collected bullets into the most compelling 2 or 3 points. Then, she would provide a framework sufficient for the reader to understand why the approach or concept is innovative by beginning with how people used to do or think about the problem. Note that she included only 2 or 3 key points. Some reviewers may like bulleted lists of innovations, that approach usually results in a mix of the trivial and the exciting, with no indication of which bullets matter most. Bullet approaches also generally fail to provide contrast for appreciating the innovation.

If you only have one point of innovation, you can structure the section as a paragraph like the first paragraph in the text box above. Sometimes you have additional points of innovation that may need more explanation than bullet points would allow. There are two ways to handle this. The first is to set up construction in series. The sentences in the box give the kind of information you would expand into several sentences.

We have two points of innovation, one technical, one conceptual. With respect to conceptual innovation, people have previously thought about it this way (citation). *By contrast, we have a new way of thinking about it*. With respect to technical innovation, here's how people use to do this (citation). Here the limitations of that approach. *Here is our novel approach*. Overall, these innovations have an impact on the field by...

You can take a similar approach but create separate paragraphs for technical and conceptual innovations. You can even combine paragraph approaches with the hybrid bullet approaches if you have a number of points to make.

INNOVATION

Conceptual: People have previously thought about it this way (citation). This has led to limitations, such as … (citation?). *By contrast, we have a new way of thinking about it*. Here's how the conceptual innovation will impact the field (in a way that is different from Significance).

Technical: Here's how people used to do this (citation). Here are the limitations of that approach. *Here is our novel approach*. Overall, here's the impact of our innovation.

Variations on these methods work for multiple points of technical innovation or conceptual innovation. I would like to emphasize that the discussion of limitations does not need to include active criticism. Sometimes the limitations had to do with the technology of the time. The example I often use is the creation of the mountain bike. "Previously two-wheeled human-powered transportation provided faster-than-walking transit, but was effectively limited to flat, level surfaces. By contrast, we have added a gearing system and robust, high-traction tires. These innovations allow two-wheeled human-powered transportation to more easily handle inclines and rough surfaces."

As noted, the NIH requires a section on Innovation, but the methods described here also work for proposals to other agencies where Innovation is a review criterion. If your application targets a high-risk or innovative program, highlight the innovation and responsiveness to the program requirements. Describing what is new would be very important particularly for NSF's RAPID and EAGER grants, or USDA Exploratory programs.

You can fold the argument for innovation into the discussion of the Background, or even the Research Plan. Some people put a brief description in the Overview as part of the "How to test/Why you" part of the framework and expand on the argument in the Background, Preliminary Data, or Research Plan. Put it where it makes sense in your proposal and where it will have the biggest impact on reviewers.

The bottom line is that no discussion of Innovation section should start with, "This work is innovative because..." because assertions can be discounted by reviewers. Provide a framework and make an argument.

Chapter 8: Background and Preliminary Data

Background

The purpose of the background section is to provide the framework for your reviewers to understand the justification for the work you propose to do. You do not need to provide a thorough literature review. As we noted in Chapter 4, the opening paragraph of the Overview/Specific Aims sets up the argument for why this work needs to be done. The background section substantiates and extends that argument.

The NIH removed formal Background and Preliminary Data sections from their proposal outlines in 2010. Reviewers still need that information! Applicants now put some of that information in Significance and most in the Approach, whether in the Rationale for each Aim or in the research description to illustrate feasibility of the approach in the applicant's hands. *All the principles described here apply to NIH grant proposals, but the location of the information will be scattered throughout the Research Strategy.* See the sample in Approach, Chapter 9.

Do not just report previous work; think about it critically.

- Was it rigorously done?
- Did you identify issues or gaps that brought you to the questions that led to this proposed project?

A thoughtful discussion of the literature does not read like a report: "Here's a fact.[cite] Here's another fact.[cite]" The literature you discuss here provides the justification for the work you propose to do and the methods you have chosen. It also provides context for your reader, and you should never lose sight of your target audience. Craft a story that takes them through a thought process.

One of the easiest ways to write this section is to organize it so that each concept has an informative subheading and a concluding take-home message. This will let the reader know what they're about to read and, at the end, why you wanted them to read it. In fact, it can sometimes be easier to write the sentences in between once you have the heading and the take-home message. It will help you hone your discussion and citation to the points that your reviewer truly needs to read. I tend to prefer organizing by conceptual area, but if it makes sense to organize the discussion by aim/objective, do that.

Here, as everywhere else in the proposal, your reader needs a narrative. Even the Background section should contain an argument. In the book Houston, We Have a Narrative, by marine scientist-turned-filmmaker Randy Olsen, Olsen maps the narrative structure to the argument structure commonly taught. The narrative structure is *And, But, Therefore*. The basic narrative structure (usually in multiple sentences) is as follows: _____ and

_____, but_____, therefore_____.[62] The common argument structure is "they say/I say", or the philosopher Georg Hegel's triad of Thesis, Antithesis, Synthesis. Consider the following: *The literature shows this and that. But our/other published data show the other thing. Therefore, the work we propose will resolve this apparent discrepancy*. There is a logic and a story, an argument for why the proposed work is important, even in the background section. Never simply throw information at the reader without context in a string of "and" sentences. Each background section or paragraph plays out as follows.

Informative subheading Start with a key framing point that the reader needs to know to appreciate why the text that will follow is important (Name, YEAR; Name, et al. YEAR). Each following AND sentence tells the reader what they need to know and sometimes also why the information is important. The BUT or Antithesis sentence or sentences provide the contrasting information. End with a clear conclusion (Olsen's "therefore" or Hegel's Synthesis) giving the take-home message for this subsection.

Write this in active voice ("We demonstrated…" or "Pedroia and colleagues reported…" not "It was demonstrated…"). You may note the American Psychological Association citation format used here, the common "Name, et al., YEAR" format. Whether you use APA or numbered citations depends mostly on the culture of your field. I recommend using the APA style for proposals to the NIH and to the Biology directorate of the NSF. For physics and engineering (DOE, NSF, NASA), readers generally expect numbered citations. For humanities proposals, your readers may expect footnotes instead of end note citations.

Don't be afraid to make comparisons between your work and others. When you write the discussion of the literature, keep these questions in mind.

- Will you simply extend other's findings?
- Will you break new ground?
- Will you translate an idea into a new area?
- Will you correct something?

Many applicants write the background as an "information dump". Here, as with every part of the proposal, you need to provide context for your readers. The organization rubric and keeping the questions in mind will help you convey the necessary information.

There are many books on writing papers and on citations. I distill my advice on citations into a few key points.

- Know why you've cited any paper, and make sure the reader does, too.

[62] Olsen, R., Houston, We Have a Narrative. University of Chicago Press, 2015. In this book he pulls apart the nature of narrative and demonstrates that science (and I would argue all scholarly work) is steeped in narrative. He warns against the, "Despite, However, Yet" structure that is all too common in academic writing. If you start with something you plan to counter ("Despite"), the reader knows you plan to counter what you're about to say and may ignore it. It clutters the story. Get to the point.

- Never cite anything you have not actually read.[63]
- Don't rely on reviews, and always provide a cue that you cited a review, e.g., "… (as reviewed by Lam, et al., 2016)" or "...(reviewed by Lam, et al. [32]" if you use numbered citations.

Remember that the entire purpose of any Background section, however it is named, is to give the reviewer context for why what you propose to do is important and likely feasible.

NSF Results from Prior NSF Support and the relationship to work in progress

The NSF has two additional sections that count as background. Sometimes applicants skip including Results from Prior NSF Support if they have never received an award from the NSF. Sometimes applicants imply the relationship to other work in progress through writing the background section. I recommend you include these two subheadings in a proposal to the NSF because the information is explicitly requested in the PAPPG.

Results from Prior NSF Support

One unspoken question in review is whether an award would be a good investment, and reviewers can form opinions about this by seeing what you made with previous grant support. If you have never received an award from the NSF, put in this heading and write, "No previous NSF funding."

If you or any co-PIs have support from the NSF that is current, including no-cost extensions, or that ended within the last five years, you must account for it, even if the award was for work not related to the current proposed project. However, if you have or had more than one award, each PI or co-PI only need to discuss the one award that is most closely related to the proposal. This includes any funding, whether for research, Graduate Research Fellowship, centers, conference awards, etc.

The NSF instructions are as follows:

> The following information must be provided:
> (a) the NSF award number, amount and period of support;
> (b) the title of the project;
> (c) a summary of the results of the completed work, including accomplishments, supported by the award. The results must be separately described under two distinct headings: Intellectual Merit and Broader Impacts;
> (d) a listing of the publications resulting from the NSF award (a complete bibliographic citation for each publication must be provided either in this section or in the References Cited section of the proposal); if none, state "No publications were produced under this award."

[63] I wish that didn't need an explicit statement.

(e) evidence of research products and their availability, including, but not limited to: data, publications, samples, physical collections, software, and models, as described in any Data Management Plan; and
(f) if the proposal is for renewed support, a description of the relation of the completed work to the proposed work.

That is a lot! And it can take up quite a bit of the Research Plan, so use your Literature Cited liberally, particularly for the complete bibliography. The NSF is not looking for editorializing in this section, just facts. Try an organization like the following, ignoring the placeholder Latin:

> [grant number] – **Title in bold.** *Intellectual Merit:* The overall objective of this proposal was vestibulum posuere porta turpis, ac sodales neque lobortis et. The central hypothesis (or research question) was ellentesque rhoncus euismod porta. Curabitur quis purus efficitur, placerat metus at, aliquet nulla. We have published X papers and Y abstracts detailing the following key results [put in results with citations]: 1) Verdant ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae. 2) Nulla quis fringilla nunc. 3) Forci luctus et ultrices posuere cubilia Curae. *Broader Impacts*: [Summarize the results of your Broader Impacts activities and describe the availability of any products ((e), above).]

Look also for models of how your peers and colleagues have answered this requirement but remember to include both the Intellectual Merit and Broader Impacts.

Relationship to other work in progress

The NSF instructions on the content of the Research Plan say that you should include

> …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 general discussion of background should provide the relationship of your proposed work to the state of the field, but the second part, the relationship to your other work in progress, is often left out. As discussed in Chapter 14, you will have to provide information on your current and pending support as part of the administrative forms. The purpose of the *Relationship to other work in progress* section in your background is to position the current project as complementary to the work already in progress, but not overlapping. I recommend a short section within your Background section with a clear heading, providing the information on how the proposed work relates, or doesn't, to the other work you are currently supported to do. Note that I said supported, not specifically funded. This notion has become increasingly complicated, but start first with grant funding, whether through external funders or internal awards.

This should be a prose section and you do not have to provide grant numbers as you do with the Results from Prior NSF Support. State generally what the other work in progress is about, and then clearly state how this work is different or is complementary, potentially even synergistic, to your other supported projects. Citation here can also be useful so that

reviewers can see how you have been productive with other research support. Citations would also let them see the contrast you describe between your current work and the proposed project.

For Humanities proposals or Program proposals: Even if you are not in a data-driven field, the reviewer needs some sense that you have already done enough work on the project to know that it will be feasible to carry it out, or that you have similar previous experience. The rubric given below for hypothesis-driven work can easily be modified to describe the preliminary work that you may have undertaken to determine, for example, if an archive has the kind of information you need. For Programmatic proposals, your needs assessment often serves as your preliminary work. It demonstrates that you are familiar with your target population and that your program plan is based on a clear understanding of the conditions on the ground.

Preliminary Data / Previous Work

The purpose of preliminary data is to show the feasibility of the work that you propose. This raises the question for many people as to whether the data should be published or unpublished. The answer is, "That depends." For work with human subjects or health services research, the majority of the supporting data may already be published. In many bench science fields, the preliminary data may have been produced the day before the application was submitted. In a YouTube video on NIH panels,[64] Ohio State University researcher Dr. John Christman delineated the difference between "supporting data" and "preliminary data". Supporting data show experiment and analyses done to publishable standard. Truly preliminary data have not yet reached the publishable level, but they can be important to include to demonstrate that a technique works in your hands.

For most research proposals, supporting data should be in a section called **Preliminary Data** (but not for the NIH; see notes below). Additional data can and should be included within the discussion of each specific aim/objective in the Approach or Research Plan (See Chapter 9). Including preliminary data in the research plan allows you to demonstrate directly for the reader that the approach works in your hands. It also provides a way to break up the text by including visual information that can often convey more than words alone.

If preliminary data do not support your hypothesis or conceptual framework, do not use it and do not try to massage it to fit. Make sure that your interpretation of your own work is accurate. Whole proposals have failed in review when the preliminary data appears counter to the conceptual framework or hypotheses paused in the application.

Sometimes the data may actually fit, but the reader is given no context as to how. The most common mistake in discussing preliminary or supporting data is to dive right into

[64] "Inside NIH Study Sections and Common Mistakes Seen on Applications" Very worth viewing for NIH applicants. Three Ohio State University professors with extensive experience on Study Section talk about the process, the mistakes, and how review really works. Retrieved September 19, 2021 from https://www.youtube.com/watch?v=p3WQsC1S0TA

the details without any framework of why the work was done. Don't make the reviewer work that hard. If they have to struggle to understand why you did an experiment, you have wasted the most precious commodity that you have in your relationship with the reviewer: their attention.

There's a very straightforward rubric that you can use to organize each discussion of the preliminary data. Similar to the Background section, each section should have some informative heading. The paragraph should give the information in this order.

- Here's the question that arose in our minds.
- Here's what we did to answer that question.
- Here's the exact methods we used.
- Here's the result(s) we obtained.
- Here's what those results mean in the context of this proposal.

In practice, this rubric becomes invisible. This approach to information flow can also work for publications. Handing your students the rubric may help speed up their writing process.

When you include figures, be sure to refer to the figure in the text. Even better, send the reviewer to a specific place within the figure ("...as seen in Figure 2, panel B"). I wish I didn't have to say this but having read many proposals I find the need to explicitly state it: *Always place the figure close to where you talk about it.* If you cannot accomplish this, refer to where the reader will find the figure ("...as seen in Figure 4, next page following.")

Construct each figure to make only one point. If you have eight figures that each have eight to ten panels that contain six to eight histograms each, the reviewer will not take the time to puzzle through every one of the 64 to 80 bar graphs.[65] The best way to be sure that your figure makes one single point is to have a figure legend title written as a sentence giving the take-home message from the figure. Contrast the two figures on the next page.

The figure on the left demonstrates the typical approaches writers take, to label the figure with a sentence fragment describing what we are looking at and some sparse details about the methods. The version on the right uses a sentence that gives the

NIH proposals do not have a section called Preliminary Data, although you need to include evidence that the work is feasible in your hands. A key piece of supporting data might go into the Significance section. The rest of the supporting data and the preliminary data should be included under each aim in a section called Justification and Feasibility. See example in Chapter 9 for the Approach.

Many **Department of Energy** proposals have a Preliminary Data section and may also have a sub-section within the discussion of each objective/aim in the research plan titled "Justification and Feasibility". Preliminary data that support the overall premise of the project go in Preliminary Data. Data to prove technical feasibility for the activities proposed for an objective go in that objective's "Justification and Feasibility" section.

[65] I will never tell you anything I have not actually seen.

conclusions from the data. What does the reviewer need to know? Why do you want them to see this figure? If they read a conclusion as the figure legend, then the cognitive process is different. They will look at the data and determine whether they agree with the conclusion. The second approach may take a bit more space, but if your reviewer looks first at the figures before reading any text, they have almost all the information they need from the figures alone. This approach can also work for figures in your publications.

Take, for example, the following versions of the same data.

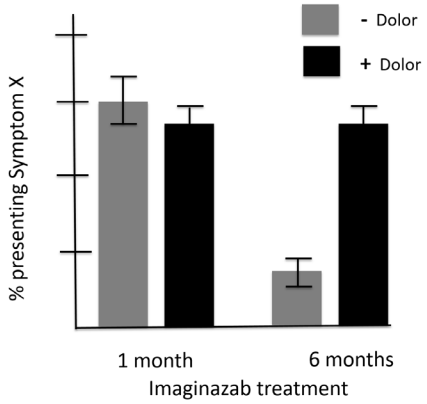

Figure 2: Relationship of Dolor co-morbidity with Imaginazab outcomes. 0.025 mg/kg Imaginazab was delivered via transfusion. Biomarker analysis was done by qPCR. Chart review was used to assess outcomes.

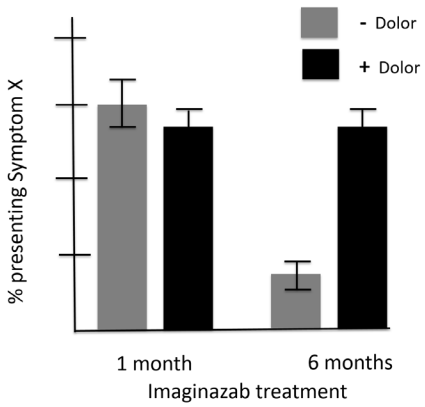

Figure 2: Patients with Dolor co-morbidity markers continue to present symptom X six months after treatment, whereas those without show significant benefit from imaginizab. We identified patients with and without Dolor comorbidity by qPCR biomarker analysis. We reviewed charts of 50 patients per group. Symptoms were assessed by patient self-report. Error bars represent standard error of the mean.

You may want to argue that the figure on the left takes less space. I would argue that if your figure isn't comprehensible, it doesn't contain as much actual information as it could, and you've wasted the space anyway. This notion also applies to figures that are too complex. If you cannot write the take-home message in one sentence, the figure is probably too complex and should be broken up.

Whether you use Microsoft Word, LaTeX, Google Docs, or any other word processor, take the time to learn how to put figures and legends together in the text. For Microsoft Word, create a text box. It is better to have the figure and legend together in the text box, rather than have a figure legend as part of the body text (see the problems in the bad version of the Approach at the end of Chapter 9.) The other method is to use Word's table function.

If you do not know how to put the graphic and the text together in a text box, try the following steps for Word: Draw the text box or select one from the Text Box menu. Press Enter to move the cursor down one and leave a blank line. Type Figure X as a placeholder for the text of the legend. Move the cursor back up to the blank line and use Insert to

insert the graphic from the file. You may need to resize the text box to make everything the way you want it. However, that figure legend is now grouped to the graphic and clearly separated from the narrative text. Make sure the text is set to wrap around the figure; don't kludge it with inserted blank lines. For instructions for using tables to have two or more panels, see the second example figure in the NIH example in Chapter 9.

Editorial notes

- Do not go below 8-point font in your figure, even for labels, and never below 9 point for the legend. Some data analysis programs will automatically create tables and graphs for you. Be sure you can alter the text or legends to maximize readability.
- Some reviewers do not like the standard Excel table formats. Decide how your reviewer will most easily understand the table and format it yourself.
- Do not make the reviewer work to decipher the labels on any panel. It only serves to irritate them. Make everything clear and large enough to read at 100% on a computer screen (the rule for the NIH), not 150%.
- Consider not making the figure and legend in Power Point and then importing them as a single graphic. This often results in grainy-looking text. It also means the font size in the legend will change if you resize the figure. (I prefer a true vector graphics program, such as Adobe Illustrator, or the open-source GIMP. There are many possibilities.)
- Keep in mind that readers may be color blind or may print your proposal to review offline. Will your use of color support that? See https://www.ascb.org/science-news/how-to-make-scientific-figures-accessible-to-readers-with-color-blindness/
- Keep your use of color consistent. If something is blue in Figure 1, it should be blue in all subsequent figures.
- Read any or all of Edward Tufte's books on visual representations of data and information.

Chapter 9: Approach/Research Plan

How important is the plan? At the NIH, they have been able to quantify exactly how important, because the reviewers provide scores both for the individual review criteria and for the Overall Impact. Matthew Eblen and colleagues analyzed the relationship between the individual criterion scores and the Overall Impact, revealing that the score for the Approach correlated most to the NIH Overall Impact score.[66] This trend was reported first by Dr. Jeremy Berg when he was director of NIGMS, correlating individual scores with Overall Impact on the very first round of using the scoring system in 2010.[67] The quality of the research plan most influences the score.

Why does Approach outrank Significance? It doesn't matter how important the problem is if they don't think you can do it. Reviewers judge the research or project plan consciously and unconsciously.

- ***First Impression:*** Do I find the description well laid out and easy to follow?
- ***Critical Analysis:*** Do I think this approach would succeed?
- ***Critical Context Analysis:*** Do I think this investigator can succeed given their track record and environment?
- ***Personal Critical Analysis:*** Would I use the approach, or do I think there is something better?

These judgements are not necessarily made in a linear or conscious way, but they always play into evaluation. As an applicant, your job is to influence the readers' impressions as much as possible.

- You can control the layout and writing style.
- You can provide the supporting and preliminary data to prove the feasibility of your planned approach.
- You can create credible collaborations and provide biographical sketches and a thorough description of the environment.
- You can describe the thought processes that led to the approach so that you can, potentially, anticipate what the reviewers might think and justify your choices before they can identify possible objections.

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[66] Eblen, M. K., et al. 2017. How Criterion Scores Predict the Overall Impact Score and Funding Outcomes for National Institutes of Health Peer-Reviewed Applications. PLOS. Retrieved September 21, 2021 from http://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0155060

[67] https://loop.nigms.nih.gov/2010/08/scoring-analysis-1-year-comparison/ Retrieved September 21, 2021.

Take for example, the following review criteria from NASA, the NIH, and the NSF:

> NASA: "Overall technical quality of the proposed work, including, but not limited to, the quality of the management plan and project timeline for carrying out the work and the effectiveness and resilience of the proposed experimental designs, methods, techniques, and approaches for achieving the proposed goals and/or objectives…"[68]
>
> NIH: "Are the overall strategy, methodology, and analyses well-reasoned and appropriate to accomplish the specific aims of the project?"
>
> NSF: "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?"

At the front of this book you will find six sample outlines for research grant proposals. The outline for the Approach or Research Plan is almost identical for every potential funder. That said, if what the funder requests is different, you should follow any outline given to you by the funder. One example is that we recommend a Justification and Feasibility section for each objective for DOE proposals generally, but not all DOE proposals need this section). Remember to think about the *purpose* of each part of the proposal outline. Although different words may be used to describe the information they want, it will likely map to something we discuss here.

These criteria, given as statements for NASA and posed as questions for the NIH and the NSF, clearly reflect similar concepts. Note the inclusion in the NSF question of "well-organized". Your research plan generally reflects your thinking. Reviewers may likely assume that if your plan is well organized, you've thought it through and will carry out the work in an organized way. Having reviewed many hundreds of client proposals, I have concluded that grant writing skills and thinking skills are inseparable. When I ask a client questions about unclear elements of their research or project plan, they often realize that the writing wasn't clear because their thinking wasn't yet clear.

The second question for the NSF criterion generally refers either to clear milestones or to an evaluation plan. Many project proposals require that you include a formal evaluation plan. For NSF CAREER proposals, there should be an evaluation plan for your education activities. See discussion below.

Planning vs. reality

Reviewers need to have a clear sense of the approach you plan to take, even though everyone reading it knows that there are elements that might change in the face of incoming results. The argument for making and describing clear plans is two-fold. First, peer reviewers need to see how you think. Second, if you have thought through your plans and expectations, you may be better prepared when the results do not turn out the way you

[68] Appears in many NASA solicitations. The NIH and NSF versions are similarly found in many specific solicitations.

expect. This latter point may seem counterintuitive; many of us have seen researchers and scholars cling to a pet hypothesis in the face of contradicting evidence. One translation of the famous Louis Pasture quote reads, “Where observation is concerned, chance favors only the prepared mind.” Use the writing of the Approach to prepare.

The Approach or Research Plan section is not a Methods section

Don’t treat the research plan like a Methods section in a paper, and I do not recommend having a separate Methods section in a grant proposal. Integrate the how with the why. Provide context for your reader. While they may want to know the details of the work, you cannot give details and leave the reader to intuit why that particular part of the work needs to be done. Start with the why and then what you plan to do and how you plan to do it. Show your thought process.

The Specific Aims/Goals/Objectives are your guiding touchstone

A note for humanities scholars: When speaking to faculty in the arts and humanities, I have occasionally encountered arguments against the need to provide any kind of plan to carry out the project. "I won’t know exactly what I am doing until I start doing it." As a reviewer, I would find such a stance very dissatisfying. If your goal is to search an archive, and you do not know what information you may find, do you have any kind of systematic approach that you plan to take? Have you thought through decision points for what you might do if you do not find the information you expect? All of scholarship and research can be described as the systematic creation of new knowledge. How does the word “systematic” play out in your context? For the NEH Collaborative program, the relevant review criterion reads: “*The clarity of the research questions being posed, the appropriateness of research methods or conference design; the appropriateness of the technology employed in the project; the feasibility of the work plan; and the appropriateness of the field work to be undertaken, the archival or source materials to be studied, and the research site.*” The specific language used may be different for specific grant opportunities, but the concepts in this chapter apply to almost any description of a project plan: Show your thought processes! The easiest way to do that is to start with the why.

Organize this section—titled Approach, Research Plan or Project Plan, depending on your funder—using the Specific Aims or Objectives articulated on the Specific Aims or Overview page. Remember, the word you use here (aim, goal or objective) should be chosen based on the cultural norms of your field and funder. Each aim should have its own section in the research plan, as shown in the table of proposal outlines at the beginning of the book. It’s quite frustrating for readers to have read aims or objectives on page 1 that are never mentioned in the research plan. You cannot expect reviewers to intuit which of your planned activities correlate to achieving which specific

aim/goal/objective. As always, your goal is to make every part of your proposal very clear.

Some kinds of projects lend themselves well to relatively independent organization by each aim/objective. Some projects, such as interventions or programs, need an overall project plan and the aims/objectives can be achieved using data and information gathered during the overall plan. We will discuss both types, starting with how to discuss each specific aim or objective. At the end of the chapter are two sample documents showing how both of those approaches could be accomplished. The outline for the overall project plan will be very similar to the outline for each aim/objective.

Here is the general outline from the table of grant outlines at the beginning of the book

Aim/Objective 1

Rationale

Context for why this activity is important

Specific activities (informative subheadings for each)

Explicit discussion of what activities will take place

Expected outcomes

What do you expect to happen?

Potential problems and alternative approaches

What will you do if things go wrong?

Within each of these sections you need to give the reviewer specific information in the order in which they will find it most helpful. You can follow rubrics for each section that will become almost invisible.

Rationale

A brief paragraph at the beginning of each section can help your reviewer. A common saying in teaching is, "Tell them what you're going to tell them. Tell them. Tell them what you told them." The Rationale solves the first part. An introductory paragraph can be very helpful to reviewers because they will not likely read your proposal in one sitting. It may have been hours or a day since they read your Specific Aims/Overview page. Make their job easy by reminding them why this aim/goal/objective is important. Here is the recommended rubric:

- Remind the reviewer of why this aim is important.
- Remind them of the key literature (and preliminary data) that justifies the aim/goal/objective in one or two sentences.
- If you stated a hypothesis on the Specific Aims/Overview page, repeat it here verbatim.
- Briefly mention the kind of approaches you will use and why they are the appropriate ones. Use just one or two sentences to "prime" the reader for the details to follow. (If you need to justify the overall approach, do so here.)
- End with a sentence on how accomplishing this aim will allow you to test the central hypothesis (if you had one) or accomplish an important part of your project.

For proposals where you have full sections for the Background and Preliminary Data, this paragraph should not be longer than a quarter of a page and can usually be accomplished in six to eight sentences.

For proposals to the NIH, the Rationale should be longer because NIH proposals do not have formal Background or Preliminary Data sections. Some of the key discussions of the relevant literature for each Specific Aim and specific preliminary data will need to be given in the Rationale. This discussion will be very targeted, but the ideas in Chapter 8 on showing your thought processes, not just reporting, apply here. See the example text/format at the end of the chapter.

As for DOE proposals, this section in NIH proposals could be titled "Justification and Feasibility" and would include the argument, with citation, for why this particular part of the work needs to be done (with citation of previous work) and the supporting data or other information that demonstrate the feasibility of your ideas.

Specific Activities

The name of this section will vary depending on the kind of proposal. For most proposals for research, I would title this subsection ***Research Design***, or you could name each experiment or activity. Give each experiment or activity an informative sub-heading. (Note: "Experiment 1" is <u>not</u> an informative sub-heading.)

For each experiment/analysis/activity:

- First sentence briefly recaps why this particular thing needs to be done—what you need to learn.
- Follow that with a statement of the general experimental approach. (If you need to justify why the specific approach you chose is better than an alternative, do so here. *See note in text box.)
- Give the specific details of how this will work. (This is the bulk of each subsection.)
- End with what you expect to learn

Writers often start with the details without giving the reader any context for why that specific experiment would need to be done. This makes the reviewer work harder, because they don't know why they should care about the details. The rubric above helps you demonstrate your thought processes to the reader. Another way to think about the rubric is the following: "Because it is important to know X, we will do Y. Our approach will be Z. This will show us how X works in this circumstance." This is almost identical to the rubric for discussing preliminary data, but the tense of the verbs change—what do you plan to do?

When you discuss the details of your approach, you should carefully balance the amount of detail you include. What does your reviewer need to know? Certainly not the molarity of a standard buffer. If you presented data using the technique and described that technique in the preliminary data, you can refer up to that previously given information by figure number, such as in the following:

> "Using the same techniques as in Figure 4, we plan to…"

You can also refer to your previously published work. However, you cannot simply refer to a paper and expect readers to go read it to learn the details. You do not need to go to the level of detail with a technique you have published as you would for a technique that is new to you or your research group, but you do need to provide some context, such as the following:

> "We will undertake this experiment using previously published techniques (Name, et al., YEAR). Briefly, …"

That "Briefly, …" should be followed with a truly brief discussion of the techniques. Help your reviewer feel confident that they know what you plan to do, and that you know how to do it.[69]

You may need to justify why you chose a specific approach, especially if you anticipate that a reviewer might suggest something different. If you considered and rejected an approach, you can put that part of your thought process in the description of the approach to interrupt a potential criticism before it fully forms in your reviewer's mind. Be straightforward and remember the balancing act. Some readers might not have had concerns about your choices and discussing why you didn't use an alternative can backfire if it sounds too defensive. Just state straightforwardly why you chose your approach. If you think you need to state why you didn't take another approach, say why.

For research proposals, you can also include preliminary data in the discussion of how you plan to carry out the project. As discussed in Chapter 8, you can draw a distinction between the supporting data that provide a strong foundation for the work you propose and the preliminary data that show technical feasibility. Both kinds can be used here as appropriate to make your point. If the grant outline that your funder expects has a "Preliminary Data" section, you can still include feasibility data here for the approaches you plan to use. Such a tactic not only provides information to the reviewer at the moment they need it, but also serves to visually break up the document. In the sample documents at the end of the chapter, I've included a piece of preliminary data within the text to demonstrate how that might work.

For proposals with collaborators, I recommend making it clear in the text who will undertake which part of the work. For NSF CAREER proposals, or other parts of the NSF where collaborator letters are limited to one prescribed sentence, you need to provide names in context for those letters to have any meaning. For the DOE, the requirement is often explicit:

[69] Another thing I wish I did not have to say: Do not cite a paper that cites another paper that cites another paper for the techniques. Cite a paper your reader can find that actually contains the methods. Apply this principle to citations in your publications, too. Whatever you cite should contain what you say (or imply) it says.

> There should be no ambiguity about which personnel will perform particular parts of the project or the time at which these activities will take place.[70]

Giving such specific information helps to avoid the trap of constant passive voice. First person active voice is more readable, and clarity of who will do what increases reviewer confidence.

Expected outcomes

Program officers want to know what will be the return on investment. Many proposal writers do not say explicitly what they expect and instead seem to expect the reader to infer that information, or to remember the specific hypotheses that were being tested. That requires your reader to work. Make it easy for the reader. The research plan usually contains a lot of details. Provide a summary: What will be the outcome of that work?

I usually see two effective ways of providing that information. One is a section at the end of the description for each aim/objective after the research details with the heading ***Expected Outcomes.*** This section would be anywhere from 1/8 to 1/4 of the page, giving the expected results for all the activities described in the research plan for that specific aim/objective. Another way is to expand a bit on the last bullet in the rubric above, "End with what you expect to learn." For each experiment, you can end with a sentence on the expected results, and a sentence with the interpretation or importance of those results. In other words, what do you expect to find and what do you think that would mean? Why would knowing this new piece of information be important? And a short Expected Outcomes section and the end of the section can integrate all of those results sentences and demonstrate how these results from the aim/objective move the field forward.

Whichever approach you choose, keep in mind that it helps your reviewer to know what you expect to find, and why that answer is important. You do not need to provide the kind of interpretation that would be in a Discussion section of the paper. It does help to show your thought processes, and a sentence on what you think the results mean in the context of the questions you plan to ask can help the reviewer see your entire rationale.

It depends on the project and the kind of work as to whether you decide to have a long, integrating Expected Outcomes section, or only short sections for each experiment and a short, integrating Expected Outcomes summary.

Potential Problems and Alternative Approaches

The NIH recently changed the Approach review criterion to explicitly include a question about whether the applicant addressed potential problems and alternative approaches. (Before that, the question appeared only in the instructions to reviewers.) The USDA RFAs usually refer to Pitfalls and Limitations in their outlines. Even if you don't find an explicit instruction to include potential problems and alternative approaches, it will likely

[70] Found in many solicitations from the DoE Office of science, including this one retrieved September 21, 2021 https://science.osti.gov/-/media/grants/pdf/lab-announcements/2020/LAB_20-2223.pdf

hurt you to leave this out. Including it shows that you have a plan if things don't work as expected.

As important as it can be to acknowledge limitations, I would never recommend noting a potential problem without having a plan to mitigate it.

The easiest way to write this section is to think through the implications of your plan. If you identify true potential problems, how will you mitigate them? What if a technique doesn't work, or a measurement approach proves less precise than expected? You do not need to go into detail about the alternatives but should provide a very brief description and citation of the alternative methods if possible.

You may be tempted to combine Expected Outcomes and Potential Problems into one subheading. Don't. The sections will serve very different purposes. You do not want to combine the idea of problems with positive results.

This section should be about potential problems and what you would do for each particular problem if it were to arise, not problems that you have already mitigated through your research design. There are two things that do not belong in this section. The first would be information about potential confounding factors that you have already mitigated through your research design. If you have addressed these potential factors in your research design, then they need not be discussed here. The second would be any big problems. If you have a very big potential problem, you may not be ready to go.

Notice the underlined word, the conditional word "would". The potential problems section should always be written as conditionals. In other words, do not say, "if this happens, then we will…" because then it reads as something you plan to do anyway. Instead, use the conditional language, "If this were to happen, then we would…" Remember, this is what you would do only if your potential problem were to occur.

I have sometimes seen applicants use the section on potential problems to make arguments against techniques they did not choose. That can be useful if the context of that argument is framed as though you would use those techniques if your chosen techniques did not work. It can be a bit tricky, because the reader may have already decided that you should have used the other technique, and the Potential Problems section may be too late to convince them. You may need to argue for why you chose one approach over another in the context of the research description (see above), similar to the discussion of potential confounding factors. Think about when your reviewer needs the information.

Some writers discuss future directions either under the Potential Problems section, or even a Future Directions subheading within the research description for each Aim/Objective. In some cases, applicants have used this section to point out experiments that a reviewer may want but would not be appropriate in the context of the proposed project. Sometimes they read like a "brain dump" of every other experiment the applicant could potentially do in the future. If you do include this kind of information, make sure to frame it first. Think about exactly why you want to include it and what your reader needs to know. The end of the whole proposal should have a short section on future directions.

When you have an overall project plan

Many research projects, as noted above, can be described as a series of aims and objectives. Some projects, including programs, clinical research, and site-based environmental research often depend upon an overall project design to achieve their aims. In that case, I recommend that you start the research plan with something I refer to as "Aim Zero", the title **Overall Research Plan** or **Overall Project Plan**. The recommended outline will look familiar:

Overall Research/Project Plan

Rationale

Why did you choose this overall plan?

Specific activities (informative subheadings)

Clearly describe activities that apply to the whole project

Potential problems and alternative approaches

Only discuss problems related to the conduct of the overall plan

The only thing missing here that would be in a regular section for an aim/objective is the expected outcomes. There are a few other subtle differences as described below.

Rationale

The Rationale here serves a slightly different purpose than the Rationale for each aim. For each aim or objective, one purpose of the rationale is to remind the reviewer of why that particular aim is important. For the Overall Research/Project Plan, your goal is to provide a general justification and framework for the overall approach you plan to take.

- Start with a sentence that frames the kind of plan that you will describe.
- Briefly justify why you have chosen this overall approach. If you have preliminary data relevant to this question, mention it here. It will be shown elsewhere.
- End with a sentence on how the activities described in the Overall Research/Project Plan will allow you to test the central hypothesis (if you had one) or provide the data to be analyzed to accomplish the aims.

Specific Activities

The name of this section will vary depending on the kind of proposal. For most proposals for research, I would title this subsection ***Research Design***, or ***Project Plan*** or you could name each activity. If each activity has a subheading such as "patient recruitment" or "defining plot grids" reviewers can follow more easily. Because you will describe activities that will provide the information for analysis, or accomplish your stated goal, a bit less justification is required for each activity. While still not a methods section, this will look a bit more like a methods section.

For each activity:

- State the purpose of the activity. For example, if you need to draw blood, say why. People often write something like the following passive sentence.

  > 1.5 mL of blood will be drawn at each patient visit.

  The reader may not care about that detail unless they know why. The approach below may take a bit more space but will provide more information.

  > Because we will measure biomarkers in Aims 2 and 3, we will draw 1.5 mL of blood at each patient visit.
  >
  > or
  >
  > To have longitudinal measures of ocean temperatures and turbidity, we will use sea drones on regular grids that will surface to broadcast recordings daily.

- Follow that with a statement of the general approach. For the second example, if the section is on creating surveillance grids in an ecosystem, say exactly how you will do it. (If you need to justify why the specific approach you chose is better than an alternative, do so here. See note above.)
- Give the specific details of how this will work. (This is the bulk of each subsection.)
- End with exactly how the results from the activities described will support specific elements of the proposal.

Potential Problems and Alternative Approaches

Focus this section only on the problems related to the overall project plan. For clinical research, there may be caveats, comments about recruitment of patients, etc. The major issues you describe here should be things that you can fix if your initial plans do not work out as you expect.

Evaluation Plan

I did not include this section to teach you how to do evaluations, but to discuss how to include evaluation in the research or project plan, *if* appropriate. Any proposal that includes outreach activities, such as some NSF Broader Impacts, the education portion of a CAREER proposal, or an Extension or Education function in an Integrated Project proposal to the USDA, should include an evaluation plan. Any program proposals should have a plan to evaluate how the program worked. The NSF considers robust evaluation important enough that their former boilerplate language recommended education programs allotting 5–10% of the budget to evaluation. NSF CAREER proposals should always have an evaluation plan for their education component, though not at the same level of

budget support. Proposals to carry out a program absolutely need a plan to evaluate whether the program or activities have the desired impact.

The NSF has a publication called The NSF User-Friendly Handbook for Project Evaluation. The short book is extremely useful, but I would like to highlight the following sentence:

> "Planning, evaluation, and implementation are all parts of a whole, and they work best when they work together."[71]

In the context of writing the Approach section, and indeed in formulating objectives for education or outreach, think about evaluations while you plan the project. What exactly are you trying to accomplish? How would you measure that? The answers to these questions—in fact, simply keeping the questions in mind—can help you avoid writing grandiose objectives by helping you focus on what you can reasonably measure.

The NSF Handbook is free to download at the link in the footnotes or type the title into any search engine to find a copy. Learn the difference between formative and summative evaluation and the quantitative and qualitative approaches you might use. An additional resource is the Principal Investigator's Guide: Managing Evaluation in Informal STEM Education Projects[72], which, as the title says, is very useful for informal outreach programs.

In your proposal, you may have limited space to describe the evaluation. Tables can help convey a lot of information and help you save space. See the example table on the next page for a simplified representation of an evaluation plan.

Subject	Method	Time point
Student attitudes [you can include sample questions or the subject areas you plan to survey]	Survey and open response	0, 12, 24 months
Impact on test scores	Document review, comparison to those not in the program	6, 12, 18, and 24 months
Teacher experience	Structured Interview	12 and 24 months

Timetable/Milestones

Many of the mission-driven agencies (DOE USDA, the Defense research agencies, etc.) may require that you state the planned milestones for a project. A table can also be useful

[71] https://www.purdue.edu/research/docs/pdf/2010NSFuser-friendlyhandbookforprojectevaluation.pdf Highly recommended for those who do not yet know what "formative" and "summative" mean. The link may move, so search for "User friendly handbook for evaluation 2010" to find a working copy. Retrieved September 21, 2021.

[72] http://www.informalscience.org/sites/default/files/caisevsapi_guide.pdf Retrieved September 21, 2021.

in that situation, too. If the funder does not clearly state the specific milestones they expect, think about your project as if it were a contract. What are the deliverables? When do you expect to accomplish each deliverable?

For more exploratory research, a decision tree with milestones included may be more useful. You can show the milestone and also the course you would take if the work doesn't proceed as expected.

For almost any grant proposal, a timeline can help reviewers understand the overall shape of the project and will indicate to your reviewer that you have thought through the project. For example, if you have an aim that will seem like a "fishing experiment," such as an unbiased screen on genomic data, you can indicate that it starts on Day 1. Use a table, such as the one following, and use Xs or arrows to indicate duration. The text under "Aim" is meant to indicate that the table should stand somewhat alone. In other words, don't just use "Aim 1" or "Experiment 2" and expect reviewers to remember the details.

Aim	Year 1	Year 2	Year 3
Description of Aim 1			
Subtask			
Subtask			
Description of Aim 2			
Subtask			
Subtask			
Description of Aim 3			
Subtask			
Subtask			

Decide if a timetable will help your reviewers see the shape of the project. They can be very useful visuals to demonstrate when aims are not dependent, and it shows Aim 3 starting in Year 1. But, if it doesn't add information, consider not including one. Pay attention to the requirements in a solicitation, though, because some proposals require a time table or full Gantt chart.

Summary and Future Directions

End the proposal with a short section titled something like Summary and Future Directions. This section serves an important purpose in providing context for the whole proposal. For pilot or career-development work, the section also gives the reviewers a clear sense of how you will use this grant to move forward. The section is short—one sentence paraphrasing the overall objective to say what you expect to accomplish and two or three sentences on the next steps.

Specific notes for applicants to the NIH

Rigor and Reproducibility

The NIH includes this specific question under the Approach criterion.

> Have the investigators presented strategies to ensure a robust and unbiased approach, as appropriate for the work proposed?

This question relates to the emphasis on rigor and reproducibility. All scientific research should be done to be sure of the most unbiased results possible. In terms of proposals to the NIH, consider the kinds of words that reflect attempts to remove experimenter or any other kind of bias: randomization, blinding, power, data handling.

- Do you plan to use a true randomization protocol for your animals, or would the first group simply be the first five you could catch?
- Will those who analyze and record the results be blinded to treatment groups, or will they know what results to "expect"?
- Did you have a process for sample size estimates, or did 10 just sound like a good number?
- Will you have true replicates, or just measure from the same source several times?
- Have you already established exclusion criteria for potential outliers, or just knock off those that are outside the curve of the other data?

Although the "or will you" questions seem absurd on the face, they need to be asked. Too many researchers, especially in some basic science fields, were never explicitly taught experimental design.[73]

I strongly recommend that you read the paper published in *Nature* in 2012 by then-director of NINDS, Dr. Story Landis and colleagues.[74] The authors give some of the background on the kind of deficiencies that led to the implementation of the rigor and reproducibility standards for proposals to the NIH. It should be required reading. The paper also describes a core set of reporting standards for rigorous study design. One way to think about the reproducibility requirements is to consider the impact of *transparency*. If methods and approaches are fully and transparently reported, one would expect the work to be more reproducible by others. As you write your Approach section, consider transparency. If you are transparent about your methods, readers can evaluate the rigor of your design.

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[73] The "first five animals you can catch" example comes from a behavior project I did as a rotation student. No one taught me any better, but they hadn't been taught, either. This lack of training has a lot to do with why NIH implemented the Rigor and Reproducibility requirement. If you work with human subjects, you would have had much better training in study design than most of my graduate school peers and mentors.

[74] Landis, S.C., et al. (2012) A call for transparent reporting to optimize the predictive value of preclinical research. Nature. 490(7419):187-91. Retrieved September 18, 2021

For some proposals, it is possible to make a blanket statement on rigor and reproducibility. If, for all experiments and analyses you describe you will use a formal randomization protocol, evaluate results in a blinded fashion, and have appropriate statistical design, then you can summarize your approaches to ensuring rigor (and removing biases) at the beginning of the Approach section. For specific experiments or analyses, you may need to provide additional information. Several study sections now include a reviewer versed in biostatistics. Their job is not to assess the significance of the work; they comment on the appropriateness of statistical approaches. That reviewer will have to be satisfied. With funding margins as slim as they are, a comment like, "Rationale for sample size was unclear" or even "No power analysis" could be sufficient to warrant an unfundable score.

Keeping transparency in mind will help you meet this review criterion. Most writers find it difficult to balance the need for brevity within the limitations of an NIH proposal with the expectation for more detail implied by the rigor and reproducibility criteria. As discussed in Chapter 4 and Chapter 5 on the Specific Aims/Overview, the traditional expectation for three specific aims no longer seems a hard and fast rule, both because of the space required for clarity and because of the limitations of the NIH modular budget.

In the 2018 re-issue of the parent announcement for the R-series (R01, R03, R21), an additional question was added to Approach review criterion.

> Have the investigators included plans to address weaknesses in the rigor of prior research that serves as the key support for the proposed project?

In the longer Rationale section for NIH proposals, you should include discussions of the relevant literature and key feasibility data. In any case where there is a weakness in prior work, especially if your proposed work depends upon the results and conclusions, you can explicitly state the limitation and say how your design will account for it.

Sex as a biological variable

The NIH recently instituted a requirement that the relevant biological variables be included in research design, analysis, and reporting. These include age, weight, sex and other health status. Researchers who work with human subjects are familiar with the need to balance for sex and gender. Researchers who work with animal models seem to struggle with how to handle sex as a biological variable. From the NIH instructions:

> "Strong justification from the scientific literature, preliminary data, or other relevant considerations must be provided for applications proposing to study only one sex."[75]

In other words, it is no longer acceptable to only use female mice because they are cheaper to house because they do not fight. It is also not acceptable to only use male animals because the field has only traditionally used males for a particular protocol. The point here is not to double your sample size and have statistical power to detect sex differences. If

[75] https://orwh.od.nih.gov/sex-gender/nih-policy-sex-biological-variable Retrieved September 18, 2021

your statistical estimation of sample size indicates that you need 10 animals, then the expectation is now that you will use 5 male and 5 female animals. It is also expected that you would be able to disaggregate the data to identify if there may be sex differences worth pursuing.[76]

Of course, if the disease affects only one sex or primarily one sex, it would be appropriate to only use that sex. If you have any questions, talk to your program officer.

It is now the norm for people who work with human subjects to consider the demographic makeup of the participant pool. Now other biological variables, such as age, weight, and other comorbidities, should be considered, *because they may be relevant to the work you propose*. It is up to you to decide what is relevant, but I would recommend that you consider explaining why you would not track these variables, particularly with human subjects.

Inclusion Across the Lifespan

In January of 2018, the NIH announced specifically that people of all ages, including children under 18 years of age and older adults, should be included in clinical research studies unless there are scientific or ethical reasons not to include them. Consideration of age was included in the original announcement about biological variables, but this policy goes further. Beginning in January of 2019, any study involving human subjects must include a plan to include participants across the lifespan, or a clear scientific or ethical justification for not including them. Progress reports for funded grants will need to include de-identified enrollment reports that include "de-identified individual-level participant data on sex/gender, race, ethnicity, and age at enrollment (in units ranging from hours to years)."[77]

Human Subjects and Vertebrate Animals as scored criteria

In the 2018 re-issue of the parent instructions for the R01, the plans to address protection of human subjects and the plans for inclusion based on sex/gender, race, ethnicity, and age became part of the Approach criterion. In the past, these descriptions would only be considered as Acceptable or Unacceptable. Now reviewers are asked to include their assessment as part of the Approach score.

NSF Broader Impacts

NSF has long required a discussion of Broader Impacts, and applications to the NSF are required to have a section headed Broader Impacts. In years past there were five separate

[76] If you have concerns about the impact of the estrus cycle on female mice, please recall that male testosterone levels vary widely within cage mates due to dominance hierarchies. Please see Shansky, R. M. (2019) Are hormones a "female problem": for animal research? *Science* 364, 825-826. @ShanskyLab on Twitter

[77] https://nexus.od.nih.gov/all/2018/01/24/nih-announces-inclusion-across-the-lifespan-policy/ Retrieved September 18, 2021

Broader Impacts review criteria, and most applicants tried to say something about all of them. I still see this habit in the applications from younger investigators who are copying their more senior mentors' approaches. The old form had to do with distribution of results, broadening participation of underrepresented groups, etc. The NSF now review Broader Impacts with the same criteria as Intellection Merit: Significance, Investigator, Approach, Innovation, and Environment. What you put forward as the impacts will be judged by whether they think you can do the work, and the impact of having done it.

For the Project Summary, the instructions state:

> The statement on broader impacts should describe the potential of the proposed activity to benefit society and contribute to the achievement of specific, desired societal outcomes.[78]

But what are those specific desired societal outcomes? In the expanded instructions for the full proposal, the NSF gives a fairly long list, which I have pulled out into bullets.

> NSF values the advancement of scientific knowledge and activities that contribute to the achievement of societally relevant outcomes. Such outcomes include, but are not limited to:
>
> - full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM);
> - improved STEM education and educator development at any level;
> - increased public scientific literacy and public engagement with science and technology;
> - improved well-being of individuals in society;
> - development of a diverse, globally competitive STEM workforce;
> - increased partnerships between academia, industry, and others;
> - improved national security;
> - increased economic competitiveness of the United States;
> - and enhanced infrastructure for research and education.

Do they expect you to have an answer for every bullet? No. In fact, these bullets do not tell the whole story. Every part of the NSF has different cultures and conventions around Broader Impacts in Standard Grant proposals. For the Social and Behavioral Sciences Directorate provided a framework for the impacts differently from this list: Scientific Opportunities and Communicative Products. [79] You need to put in some research, reading the public Project Summaries of awards in your field, to see what people include as Broader Impacts. Talk with your colleagues and your program officer.

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[78] See paragraph starting with "The project description must contain…" Retrieved September 18, 2021 from https://www.nsf.gov/pubs/policydocs/pappguide/nsf13001/gpg_2.jsp#IIC2d

[79] Dear Colleague letter, March 18 2021. Retrieved September 21, 2021 from https://www.nsf.gov/pubs/2021/nsf21059/nsf21059.jsp

And how do they expect you to create these outcomes? In the PAPPG, the following information comes before the list, but I put it after to help frame how you decide what to do and what to write. And you must be thoughtful here; if the Broader Impacts appear simply tacked on, unimaginative, it will hurt your proposal.

> Broader impacts may be accomplished through
>
> - the research itself,

Think about your research in context. How would the research results potentially impact economic development, well-being or national security? How will it impact the field (scientific opportunities)?

> - through the activities that are directly related to specific research projects,

Will you be training students? Will you have an undergraduate course where the student labs are actual research questions? Will you include your research in your teaching?

> - or through activities that are supported by, but are complementary to the project.

You may choose to engage in outreach activities, such as working with a classroom or giving presentations to community service clubs (Kiwanis, Civitan, Lions) about your research or the general importance of research. For an NSF CAREER application, this might correlate to your education plan.

Ideally, the Broader Impacts should be creative, credible, doable, and have a measurable impact. Use the three bullets above, the research itself, activities related to the research, or activities supported by or complementary to the research. Remember to include anything about the institutional environment that supports your Broader Impacts plan in the Facilities, Equipment, & Other Resources page (see notes in Chapter 13).

Broader Impacts could be the subject of its own book, but I hope this has been helpful.

Example documents

Four example documents follow. The first shows an example of the layout and information a Research Plan with independent aims. The second shows an NIH Approach with independent aims to demonstrate where literature and preliminary data can be included in the Rationale. The third shows an example of a section with an overall study design from which the aims/objectives follow. Much of the text is repeated because within each subsection I give the kinds of sentences you need in each part to convey the why before the what. The sections are shorter than they would be in your full proposal.

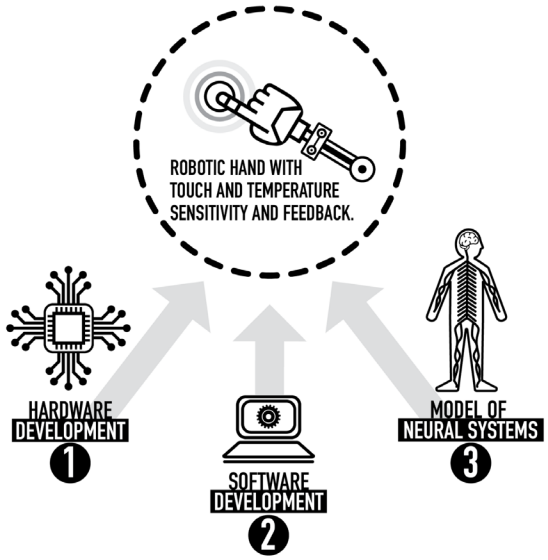
The examples give methods for clear layout, and the text gives instructions as to what information should be put there.

The “bad example” document also contains a great deal of *Loram ipsem* typesetter text, as elsewhere in the examples. You will find English sentences scattered in the text, examples of what not to do.

[Example of a version with three independent aims/objectives]

D. Research Plan

If you have an overall schematic, such as shown at the right, you can give two or three sentences discussing how the aims will together test your central hypothesis or research question. Sometimes writers will put a schematic on the Specific Aims/Overview page, but it often has more impact for the reader here when they have more context for the details. You don't have to create such a schematic, but they can be useful in both clarifying your thinking and in communicating with reviewers. Do what best serves to communicate with your reviewers.



Sometimes a figure with the schematic of how the aims/objectives fit together can be useful here. Some investigators insist you have a figure on the first page of the proposal, but that figure can confuse readers until they've read some of the text. A figure that doesn't work on page 1 can often work well here.

D.1 Objective 1: Repeat the objective from the Overview page verbatim as the section title

D.1a Rationale Remind the reviewer of why this aim is important. Remind them of the key literature and preliminary data in one or two sentences. If you had a hypothesis on the Specific Aims/Overview page, repeat it here verbatim. Briefly mention the approaches you will use and why they are the appropriate ones. End with a sentence on how accomplishing this aim will allow you to test the central hypothesis. This should not be longer than a quarter of page, you should feel comfortable using citations as appropriate here.

D.1.b Informative heading for each experiment/analysis/activity First sentence briefly recaps why this particular thing needs to be done—what you need to learn. Follow that with a statement of the general experimental approach. If you have a plan for mitigating confounding factors (not potential problems), that's part of the experimental plan. Then give the specific details of how this will work. End with what you expect to learn.

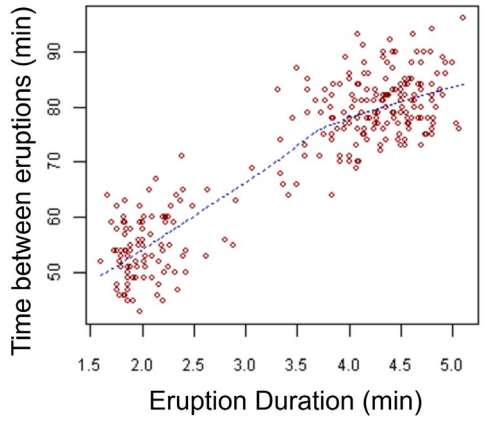


Figure 2. These Preliminary Data show that the technique works in your hands. Add text giving the reader a sense of what you did. (Image source: Wikipedia)

D.1.b.1 Have a clear hierarchy for subheadings to give the reader visual cues that you use consistently throughout the document

D.1.b.2 Make each subheading informative so that you do not waste space or the readers' attention by writing something like "Study 1" as the heading. Note how the subheadings here and above were part of the sentence.

D.1.c Informative heading for each experiment/analysis/activity

First sentence briefly recaps why this particular thing needs to be done—what you need to learn. Follow

that with a statement of the general experimental approach. If you have preliminary data showing the technique works in your hands, be sure to refer to it here (Figure 2, previous page). End with what you expect to learn. A note here on the figure: the figure legend title should be a whole sentence stating that take-home message. Do not simply state what we are looking at, but instead say why you included the data. If you reproduce published data, be sure to give the citation.

D.1.d Expected Results Briefly discuss the expected outcomes and relate them back to the purpose of this aim and of the overall project. In other words, what do you expect to find, and what do you think that will mean in the grand scheme of things.

D.1.e Potential Problems and Alternative approaches
Do not set up straw men here just to knock them down. Be honest about your potential problems and have a plan to mitigate them. Rather than go into detail, feel comfortable citing papers to give the details of the method you would use. Do not go into petty details. If you list too many problems, you can convince reviewers that it will not work. Big, killer problems don't belong here, because you have to solve those before you would be ready to apply. Remember always as you write this section to use conditional language: "If this were to happen, then we would…." Only discuss what you would do if your primary plan did not work out as you hoped. Justification for the approaches you chose belongs in the research plan. Many confounding factors that you have mitigated in the research plan belong in the research.

D.2 Objective 2: Repeat the objective from the Overview page verbatim as the section title

D.2.a Rationale Remind the reviewer of why this aim is important. Remind them of the key literature and preliminary data in one or two sentences. If you had a hypothesis on the Specific Aims page, repeat it here verbatim. Briefly mention the approaches you will use and why they are the appropriate ones. End with a sentence on how accomplishing this aim will allow you to test the central hypothesis.

D.2.b Informative heading for each experiment/analysis
Repeat the pattern on the previous page, as appropriate. The specific way that you use subheadings does not matter. Some people like to number them. I would caution you against substituting numbering schemes that result in 2.C.1.b-type headings without also using a clear hierarchy of visual emphasis. When everything is in bold, it can be very difficult for the reader to figure out "where" they are in the flow of information.

D.2.b.1 Have a clear hierarchy for subheadings to give the reader visual cues that you use consistently throughout the document

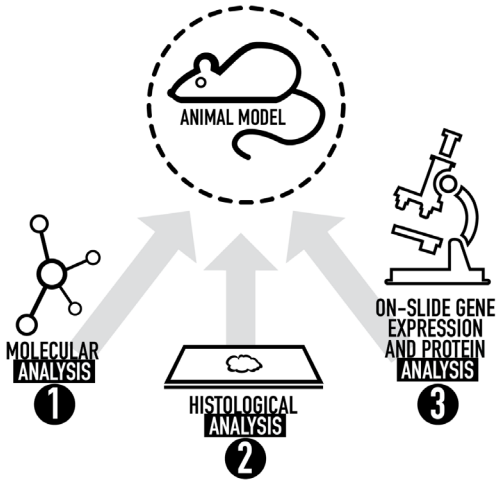
D.2.b.2 Make each subheading informative so that you do not waste space or the readers' attention by writing something like "Study 1" as the heading. Indentations of paragraphs, as shown here, can provide a readable layout, but you may not be able to afford the space.

D.2.c Expected Results
Briefly discuss the expected outcomes and relate them back to the purpose of this aim and of the overall project. In other words, what do you expect to find, and what do you think that will mean in the grand scheme of things.

D.2.d Potential Problems and Alternative approaches
Do not set up straw men here just to knock them down. Be honest about your potential problem and have a plan to mitigate them. Etc.

APPROACH

If you have an overall schematic such as shown at the right, you can give two or three sentences discussing how the aims will together test your central hypothesis or research question. If you have global information about your Rigor and Reproducibility approaches that apply across all or most Aims, you can give it here (some applicants put this information in a text box). Will all analysis be performed by individuals blinded to treatment condition? Will you always have three biological replicates? Be explicit here, and if the Rigor and Reproducibility information is the main point of this paragraph, give it a bolded subheading, like "Rigor and Reproducibility". Do what best serves to communicate with your reviewers.



Sometimes a figure with the schematic of how the aims fit together can be useful here. Make sure the figure legend title is a take-home message--why the reader is looking at this, not just what they're looking at. These cartoons sometimes work much better here than on the Specific Aims page. You don't have to create such a schematic, but they can be useful in both clarifying your thinking and in communicating with reviewers. Do what best serves to communicate with your reviewers.

AIM 1: REPEAT THE AIM FROM THE SPECIFIC AIMS PAGE VERBATIM AS THE SECTION TITLE

Rationale Start with a short paragraph to remind the reviewer of why this aim is important. Remind them of the key literature and preliminary data. You can take a few paragraphs here. Start with a brief introductory para-graph stating the reason this aim is important. If you had a hypothesis on the Specific Aims page, repeat it here verbatim. Briefly mention the approaches you will use and why they are they are the appropriate ones. End with a sentence on how accomplishing this aim will allow you to test the central hypothesis.

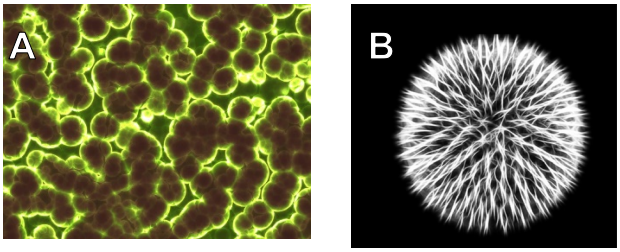


Figure 2: Make the figure legend title a bolded sentence giving the take-home message of the figure. Then give the reader an idea of what you did. If the figures shows quantitative data, what did you measure? If it shows visual data, what are we looking at and how did you obtain the images? What was the treatment? Images A and B were downloaded from pixabay.com. Placement was accomplished using a table without showing the grid lines, and the figure legend is in a single, merged cell of the table.

Justification and feasibility

The following paragraph(s) substitute for a separate background and preliminary data section. They should give more nuance for the justification for the work and the approaches for this Aim. Rather than separate into Background and Preliminary Data, I suggest you create an integrated discussion. The rubric in Chapter 8 for discussing preliminary data applies here with an addition—the framing literature (see also Aim2, next page). For every key result you show, provide the framework for your thought processes. Here's the rubric: Start with discussing the key papers upon which you have based your proposed work. How good is the work? What did they miss or potentially get wrong? (Remember to include your own work!) What did you do in response to that? (Preliminary &/or supporting data) How do these results support the proposed project? Spell out everything clearly and concisely; the rubric becomes invisible.

One of the criteria under Approach is "Have the investigators included plans to address weaknesses in the rigor of prior research that serves as the key support for the proposed project?" You can use this section to say what the weaknesses were and either 1) how your preliminary data show the prior

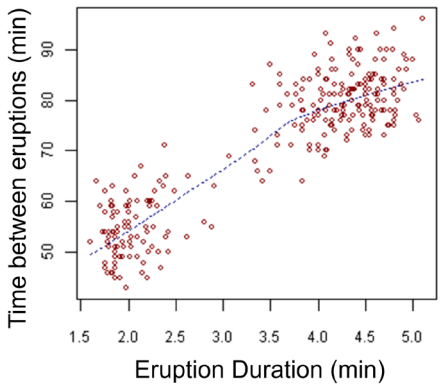


Figure 2. These Preliminary Data show that the technique works in your hands Add text giving the reader a sense of what you did. If you reproduce published data, be sure to give the citation. (image source: Wikipedia)

results were correct and how they support this aim and/or 2) how you will address the weaknesses of the prior work.

Research Plan

Informative heading for each experiment/analysis/activity First sentence briefly recaps why this particular thing needs to be done—what you need to learn. Follow that with a statement of the general experimental approach. If you have a plan for mitigating confounding factors (not potential problems), that's part of the experimental plan. Then give the specific details of how this will work. End with what you expect to learn.

Have a clear hierarchy for subheadings Make sure you give the reader visual cues that you use consistently throughout the document

Make each subheading informative Never waste space or the readers' attention by writing something like "Study 1" as the heading.

Informative heading for each experiment/analysis/activity First sentence briefly recaps why this particular thing needs to be done—what you need to learn. Follow that with a statement of the general experimental approach. If you have preliminary data showing the technique works in your hands, be sure to refer to it here (Figure 2). End with what you expect to learn. A note here on the figure:

Expected Results

Briefly discuss the expected outcomes and relate them back to the purpose of this aim and of the overall project. In other words, what do you expect to find, and what do you think that will mean in the grand scheme of things.

Potential Problems and Alternative approaches

Do not set up straw men here just to knock them down. Be honest about your potential problems and have a plan to mitigate them. Rather than go into detail, feel comfortable citing papers to give the details of the method you would use. Do not go into petty details.

AIM 2: REPEAT THE AIM FROM THE SPECIFIC AIMS PAGE VERBATIM AS THE SECTION TITLE

Rationale

Start with a short paragraph to remind the reviewer of why this aim is important. Remind them of the key literature and preliminary data. You can take a few paragraphs here. Start with a brief introductory paragraph stating the reason this aim is important. If you had a hypothesis on the Specific Aims page, repeat it here verbatim. Briefly mention the approaches you will use and why they are they are the appropriate ones. End with a sentence on how accomplishing this aim will allow you to test the central hypothesis or contribute to achieving the Overall Objective.

Justification and Feasibility

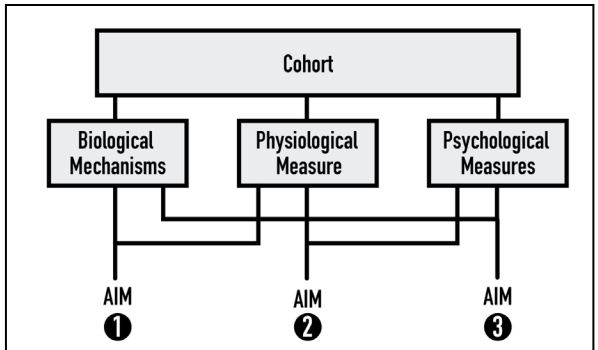
The following paragraph(s) should give more nuance for the justification for the work and the approaches. Rather than separate into Background and Preliminary Data, I suggest you create an integrated discussion. The rubric in Chapter 8 for discussing preliminary data applies here with an addition—the framing literature. For every key result you show, provide the framework for your thought processes.

The rubric can also be broken down as, "We read W and thought X, so we did Y using approach Z. We found A, which we think means B." In this case, what it means is either that you have support for your hypothesis, or a clear direction for the questions you will ask within this aim. ETC…

[When you need an overall Study design—field research, clinical trials, intervention research. For NIH proposals, adapt the Introduction/Rationale as above.]

APPROACH/RESEARCH PLAN

OVERALL STUDY DESIGN



Sometimes a figure with the schematic of the overall study flow can be useful here.

Introduction Give a brief introduction to the overall study design. Tell the reviewers the generalities of the approach and the rationale for choosing that method. This should probably be less than ¼ of the page. Make sure you that you explicitly state that this overall study design will provide the data to be analyzed in each of your specific aims. If you can specifically tag certain activities to aims (e.g., blood samples for biomarker analysis in Aim 2 and stress levels in Aim 3, or video-capture of species behavior for all objectives), it will help you reviewer see the overall shape of the project before you give them the details. This approach can work for larger-scale ecology projects, certain anthropology or other social science project, or for biomedical or patient-based research. Use this approach when one study design provides all the data that will be analyzed for the specific Objectives or Aims. You still include the specific objectives, but the text becomes shorter because it focuses on data analysis, not acquisition.

Selection of Field sites

This heading is just an example. First sentence briefly recaps why this particular thing needs to be done—for example, if this section is about selecting a study site or specific study population, provide some framing. Follow that with a statement of the general approach. Do not be afraid to use graphics as example data on your system.

Identification of study areas (If you have sub-sections, give clear subheadings.) How will you select them? What have you done/will you do to decrease the influence of selection biases?

Placement of cameras and data collection (If you have sub-sections, give clear subheadings.) How will you select them? What have you done/will you do to decrease the influence of selection biases?

Patient samples for biomarkers

This heading is just an example but give specific subheadings. For example, if you need morphological parameters, title the section "Morphological measures" and discuss how you would measure relevant parameters to your study.

Informative sub-subheading If you measure many different things, give each thing a subheading rather than bury it all in one big paragraph.

Informative sub-subheading If you measure many different things, give each thing a subheading rather than bury it all in one big paragraph

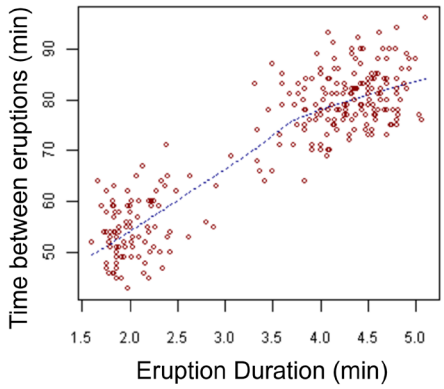
Potential Problems and Alternative Approaches

Only discuss issues that are relevant for the Overall Study Design, such as participant recruitment and retention, potential issues with data or sample gathering

AIM 1: REPEAT THE AIM FROM THE SPECIFIC AIMS/OVERVIEW PAGE VERBATIM

Rationale Remind the reviewer of why this aim is important. Remind them of the key literature and preliminary data (or circumstances for your project) in one or two sentences. If you had a hypothesis on the Overview page at the start of your proposal, repeat it here verbatim. Briefly mention the approaches you

will use and why they are they are the appropriate ones. End with a sentence on how accomplishing this aim will allow you to test the central hypothesis. Because the larger research or project design is in the Overall Research Design section, focus each aim on the specific analyses relevant to that aim.



Preliminary Data showing that the technique works in your hands. Add text giving the reader a sense of what you did. (image source: Wikipedia)

Informative title of the relevant analysis. How will you analyze the data or evaluate the activities that are relevant to your first objective? Start each section with the purpose of the analysis, such as this somewhat silly example.

Informative heading for each experiment/analysis/activity First sentence briefly recaps why this particular thing needs to be done—what you need to learn. Follow that with a statement of the general experimental approach. If you have a plan for mitigating confounding factors (not potential problems), that's part of the experimental plan. Then give the specific details of how this will work. End with what you expect to learn. If this works better broken into parts, create subheadings.

Informative heading for each experiment/analysis
First sentence briefly recaps why this particular thing needs to be done—what you need to learn. Follow that with a statement of the general experimental approach. Then give the specific details of how this will work. If you have a plan for mitigating confounding factors (not potential problems), that's part of the experimental plan. End with what you expect to learn.

Expected Results
Briefly discuss the expected outcomes and relate them back to the purpose of this aim and of the overall project. In other words, what do you expect to find, and what do you think that will mean in the grand scheme of things.

Potential Problems and Alternative approaches
Do not set up straw men here just to knock them down. Be honest about your potential problems and have a plan to mitigate them. Do not go into petty details. Big, killer problems don't belong here because you have to solve those before you would be ready to apply.

AIM 2 REPEAT THE AIM FROM THE OVERVIEW PAGE VERBATIM AS THE SECTION TITLE
ETC

DON'T DO THIS

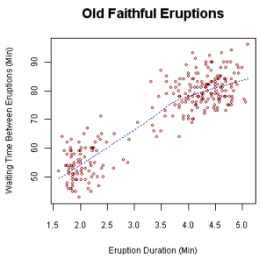
AIM 1

Experiment 1 ed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo. Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur? Quis autem vel eum iure reprehenderit qui in ea voluptate velit esse quam nihil molestiae consequatur, vel illum qui dolorem eum fugiat quo voluptas nulla pariatur?

Heading	Heading	Heading
Details you need to know but can't actually read	More of the same	Even more of the same
Lots of issues	++ cvg	++ cvg
Condition 2	-cvg	-cvg
Condition 3	++thing	++thing
Condition 4	Detail 8090	Detail 8090
Condition 5	More details unread	More details unread

Experiment 2 Dive straight into the explicit details and don't bother to explain the table next to the sentence. Also, make sure the table formatting is unattractive and makes it harder to discern the important information. *A*periam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo. Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur? Quis autem vel eum iure reprehenderit qui in ea voluptate velit esse quam nihil molestiae consequatur, vel illum qui dolorem eum fugiat quo voluptas nulla pariatur? And where is experiment 2?

<u>Have a random hierarchy for subheadings</u> Don't bother to give the reader consistent visual cues. Also, be sure to have things in a paragraph that are bolded and embed lists. For example, **(1)** sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, **(2)** sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, **(3)** sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam,



Thing you're looking at To annoy your reviewer, be sure to have the figure and the legend separated on the page.

Informative heading for each experiment/analysis sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, **Be sure to bold a sentence in the middle, so it's the only thing they read.** Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur? Quis autem vel eum iure reprehenderit qui in ea voluptate velit esse quam nihil molestiae consequatur, vel illum qui dolorem eum fugiat quo voluptas nulla pariatur?

Potential Problems and Alternative approaches

Set up straw men here just to knock them down. Better yet, leave this section out!

Do not give a reviewer something you would not want to try to read.

Chapter 10: Title and Abstract

The title and abstract may be the only thing read by people who have an impact on the funding decision. They can have a significant influence on the choice of reviewers. You can help the review officers choose the "right" reviewers—those most qualified to review your proposal—by making sure certain keywords that reflect necessary expertise are included in your title and abstract.

For example, if your project includes heavy mathematical modeling, you would want a reviewer included with such expertise. If you want your proposal to be reviewed by the tumor metastasis study section at the NIH, make sure the word metastasis is featured in the title and abstract. Conversely, if you want to avoid certain kinds of reviewers, don't include keywords that would indicate their expertise would be appropriate.

Title

> Among the many decisions faced by authors composing an academic title, the most basic choice is whether to *engage* the reader, *inform* the reader, or do both at once.[80]

Titles can seem difficult to write, and it can be difficult to walk the line between an attention-getting title and a title that induces an eye roll in your reader. As you can guess from the last comment, titles that are overly cute rarely help you in a grant proposal. It is usually better to go with a pedestrian title than fail in an attempt at a clever title.

Several approaches can help you construct an effective title. Used in combination, you will likely develop a title that conveys to the reviewer the importance of the project.

Remember that a title should reflect the content of the proposal, but it should not refer to actions. In a grant proposal, the product is more important than the process. Throughout the discussions in this book—the Specific Aims/Overview page, presentation of preliminary data, presentation approach—we have used the formulation of *Problem: Solution*. You can use this approach in the title, too.

Some people do not like titles with colons in them because often the colon separates a broad statement from an extremely specific descriptor, neither of which ends up being tremendously informative. However, if you put the problem on one side of the colon and the solution on the other, you can give the reviewer a strong sense of the content of your

[80] Sword, H. Stylish Academic Writing. Harvard University Press, 2012, pp 78

proposed project. Or, if *Problem: Solution* doesn't fit, you can try the "engaging: informative" technique.[81] Overall, though, I recommend avoiding trying to be cute.

The following steps include approaches modified from the wikiHow page on constructing titles for essays or for fiction.[82]

1. The first step is to identify any limitations on the title. The NIH permits 200 characters including spaces. The USDA permits only 140 characters including spaces. For the NSF, your title simply needs to fit in the box, but some must start with the grant mechanism, such as CAREER: Title of Proposal. NEH forbids titles with colons. Pay attention to these limitations, because if your title is longer than allowed, most electronic submission portals will simply cut it off at the restricted length. Limitations can sometimes help spark your creativity.

A colleague of mine reviewing fellowship proposals for the NIH noted that almost half of the titles were incomplete because the submission software cuts off titles mid-word at the NIH limit of 200 characters and spaces. This did not create a good impression.

2. Once you identify the limitations, create a word list that reflects the major ideas. Keep in mind the need to include some indication of the expertise required to review the proposal. For applicants to the NIH, this can be very straightforward; simply include a buzzword or two from the name of the target review group. Give yourself a list of 8 to 10 words, at least, and up to 12 to 15. Brainstorm. You may not use all the words you write down but creating the word list will help you identify the most important parts of your proposed project.

3. Use your word list and make four to five titles, at least. Find someone who has never seen them before to say them aloud. If they stumble over any one of them, throw it out. If your proposal is discussed in a panel, someone would have to read your title aloud. If you have made it difficult to say because of an infelicitous arrangement of words, then the negative impression that follows is your fault, not the speaker's.

4. Once you have titles that read aloud easily and sound good, ask for advice. Show several people your list of potential titles and ask which they prefer. Quite often, most people will prefer the same title. Often, they do not choose your personal favorite. Do not ignore them.

An additional consideration for your title: politics. Be cautious if you work in certain areas and remember that the title will be publicly accessible, whether through federal grant databases or foundation tax returns. Consult your colleagues, and even potentially your administration about words that could be misinterpreted or bring unwanted attention.

[81] Ibid, pp. 68

[82] https://www.wikihow.com/Come-up-With-a-Good-Title Retrieved September 21, 2021

For NIH applications, the title should ideally contain buzzwords relevant to your targeted Study Section to help assure it will be assigned where you want.

Abstract

Different funders have specific restrictions on the abstract. For the NIH you have 30 lines. For the NSF you have one page, about 4,600 characters and spaces, that must be divided among three headings (Overview, Intellectual Merit, and Broader Impacts). For the USDA you have 250 words. Always read the instructions. In some cases, you must explicitly include in the abstract the topic area from the RFA or solicitation to which you are responding, which takes space and increases your need for brevity.

Remember also that your abstract may influence the selection of reviewers, so crafting an abstract that indicates the knowledge needed can help program officers and review officers identify appropriate reviewers.

There are very straightforward methods to constructing the draft of your abstract. Below is a text box containing a rubric adapted from the University of North Carolina's Writing Center on writing abstracts for publication.[83] You should always wait until the end to write the abstract because you can harness work you have already done. Use a copy-and-paste approach, using sentences that you have already written to create your first draft.

Simple organization for an abstract:

- ***Reason for writing:***
  What is the importance of the research? Why would the funding agency or your reviewer care?
- ***Problem:***
  What problem do you propose to solve? What is the scope of the project? What is the main argument/thesis/claim?
- ***Methodology:***
  What are the key approaches that will be used?
- ***Implications:***
  What changes should be implemented as a result of the findings of the work? How does this work add to the body of knowledge on the topic?

We can address each of these bolded headings and answer the questions with text you already created. Begin constructing your draft with the ***Problem***. Paste in the sentence or sentences you wrote for the end of the opening paragraph of the Specific Aims/Overview, stating the key barrier to progress.

Next paste in sentences related to the ***Methodology***.

[83] Modified from http://writingcenter.unc.edu/handouts/abstracts/ Retrieved September 21, 2021. Check it out. They have good advice on writing abstracts for papers, among other things.

- Objective (key next step)
- Hypothesis or Research Question (which also relates to the Problem)
- Aims/Goal/Objectives (also information on the approach, if there is room)
- Innovation (can be excluded if there is no room or if innovation is not a major driver of review)

Next paste in the statement of Significance, the sentence that you may have italicized framing the impact of this work, giving the ***Implications***.

As you begin to edit, add a framing sentence or two at the very beginning to provide the ***Reason for writing***, the first bullet in the box. Avoid giving too much background; give just enough that they can understand the problem.

Once you have the sentences in place, edit the abstract so that it reads smoothly, adding in transitions as needed. I recommend that you consider editing the abstract to read in the third person. In the past, both the NIH and the NSF included a specific instruction for the project summary/abstract to be in the third person, which many people disregarded with no consequences. However, if you edit the abstract to the third person, it will change the pasted-in sentences enough that any reader who first reads the abstract and turns straight to the Specific Aims/Overview page will not feel as though the sentences are perfectly redundant.

Be sure to review the instructions

In many cases, there are explicit instructions for what must be in the abstract. For proposals to the DOE Office of Science, the abstract must have the title and the list of participating scientists, their roles (PI, co-PI) and institutional affiliations. For some RFPs with multiple priority areas, the instructions may require that you include explicit statement of the agency priority to which you are responding, down to the exact wording from the solicitation pasted into the abstract. And do not exceed the word limit!

The NSF Project Summary

The NSF Project Summary has a limit of one page, with three required sections in the online form: Overview, Intellectual Merit, and Broader Impacts. You will find the three boxes labeled in FastLane or Research.gov, the new portal for proposal submissions to the NSF. Adapt the rubric in the required NSF subheadings for the Project Summary:

Overview

- Paste in the Key Barrier to Progress
- Paste in the Objective
- Edit and provide framing information to provide sufficient background for why the work needs to be done

Intellectual Merit

- Hypothesis (which also relates to the Problem)

- Aims (also information on the approach, if there is room)
- Innovation—how the work is "creative and original"
- Significance of the work to the field

Broader Impacts

- Significance of the work to society
- Projected impacts of any outreach activities related to the work

If you draft the Project Summary in a word processer and then paste in the text to the boxes in the online form in Research.gov (which is replacing FastLane), be sure to check to see how the software will render the document in the proposal image. Microsoft Word's Smart Quotes, which turn straight quotes into curved ones, can show up as a "**?**" in the final PDF version available to reviewers (as in don?t). If absolutely necessary, you may upload your own page only if you must use unusual characters or mathematical formulas in the Project Summary. If you create your own document, you must use the three headings, and some poor compliance officer at the NSF will have to manually check to see if you followed the instructions. Better to spell out β as beta here.

The NIH "Project Narrative"

The Project Narrative appears on the NIH RePORTER database as the Public Health Relevance statement, but in ASSIST it is called the Project Narrative and us uploaded as a separate document. Although you upload a full page, you have a limit of only three sentences. I've seen proposals returned without review because the Project Narrative had more than three sentences. The target audience is the taxpayer, so if you are tempted to include any gene names or disease terminology beyond what a lay reader will understand, stop. Think of this as the "Uncle Bob on the tractor" section. The reader may be sophisticated within their own sphere (farmers run complex systems), but they share none of your vocabulary. If you're tempted to include "NF-κB", or anything similarly specific, don't. Plain language is key.

Start with, "This is relevant to public health because…" or similar wording. If you can include reference to a specific, published NIH priority area, whether at the global or Institute/Center level, do so. Most of the Institutes and Centers have mission statements and priority areas on their web sites, and you can even directly use their language. The Narrative is short, and your peer reviewers do not put much stake in it. However, these kinds of statements help staffers at the NIH justify your research to Congress and the taxpayers. Should taxpayers or Congressional staffers peruse the NIH RePORTER database of funded grants they should see a clear value to the work NIH funded you to do.

Chapter 11: Biographical Sketches

Many federal agencies have a required form or format for a formal biographical sketch. Some funders only give slightly vague instructions. Look for the instructions and use them to craft the biosketch. As with other information required for a grant application, look for those embedded lists: "Applicant should describe the qualifications of the personnel, including professional preparation, key accomplishments, previous grants and history of disseminating results." If you must upload a biographical sketch, then those headings would become the subheadings on the biographical sketch. If you must discuss the personnel in the body of the proposal, then the paragraph about each key person should simply follow that rubric, and give the information, in that order, in clear sentences.

If the proposal is to a federal agency focused on science, and if they do not give you a specific template, try this one from the NSF, reproduced from the 2022 PAPPG:[84]

Applicant Name
Title
Institution

(a) Professional Preparation

A list of the individual's undergraduate and graduate education and postdoctoral training (including location) as indicated below:

Undergraduate Institution(s)	Location	Major	Degree & Year
Graduate Institution(s)	Location	Major	Degree & Year
Postdoctoral Institution(s)	Location	Area	Inclusive Dates (Years)

(b) Appointments

A list, in reverse chronological order, of all the individual's academic/professional appointments beginning with the current appointment. Appointments include any titled academic, professional, or institutional position whether or not remuneration is received, and whether full-time, part-time, or voluntary (including adjunct, visiting, or honorary). With regard to professional appointments, senior personnel must identify all current domestic and foreign professional appointments outside of the individual's academic, professional, or institutional appointments at the proposing organization.[85]

[84] Reproduced verbatim from https://www.nsf.gov/pubs/policydocs/pappg22_1/nsf22_1.pdf. Instruction documents are updated annually, and you need to check them for changes.
[85] List everything. Everything. The changes here are, in my opinion, in response to the issues with the Thousand Talents program, with investigators having support and resources that were not in the form of direct payments. Work with your research administrators early on this.

(c) Products

A list of: (i) up to five products most closely related to the proposed project; and (ii) up to five other significant products, whether or not related to the proposed project. Acceptable products must be citable and accessible including but not limited to publications, data sets, software, patents, and copyrights. Unacceptable products are unpublished documents not yet submitted for publication, invited lectures, and additional lists of products. Only the list of ten will be used in the review of the proposal.

Each product must include full citation information including (where applicable and practicable) names of all authors, date of publication or release, title, title of enclosing work such as journal or book, volume, issue, pages, website and URL, or other Persistent Identifier[86]. Senior Personnel who wish to include publications in the products section of the biographical sketch that include multiple authors may, at their discretion, choose to list one or more of the authors and then "et al." in lieu of including the complete listing of authors' names.

(d) Synergistic Activities (not usually included outside of the NSF)

A list of up to five distinct examples that demonstrate the broader impact of the individual's professional and scholarly activities that focuses on the integration and transfer of knowledge as well as its creation. Examples should be specific and could include, among others: innovations in teaching and training; contributions to the science of learning; development and/or refinement of research tools; computation methodologies and algorithms for problem-solving; development of databases to support research and education; broadening the participation of groups underrepresented in STEM; and service to the scientific and engineering community outside of the individual's immediate organization.

Synergistic activities must be specific and must not include multiple examples to further describe the activity. Examples with multiple components, such as committee member lists, sub-bulleted highlights of honors and prizes, or a listing of organizations for which the individual has served as a reviewer, are not permitted.

As you can see, the instructions give quite specific requirements, and yet applicants often fail to follow them.[87] One common error is the failure to include the URL, DOI, or other persistent identifiers for the publications or products. Another mistake for applications to the NSF is to ignore the last paragraph and make lists in the Synergistic Activities section (e.g. "Reviewer:" and a list of journals). Note that non-NSF funders will likely <u>not</u> include Synergistic Activities. Always read the instructions.

[86] You can use DOIs, URLs, or PubMedCentral. See next page.

[87] I have found this particularly true with USDA biographical sketches. The only one I've seen that followed the instructions on the first draft was the biosketch for a former USDA National Program Leader.

The NSF requires the use of either SciENcv (Science Experts Network Curriculum Vitae) or the NSF fillable PDF form.[79,88] The SciENcv format may eventually be used across many federal grant applications. The SciENcv tool is associated with NIH, and anyone using it can set up a MyBibliography as part of NIH's PubMedCentral, even for physics and engineering. This allows you to easily provide electronic locators for your publications. Locators can be Digital Object Identifiers (DOI), a direct link URL, PubMedCentral ID (PMCID), or other resource such as pre-print servers. You can use ORCID or MyBibliography. Do not link to a personal web page. It may be increasingly common for federal agencies to require SciENcv, with ORCID or MyBibliography, so check the instructions. Note also that the NSF fillable PDF does not contain the details given above; you need both the instructions and the form. NSF biosketches have a 3-page limit, up from the 2-pages that have been normal for decades.

In many humanities and arts grants, the requirements for the biographical information usually contain one of those embedded lists of implied headings as described above. It will contain something like, "For each key personnel, provide a description of their qualifications, previous experience, and success in dissemination." If they want separate biosketches, then use the embedded list to create subheadings: Qualifications, Previous Experience, Success in Dissemination. If they want the description in paragraph form in the body of the proposal, give them each piece of information in exactly the order listed in the instructions.

For applicants to the NIH

NIH biographical sketches also have very prescribed formats. Again, follow the directions, and I strongly suggest creating a profile for SciENcv.

The Personal Statement may be unique to the NIH biosketch, and many applicants struggle both with the Personal Statement and with the narrative Contribution to Science. The NIH provides clear instructions. If you follow them, it will make these sections easier to write. The NIH example[89] also gives you a sense of how long these paragraphs should be and what should be in them.

Reviewers read the Personal Statement, especially if they do not know you. I have heard NIH officials say that when they changed the biographical sketch in 2010, the Personal Statement and the Contributions sections were created have reviewers look at the applicant as more than a count of how many items in Positions and Honors and how many papers they could cram on the page. See the instructions on the following pages, taken verbatim from the NIH biosketch page with instructions.[90]

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[88] https://www.nsf.gov/bfa/dias/policy/biosketch.jsp Set up your SciENcv profile well before your grant deadline at https://www.ncbi.nlm.nih.gov/sciencv/. Last checked September 21, 2021.

[89] http://grants.nih.gov/grants/forms/non-fellowship-biosketch-sample-2021.docx (takes to a save file window. Last checked September 21, 2021)

[90] https://grants.nih.gov/grants/forms/biosketch.htm The link above is from this page. If future changes are made, they will likely be posted here. There have been changes to the biosketch as of May 2021. Last checked September 21, 2021.

Section A. Personal statement

> Briefly describe why you are well-suited for your role(s) in this project. Relevant factors may include: aspects of your training; your previous experimental work on this specific topic or related topics; your technical expertise; your collaborators or scientific environment; and/or your past performance in this or related fields, including ongoing and completed research projects from the past three years that you want to draw attention to (previously captured under Section D. Research Support).

Stick to the facts, here. The Personal Statement is not personal. You can discuss any lapses in productivity, such as for a health emergency, but make the point without emotion.

For your own personal statement, start with the objective of the project and then describe why you are well qualified to undertake it. The four citations that follow should substantiate the description. You should also describe your relationship with your collaborators. If you have collaborators on this proposal and published with them in the past, include at least one of those publications as one of the four after the Personal Statement. Consider ordering the citations by reverse chronology[91], not your perceived order of importance.

For the statements by your collaborators, the first sentence should describe their role on the project. Then the subsequent information describes why they are qualified to have that role. The mistake most people make is to take a boilerplate personal statement and tack something about their role on the end. Be sure to customize the personal statement for every biographical sketch attached to your submission. It may not sink your application to include a biosketch clearly written for a different proposal, but it will certainly irritate many reviewers. Customize the publications listed for your collaborators. Importantly, if you alter a collaborator's biosketch in any way, do not submit it with your proposal unless they have seen and approved your changes.

The NIH biosketch instructions were updated in 2021. What used to be Part D, Research Support/Scholastic Performance has been removed except for Fellowship proposals, which have D. Scholastic Performance. Now the NIH recommends that notable research support, current or ended over the last 3 years, should be included in the Personal Statement. The format for that information is very simple, as you will see in the NIH example reproduced later in this chapter. Present the current and recently completed funding that best supports your project. It may not be relevant if you have 0.25 person-months on a number of funded grants unrelated to the current project. Because you cannot state time commitment in the listing, reviewers might conclude you already have sufficient funding.

The instructions go on to say:

[91] NIH biosketches used to require all information in chronological order. Now the training table is in chronological order, but now the instructions indicate a requirement that part B, Positions, Scientific Appointments and Honors, be given in reverse chronological order. The instructions do not indicate order of citations. But pick either chronological or reverse and stick to it through the whole biosketch.

> You may cite up to four publications or research products that highlight your experience and qualifications for this project. Research products can include, but are not limited to, audio or video products; conference proceedings such as meeting abstracts, posters, or other presentations; patents; data and research materials; databases; educational aids or curricula; instruments or equipment; models; protocols; and software or netware. Use of hyperlinks and URLs to cite these items is not allowed.
>
> You are allowed to cite interim research products. **Note:** interim research products have specific citation requirements. See related Frequently Asked Questions for more information.

What do they mean by interim research products? These include items like preprints and preregistered protocols.

> To cite the product, include the Digital Object Identifier and the Object type (e.g., preprint, protocol) in the citation. Also list any information about the document version (e.g., most recent date modified), and if relevant, the date the product was cited. [92]

Follow the instructions. Stick to the facts here and use the four publications to document anything you state. If for example you are a mentor and your graduate student proposes a project with electrophysiology in their fellowship application, be sure that the publications you include for the Personal Statement show your expertise in electrophysiology. Again, you talk about your relationship with collaborators on this proposal, include a co-authored paper or interim product the list.

Lastly, a reminder that the list of up to four citations for the Personal Statement comes after the list of notable funding. They can also be cited both here and in your Contribution to Science (see below).

Section B. Positions, Scientific Appointments and Honors

The NIH instructions say:

> List in reverse chronological order all current positions and scientific appointments both domestic and foreign, including affiliations with foreign entities or governments. This includes titled academic, professional, or institutional appointments whether or not remuneration is received, and whether full-time, part-time, or voluntary (including adjunct, visiting, or honorary).

Two notable changes here. One is the change to reverse chronological order. The other is the explicit inclusion of scientific appointments that may not involve any remuneration.

[92] *NOT-OD-17-050: Reporting Preprints and Other Interim Research Products*. (2017, March 24). NIH.Gov. https://grants.nih.gov/grants/guide/notice-files/not-od-17-050.html

NIH asks applicants to provide complete transparency about their involvement with any organization, academic or commercial, domestic or foreign.[93]

Contribution to Science

The NIH instructions are very clear, but few people follow them.

For each contribution, indicate the following:

- the historical background that frames the scientific problem;
- the central finding(s);
- the influence of the finding(s) on the progress of science or the application of those finding(s) to health or technology; and
- your specific role in the described work.
- Figures, tables, or graphics are not allowed.

  For each contribution, you may cite up to four publications or research products that are relevant to the contribution. If you are not the author of the product, indicate what your role or contribution was.[94]

The bullet points give you the exact outline for the paragraph. Simply follow the outline. Do not include graphics or hyperlinks to additional materials.

Many applicants "undersell" their work in the Contribution to Science section. If you simply follow the rubric in the bullets above, you will write a good paragraph placing your contribution in context. For young investigators, you can include work from your training period where you were a middle author; simply state your contribution to the work. Do not limit your Contributions to only those specifically relevant to the proposed project. I would put those first (not chronological, see below) and include anything you feel was a contribution. One of the mistakes noted below is to have over 15 publications and yet list only two contributions. Use the bullets in the instructions to make mini-stories about you and your work.

Give each contribution an informative subheading. The example biosketch given by the NIH takes a different approach, framing each contribution chronologically ("My early work…"). I disagree with this approach. It does not usually matter when you did the work.

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[93] Investigators have faced criminal charges over lack of disclosure in the past, assuming that because there was no explicit requirement to disclose support that was not direct, they could leave it off. An extreme example of "not-direct" support: an appointment at a foreign university where you do not receive payment directly but direct a fully funded laboratory. A less extreme case: serving on a scientific board of a company, and they sometimes give you free reagents or animal models not readily available. Report both.

[94] http://grants.nih.gov/grants/forms/application-guide-biosketch-instructions-rev-06-28-2021.docx Leads to a downloadable Word document. Retrieved September 23, 2021.

It matters what you did and the impact on the field. The informative subheading will help frame your work for reviewers, and you can place each contribution in whatever order you think would be most useful in the context of the particular application.

At the end of the Contribution to Science section, include a link to your full citation list on the National Center for Biotechnology Information's MyBibliography. A quick search on NCBI and MyBibliography will help you find the online instruction book. This resource can automatically import your PubMed bibliography, and you can add other relevant entries, such as book chapters or very recent abstracts. (I should note that there is indication that ORCID links will be integrated with the NIH eRA Commons, but my reading is that they do not (yet) substitute for the MyBibliography link on the biographical sketch.[95]) They are now required for all NIH training grant appointments (T, F, K mechanisms). [96]

Several common mistakes:

- Including more than four citations after each Contribution
- Failing to include a link to your curated list of publications on MyBibliography at the end of the Contribution section
- Linking to Google Scholar or to a personal or university webpage
- Linking to PubMed with your name as the search term
- Including only 2 Contributions when you have more than 15 publications

There are additional nuances in the instructions about citing research products that are not peer-reviewed, including patents, abstracts, book chapters, instructional videos, etc. Be cautious here. Citing a very recent abstract that is publicly available might help by demonstrating that the work has been presented, but a two-to-three-year-old abstract will make reviewers wonder why the work hasn't proceeded to publication yet. You can also cite Pre-prints from BioRxiv or other pre-print servers. Do not cite pre-prints available on your own web page. Do not cite more than 4 publications for each Contribution. See notes above about interim publications in the Personal Statement. They apply here.

Note that in the NIH example (see links and example with notes that follows) that the citations under the Personal Statement are numbered, but the citations for each contribution to science are lettered. This provides a visual cue that the citations serve two different purposes. In other words, you can have the same paper in a Contribution that you have for the Personal Statement. By no means, however, should you consecutively number all the citations and pretend that they are footnotes.

The sample NIH biosketch gives a very nice example of a good layout for section B. Positions, Scientific Appointments, and Honors. Scientific Appointments includes non-compensated positions. Note that in 2021, the order for section B changed to reverse chrono-

[95] Open Mike blog Nov 15, 2017. Retrieved September 21, 2021, at https://nexus.od.nih.gov/all/2017/11/15/teaming-with-orcid-to-reduce-burden-and-improve-transparency/
[96] https://grants.nih.gov/grants/guide/notice-files/NOT-OD-19-109.html Retrieved September 21, 2021.

logical order and section D. Research Support and/or Scholastic Performance was removed.[97]

The following document is from NIH, with modifications and specific comments ***[in bracketed text]***. The NIH example gives an excellent illustration of layout. However, it can be more effective to use informative subheadings for each Contribution to Science rather than the chronology approach of the NIH example. In the first Contribution in the version beginning on the following page, I have edited the original NIH sample text for the first Contribution to Science to provide an example of using subheadings.[88] (I also edited to remove the anthropomorphisms in the original text.)

Source: http://grants.nih.gov/grants/forms/non-fellowship-biosketch-sample-2021.docx [99]

[97] The old form page called section D "Additional Information: Research Support and/or Scholastic Performance". Section D was removed, but for Fellowship proposals, you will need D. Scholastic performance. Use this template from NIH: http://grants.nih.gov/grants/forms/biosketch-blank-fellowship-format-rev-12-2020-exp-02-28-2023.docx Last checked September 21, 2021

[98] See the dissection of my edits in chapter 16.

[99] Note: we have annotated the NIH Sample in the pages that follow.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Hunt, Morgan Casey

eRA COMMONS USER NAME (credential, e.g., agency login): huntmc1

POSITION TITLE: Associate Professor of Psychology

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of California, Berkeley	BS	05/2003	Psychology
University of Vermont	PHD	05/2009	Experimental Psychology
University of California, Berkeley	Postdoctoral	08/2013	Public Health and Epidemiology

A. Personal Statement

I am an Associate Professor of Psychology, and my research is focused on neuropsychological changes associated with addiction. ***[This is fine, but for the PI, we recommend starting with the objective of the project. For all collaborators, start with their role in the project. The body of the statement explains why each person is qualified for the role they play.]***I have a broad background in psychology, with specific training and expertise in ethnographic and survey research and secondary data analysis on psychological aspects of drug addiction. As PI or co-Investigator on several university- and NIH-funded grants, I laid the groundwork for the proposed research by developing effective measures of disability, depression, and other psychosocial factors relevant to the aging substance abuser, and by establishing strong ties with community providers that will make it possible to recruit and track participants over time as documented in the following publications. In addition, I successfully administered the projects (e.g. staffing, research protections, budget), collaborated with other researchers, and produced several peer-reviewed publications from each project. As a result of these previous experiences, I am aware of the importance of frequent communication among project members and of constructing a realistic research plan, timeline, and budget. The current application builds logically on my prior work. During 2015-2016, my career was disrupted due to family obligations. However, upon returning to the field, I immediately resumed my research projects and collaborations and successfully competed for NIH support. In summary, I have the expertise, leadership, training, expertise and motivation necessary to successfully carry out the proposed research project.

Ongoing and recently completed projects that I would like to highlight include:

Use this format with the **Grant number**
Name (PI); applicant's role if not PI
Start and end dates
Title of proposal

R01 DA942367
Hunt (PI)
09/01/16-08/31/21
Health trajectories and behavioral interventions among older substance abusers

R01 MH922731
Merryle (PI), Role: co-investigator
12/15/17-11/30/22
Physical disability, depression and substance abuse in the elderly

Previous versions included a one-sentence description of the project, but NIH does not indicate including that information here.

R21 AA998075
Hunt (PI) 01/01/19-12/31/21
Community-based intervention for alcohol abuse

Note that the citations here are numbered. Under Contributions to Science citations are lettered. This difference provides a visual indicator that the same publication can be cited in two places. The citations serve different purposes. Here they support what you have in the Personal Statement.

Citations:

1. Merryle, R.J. & **Hunt, M.C.** (2015). Independent living, physical disability and substance abuse among the elderly. Psychology and Aging, 23(4), 10-22.
2. **Hunt, M.C.**, Jensen, J.L. & Crenshaw, W. (2018). Substance abuse and mental health among community-dwelling elderly. International Journal of Geriatric Psychiatry, 24(9), 1124-1135.
3. **Hunt, M.C.**, Wiechelt, S.A. & Merryle, R. (2019). Predicting the substance-abuse treatment needs of an aging population. American Journal of Public Health, 45(2), 236-245. PMCID: PMC9162292
4. Merryle, R. & **Hunt, M.C.** (2020). Randomized clinical trial of cotinine in older nicotine addicts. Age and Ageing, 38(2), 9-23. PMCID: PMC9002364

B. Positions, Scientific Appointments, and Honors

Scientific Appointments includes uncompensated positions.

Positions and Scientific Appointments

2021– Present	Associate Professor, Department of Psychology, Washington University, St. Louis, MO
2020 – Present	Adjunct Professor, McGill University Department of Psychology, Montreal, Quebec, Canada
2018 – Present	NIH Risk, Adult Addictions Study Section, members
2015 – 2017	Consultant, Coastal Psychological Services, San Francisco, CA
2014 – 2021	Assistant Professor, Department of Psychology, Washington University, St. Louis, MO
2014 – 2015	NIH Peer Review Committee: Psychobiology of Aging, ad hoc reviewer
2014 – Present	Board of Advisors, Senior Services of Eastern Missouri
2013 – 2014	Lecturer, Department of Psychology, Middlebury College, Middlebury, VT
2011 – Present	Associate Editor, Psychology and Aging
2009 – Present	Member, American Geriatrics Society
2009 – Present	Member, Gerontological Society of America
2009 – 2013	Fellow, Division of Intramural Research, National Institute of Drug Abuse, Bethesda, MD
2006 – Present	Member, American Psychological Association

Honors

2020	Award for Best in Interdisciplinary Ethnography, International Ethnographic Society
2019	Excellence in Teaching, Washington University, St. Louis, MO
2018	Outstanding Young Faculty Award, Washington University, St. Louis, MO

C. Contributions to Science

[I do not recommend using the chronological formulation used in the NIH original example and seen in contributions 2 and 3, below. I have edited this first contribution. Instead of starting with "my early work", as in the original, it is much more friendly and useful to your reviewers to include informative subheadings. The first entry here has been edited from the original NIH sample to serve as an example for the approach I suggest you use. Note how these paragraphs follow the NIH rubric: State of the field before the work was done, key results, impact of the results, the person's contribution to the work. See Chapter 16 for a dissection of the edits performed on this paragraph.]

1. **Substance abuse in older adults** Substance abuse is often overlooked in older adults, because many older adults were raised during an era of higher drug and alcohol use as compared to today. There are reasons to believe that this will become an increasing issue as the population ages. We found that older adults seek help to deal with emerging addiction problems through both mental health providers and in a variety of primary care settings. In the publications listed below, we document this emerging problem and provide guidance for primary care and geriatric mental health providers to recognize

symptoms, assess the nature of the problem, and apply the necessary interventions. By providing evidence and simple clinical approaches, this body of work has changed the standards of care for addicted older adults and will continue to provide assistance in relevant medical settings well into the future. I served as the primary investigator or co-investigator in all of these studies.

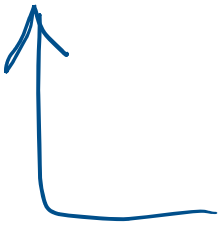
2.
   a. Gryczynski, J., Shaft, B.M., Merryle, R., & **Hunt, M.C.** (2013). Community based participatory research with late-life addicts. American Journal of Alcohol and Drug Abuse, 15(3), 222-238.
   b. Shaft, B.M., **Hunt, M.C.**, Merryle, R., & Venturi, R. (2014). Policy implications of genetic transmission of alcohol and drug abuse in female nonusers. International Journal of Drug Policy, 30(5), 46-58.
   c. **Hunt, M.C.**, Marks, A.E., Shaft, B.M., Merryle, R., & Jensen, J.L. (2015). Early-life family and community characteristics and late-life substance abuse. Journal of Applied Gerontology, 28(2),26-37.
   d. **Hunt, M.C.**, Marks, A.E., Venturi, R., Crenshaw, W. & Ratonian, A. (2018). Community-based intervention strategies for reducing alcohol and drug abuse in the elderly. Addiction, 104(9), 1436-1606. PMCID: PMC9000292

2. In addition to the contributions described above, with a team of collaborators, I directly documented the effectiveness of various intervention models for older substance abusers and demonstrated the importance of social support networks. These studies emphasized contextual factors in the etiology and maintenance of addictive disorders and the disruptive potential of networks in substance abuse treatment. This body of work also discusses the prevalence of alcohol, amphetamine, and opioid abuse in older adults and how networking approaches can be used to mitigate the effects of these disorders.
   a. **Hunt, M.C.**, Merryle, R. & Jensen, J.L. (2015). The effect of social support networks on morbidity among elderly substance abusers. Journal of the American Geriatrics Society, 57(4), 15-23.
   b. **Hunt, M.C.**, Pour, B., Marks, A.E., Merryle, R. & Jensen, J.L. (2018). Aging out of methadone treatment. American Journal of Alcohol and Drug Abuse, 15(6), 134-149.
   c. Merryle, R. & **Hunt, M.C.** (2020). Randomized clinical trial of cotinine in older nicotine addicts. Age and Ageing, 38(2), 9-23. PMCID: PMC9002364

3. Methadone maintenance has been used to treat narcotics addicts for many years, but I led research that has shown that over the long-term, those in methadone treatment view themselves negatively and they gradually begin to view treatment as an intrusion into normal life. Elderly narcotics users were shown in carefully constructed ethnographic studies to be especially responsive to tailored social support networks that allow them to eventually reduce their maintenance doses and move into other forms of therapy. These studies also demonstrate the policy and commercial implications associated with these findings.

   a. **Hunt, M.C.** & Jensen, J.L. (2013). Morbidity among elderly substance abusers. Journal of the Geriatrics, 60(4), 45-61.
   b. **Hunt, M.C.** & Pour, B. (2015). Methadone treatment and personal assessment. Journal Drug Abuse, 45(5), 15-26.
   c. Merryle, R. & **Hunt, M.C.** (2018). The use of various nicotine delivery systems by older nicotine addicts. Journal of Ageing, 54(1), 24-41. PMCID: PMC9112304
   d. **Hunt, M.C.**, Jensen, J.L. & Merryle, R. (2020). The aging addict: ethnographic profiles of the elderly drug user. NY, NY: W. W. Norton & Company.

Complete List of Published Work in MyBibliography:
https://www.ncbi.nlm.nih.gov/myncbi/1ICifFFV4VYQZE/bibliography/public/



- This link must be to a government-run page, so do not use Google Scholar or ResearchGate.
- Create a MyBibliography page. Do not just search your own name on PubMed and copy the link.
- Curate this page to include other products, such as book chapters, patents, etc.
- Make sure your link works and is public.

Chapter 12: Budgets and Justifications

The budget gives the story of the project in terms of needed resources to carry out the work. Everything you plan to do has implications in the budget, whether it's people's time, materials, or even the fact that you don't have to request funds for something because a donor or the institution will cover that cost. Budgets and budget justifications are a bit like a murder mystery or Watergate: follow the money. If you discuss a project element in the proposal narrative, but don't include it in the budget, it looks like you might not know what you're doing. If you have funds in the budget for something not described in the narrative, it causes the same problem. The requested resources must match the story in the research plan.

Use real numbers whenever possible to create a budget. If this is new to you, or even if you've created budgets before, look for help from a department administrator or the research administration professionals in your office of sponsored programs. To create real numbers, think through what you need to do the project—personnel, supplies, software licenses, travel, equipment. How much do the items cost? What do you need for participant support? Do a bit of research so that your travel request reflects current airfares, hotel costs, meeting registration, and university *per diem* allowances.

If you think about the budget as part of developing the research plan—*What resources will this part require?*—you can avoid proposing a project that will be seen as "overly ambitious". The plan and budget must fit into the scope of the grant type to which you are applying, the box bounded by money and time. Also remember the most damning thing I've ever heard said about a budget: "If they don't know how much it costs, they don't know how to do it." And in that case, the applicants had not asked for <u>enough</u> money; the budget was too small.

The easiest way to create a justification is to use the headings on the budget form page as the headings for your justification. List the key items under each heading. To justify those costs, say what you

Grants from federal agencies have extensive rules about spending. So many rules. For example, you must fly on a US-flagged carrier if you pay for the flight with federal grant funding, even if it is more expensive. The professionals in your office of sponsored programs, sometimes called the office of research administration, are paid to know these rules so you don't have to. Do not make their jobs harder. Consult them early in the proposal development process. They can help you with the federal and university-specific rules, potentially help you find the numbers you need, and be sure you are responsive to other solicitation requirements, not just budgets. Research Administration professionals can be your allies, if you consult them early and often, and give them what they need, when they need it.

The question of personnel can be a tricky one because often you cannot hire the personnel without the grant funding. Think about the kind of personnel you expect to need and spend time considering exactly what their roles and responsibilities will be. Then, when you write the budget justification for a To Be Named position, you can make it clear that the work cannot go forward without the person described.

need, why you need it, and where you got the number that appears on the budget form page.

Personnel can comprise the most expensive items in your budget. Many applicants don't bother to truly justify the personnel. Don't just list a name and the time commitment; be specific. See the example for an NIH Personnel Justification, below. You can use the subheading examples given there unless your funder has specific headings they suggest or require that you use for the justification.

For all other line items, ***use the headings in the budget form to organize the budget justification***. Typically, you will need to provide line items for Supplies, Travel, Consultant Costs, tuition, and so on. Here is a simple rubric to justify each item in the budget is the following:

- State what the item is (or who the person is).
- Why you need it (or what, exactly, the person will do).
- Where you got the number that appears on the budget form page.

There really is no mystery in justifying budgets. The better you explain what you need and why, the harder it is for program administrators to blanketly cut the budget.

NIH Modular Budgets

The NIH has two potential approaches for the budget, modular and non-modular. Modular budgets have a limit of $250,000 per year in increments of $25,000. A "full modular" budget means 10 modules of $25,000 per year. For modular proposals to the NIH, you need only justify the Personnel. For non-modular budgets, use the instructions above.

For R03 applications, you have two modules per year. For R21 applications you have a total of 11 modules ($275,000) split over two years. This means you will need to place one module extra in one year and provide a text for the "Additional Narrative Description" to explain the change in module. Give a scientific reason for the allocation of resources.

In an NIH modular budget, do not include the Additional Narrative Description unless you need, for any reason, to explain a change in the number of modules requested between years. Many applicants mistakenly provide the rest of the budget justification (travel, supplies, etc.). If you don't have a change in module, you do not need this additional document. As noted above, budgets over $250,000 per year require a full breakout budget and justification as described at the top of the chapter. For NIH budgets of over $500,000 per year, you need permission to apply.

A layout for a modular budget justification is below:

Personnel Justification*

Key personnel**

Principle Investigator, PhD will serve as project director. They will be responsible for all scientific oversight and management of the research. They will also direct and contribute to the publications, etc. Indicate the time in person-months.

Key Collaborator, MD, PhD, will do very specific things.Describe each person with respect to their role in the project, their qualifications for the role, and the time that they will devote in person months.

Other significant contributors

Consultant Person, MD and other contributors. These would generally be people without specific time devoted to the process. Some of these people should probably also supply biographical sketches. Anyone who does not appear on the budget for salary should supply a letter detailing their support for the project.

Other Contributor, PhD, and give the details of what they will do. You can also refer to the biographical sketch.

Other

List each of your assistants, technicians, graduate students and other personnel here, by name or role, using bold-type headings as modeled above. Be specific about the role in the project and time. These are people who could be replaced.

*This should be the first part of a non-modular justification
** "Key" should be considered those without whom the project could not move forward.

Chapter 13: Facilities and Other Resources

There are many other parts of proposal development that most would agree are less fun to construct than the research plan. These include: facilities pages, budgets, forms, and other parts of the process that seem less creative. Often these sections are left to the very end of the application process.

These forms are easy to do well, and they are equally as easy to do badly. They can become less onerous if you think about why these pages exist. What does the reader need to know? Why do they need to know it? Two of the review criteria are Investigator and Environment. What is the most efficient way for the reviewer to judge these? Biographical sketches and Facilities pages, of course. I have heard reviewers say that if they had gotten to the point of carefully reading your facilities page, you are already in trouble. That is probably true. However, if your facilities page is thorough and well formatted, it leaves a positive impression as they scroll by.

For the most part, when you have created a good Facilities & Other Resources page or a well-formatted biosketch, it only needs minor editing for every proposal.

The NSF PAPPG contains the following:

> In order for NSF, and its reviewers, to assess the scope of a proposed project, all organizational resources necessary for, and available to a project, must be described in the Facilities, Equipment and Other Resources section of the proposal.

The NSF once had several boxes with headings on FastLane, their previous submission portal[100], but now you create your own page to upload.

Minimal instructions are given in either the NSF PAPPG or the NIH SF424 Application Guide for the content you are supposed to provide. The NIH instructions read:

> Describe how the scientific environment in which the research will be done contributes to the probability of success (e.g., institutional support, physical resources, and intellectual rapport). In describing the scientific environment in which the work will be done, discuss ways in which the proposed studies will benefit from unique features of the scientific environment or from unique subject populations or how studies will employ useful collaborative arrangements.

[100] FastLane is still in use, but as of this writing, NSF is moving to Research.gov.

That does not provide much guidance! Historically, grant applications to the NIH used the PHS 398 grant application forms, which included a form page with specific headings, similar to the headings that used to be on the NSF's FastLane proposal submission portal. The headings can be found buried within a sentence in the PHS 398 instructions:

> Identify the facilities to be used (laboratory, clinical, animal, computer, office, other).

For every funder, always look for such lists embedded in sentences, because they give you the headings that you should use.[101] In this case:

Laboratory
Clinical
Animal
Computer
Office
Other

These were also the headings in the old NSF FastLane form (although Clinical had been dropped in recent years). Use the appropriate headings to create the page, and then fill in the details. In some cases, you will be asked to provide information in narrative form, particularly for foundations and program proposals. Sometimes you will find an embedded list of the information they want. If you do not find such a list, think about exactly what someone needs to know to believe that your project will work. Think how an outsider would potentially view your proposal.

You may think I have gone a bit overboard in the discussion of the facilities pages. However, one of our proposals submitted to the Department of Education scored 97 points out of 100, and the funding line was 98. They had taken off two points because we had failed to explicitly state that the graduate students had desks. It does not take a lot of effort to do a good job with this section, so do not give it short shrift.

The sections are not mere formalities, even if reviewers say that they do not look at them carefully. Generally, reviewers skim this section to make sure that it is well formatted and complete, and that if they need to find specific information it should be there. The NSF instructions say, "Proposers should include an aggregated description of the internal and external resources (both physical and personnel) that the organization and its collaborators will provide to the project, should it be funded." Note that they include both physical resources and personnel.

[101] Turn the items in comma-delimited lists given within a sentence into headings. This approach can help you organize many parts of grant proposals, such as the NSF Postdoctoral Researcher Mentoring Plan, or the NIH Multiple PI Leadership Plan. The instructions for each of these sections contain embedded lists. Make them your headings.

In the samples below, we recommend an opening paragraph that briefly summarizes why the project will succeed at your institution. This summary paragraph integrates the detailed information that follows and allows you to include information that would not appear under each of the specific subheadings. In the analysis of the relationship of individual criterion scores to overall impact discussed in Chapter 9, the review criterion that least influenced Overall Impact was Environment. Why? Because you should have what you need. Generally, Environment scores only go down when the applicant fails to provide the information.

Equipment

Proposals to the NIH require a separate Equipment page, where you should list everything over $5,000. For NSF proposals, Equipment goes under Other Resources. For both agencies, I recommend using three subheadings as shown below:

Equipment in the PI's Laboratory

- List everything over $5,000 that is relevant to the proposed project.
- Use a list form rather than a paragraph.
- Give make and model number for non-standard pieces. (You don't need manufacturer information for standard items like ultracentrafuges. I would include make and model details for major equipment like microscopes, mass spectrometers, and so on.)

Shared Equipment

- List the key shared equipment required for this project.
- Give make and model number.

Core Facilities

- *Make a subheading for each core*
    - List the equipment in that core relevant to this project.
    - Give make and model number.
    - Do not give every piece of equipment in that core, just the relevant ones.
- *Make a subheading for each core*
    - For example, if you do functional magnetic resonance imaging, list only the machine that you use.
    - Do not list every clinical magnet in the hospital.

For NIH the information on equipment is uploaded on a separate page titled **Equipment**. For NSF and other agencies, it is part of the Facilities, Equipment, and Other Resources page.

On the following pages you will find examples of the layout for a facilities page for the NIH and for the NSF. Instead of including example text, after each of the headings you will find suggestions for how to present and organize the information. The text under each heading describes what kind of information you should put there. The NSF version can be adapted to other funders and is based on the old FastLane forms.

NIH Suggestion

The Environment review criterion contains the following:

> Will the project benefit from unique features of the scientific environment, subject populations, or collaborative arrangements?

To answer this question, begin your Facilities & Other Resources page with a paragraph that summarizes key elements of the environment that summarizes unique features or features that do not fit into the narrow categories listed above. It should not be more than a quarter of the page. Mention key collaborations that provide you with unique resources or combinations of skills. Mention other elements of the environment such as the existence of a CTSA at your institution. These will be detailed later under Other.

If you are an Early Stage Investigator (within 10 years of your terminal degree), include an additional paragraph to describe the resources invested in you, but do not give a dollar figure. Talk about what your startup allowed you to do, departmental funding for students, and so on. Give the paragraph a title like "Institutional Investment in the Success of the ESI".[102]

Then, list the specific facilities using the subheadings given above, and describe them completely. You do not have a page limit, but do not go overboard. This example gives you a layout and the kind of information that should be under each heading.

Facilities & Other Resources

Key elements of the environment: Use the instructions to organize this paragraph. It should not be longer than a quarter of the page, if that. How does the overall scientific environment in which the research will be done contribute to the probability of success (e.g., institutional support, physical resources, and intellectual support)? What are the unique features of the scientific environment or unique subject populations? Are there other ongoing studies that will allow useful collaborative arrangements? Do not give the history of the institution. Stick to the point. The details of your research environment will follow.

Institutional Investment in the ESI: If you qualify as an ESI, within 10 years of your terminal degree, include a section on the institutional support you have received. The description should include elements that your institution has provided, such as resources for traveler training, career enrichment programs, any logistical support, and financial support (e.g., protected time for research, a post-doc, support for technicians and graduate students, and the startup funds for equipping your laboratory). Important note: Do not give any dollar figures for your startup. A generous amount in one part of the country may seem very inadequate in another. Focus the description on what you can do with that startup money.

[102] For NIH, make sure you are registered in the NIH eRA Commons as an ESI, because there are advantages in review and funding. Talk to your research administration staff if you have questions on your eRA Commons ID. Do not register yourself.

Laboratory – Give a detailed description of your laboratory including square footage, number of benches, refrigerators, gel boxes, chemical mixing station, and so on. Basically, anything under $5,000 should be mentioned here. (Equipment over $5,000 goes on the Equipment page.) Do not assume that the reviewers will assume that you have all the equipment you need. For this section, you do not need give details, such as brand names, but you do need to give a full picture of the laboratory resources available to you. Do not use a generic statement like, "The PI has all necessary equipment to carry out the proposed work."

Clinical – Describe the relevant features of the hospital. A common mistake is to copy and paste boilerplate language from the hospital website. Details such as the date of the hospital's founding are not relevant to your reviewer for most grant proposals. If clinical resources are not relevant to your proposal, put N/A. It is perfectly acceptable to leave this section out if you require not clinical resources, but it doesn't hurt a bit to leave it in and look like you know what the required information is.

Animal – Briefly describe the animal care resources. If any of your veterinarians are certified for laboratory animal medicine (ACLAM diplomate, AAALAC), that should be mentioned. If your work involves infectious agents, describe the procedures and facilities within the vivarium to control infectious agents. If animal resources are not relevant to your proposal, put N/A. It is perfectly acceptable to leave this section out, but it doesn't hurt a bit to leave it in and look like you know what the required information is. If your work requires biosafety housing or surgical facilities, be clear your animal facility can provide it.

Computer – Describe the computational resources, and do not be afraid to list the number and type of desktop and laptop computers. You should state that they all have standard office software, and also describe any other relevant software, such as visualization, image analysis, or site or individual licenses for statistical packages.

Office – Describe your office, including square footage. Do not hesitate to describe elements such as tables or desk extensions to accommodate small meetings. Give the location of the office relative to the laboratory.

Other – Use this section to detail information mentioned in the opening paragraph.

> *Core facilities* – For each core facility, list the title of the core, state the purpose of the core, and then state the relevance of the core to the proposed project. List them with specific subheadings, and do not fold them all into a paragraph. For the NIH, you do not have page limitations. Specific equipment within the core should be on the Equipment page.
>
> *Institutional support* – If you have specific support from your institution that gives you access to a population, equipment, or anything else, be sure to list it here with a more informative heading.
>
> *Intellectual environment*[103] – Describe your key collaborative arrangements, detail any group meetings or brown bag lunches for discussing current research that take place at

[103] The NIH instructions quoted above include discussing intellectual rapport. This is where you can provide the details information.

your institution and in which you participate. In some cases, it may make sense to describe specific individuals who may not be formal collaborators on the proposal, but who would provide both intellectual and technical resources. Do not make this one paragraph. Use lists.

NSF Suggestion (can be used for other funders if not guidance is given.)

Facilities, Equipment, & Other Resources

Summary of the Research Environment: Use the instruction to organize this paragraph. It should not be longer than a quarter of the page, if that. How does the overall scientific environment in which the research will be done contribute to the probability of success (e.g., institutional support, physical resources, and intellectual support)? What are the unique features of the scientific environment or unique subject populations? Are there other ongoing studies that will allow useful collaborative arrangements? Do not give the history of the institution. Stick to the point. The details of your research environment will follow.

Laboratory – Give a detailed description of your laboratory including square footage, number of benches, refrigerators, freezers, chemical mixing station, and so on. Basically, anything under $5,000 should be listed here. (Equipment over $5,000 goes on the in the discussion below under Other, and see notes on Equipment, above.) Do not assume that the reviewers will assume that you have all the equipment you need. For this section, you do not need give details such as brand names, but you do need to give a full picture of the laboratory resources available to you. If your work does not need a laboratory, leave this heading out.

Computer – Describe the computational resources, and do not be afraid to list the number and type of desktop and laptop computers. You should state that they all have standard office software, and also describe any other relevant software, such as visualization, image analysis, or site licenses for large statistical packages. The more computational work you do, the more detail you should provide here.

Office – Describe your office, including square footage. Do not hesitate to describe elements such as tables or desk extensions to accommodate small meetings. Give the location of the office relative to the laboratory.

Other – Use this section to detail information that does not come under the headings above. For example, some USDA proposals should clearly describe the heavy equipment available to them, or the research fields that they will use. Use clear subheadings and then describe the relevant equipment and facilities.

Equipment

Equipment in the PI's Laboratory

List everything over $5,000 that is relevant to the proposed project. Use a list form rather than a paragraph. Give make and model number for major pieces

Shared Equipment

List the key shared equipment required for this project. Give make and model number.

Core Equipment

If you will use equipment in a core facility, give the name of the core and list the relevant equipment. Give make and model number. If the core has a paid technician or scientific director, you should mention them here by name and give their role in the core as it relates to the work you propose.

Other resources Use this section to describe institutional support or other elements that demonstrate you have all the needed resources.

Institutional support – If you have specific support from your institution that gives you access to a population, equipment, or anything else, be sure to list it here. For proposals to the NSF, most cost-sharing is prohibited. Remember than NSF requests information on both the physical and personnel of your environment. If your time, or the time of an evaluator for a CAREER application would be supported by the institution, you cannot put a person in the budget form page without requesting funds. The institutional support is described here, with *no mention of specific monetary or time commitments*. Keep yourself out of trouble and talk to your research administrators if you have any questions about institutional support and the NSF rules.

Intellectual environment – Describe your key collaborative arrangements, detail any group meetings or brown bag lunches for discussing current research that take place at your institution and in which you participate. In some cases, it may make sense to describe specific individuals who may not be formal collaborators on the proposal, but who would provide both intellectual and technical resources. Do not make this one paragraph. Use lists.

Core facilities – For each core facility, list the title of the core, state the purpose of the core, and list the specific equipment in the core that will be used for this project. List each one with specific subheadings, and do not fold them all into a paragraph. The NSF and other agencies may have a three-page limit, but rarely will you need all three pages. Use the space to make it readable.

Environment related to Broader Impacts Activities – This is a generic heading to note that you should give specific headings for parts of your environment that support your Broader Impacts activities. For example, you might have a heading for "Support for Students from Historically Excluded Groups", and then list such support, like an LSAMP grant or REU. You might have something about "Support for informal science

outreach" or the name of something your institution does that will support the success of your Broader Impacts activities. This is particularly relevant for CAREER applications.

Additional important things – If you will have access to something extraordinary, such as a synchrotron at a National Laboratory, describe that access here.

Specific notes for early career applications:

- **NSF CAREER applicants:** Use the Other Resources section to also describe anything related to your education plan. Does the institution have a Louis Stokes Alliances for Minority Participation (LSAMP) program? Will you participate in a funded Research Experience for Undergraduates (REU) program? Will the institution support a student, or perhaps the services of an evaluator? Use this to describe institutional support without giving monetary or specific effort information. You need to avoid the rules against committed cost sharing. Be sure to discuss these issues with your research administrator.

- **NIH F and K Award applicants:** Use the Other section to describe in more detail any courses you will take. In the body of the Career Development Plan, be sure to state what courses you might take and why exactly they contribute to your development but put the full course description under the sub-heading "Educational resources" under Other on the F&OR.

Chapter 14: More “Administrative Forms”

I would strongly refer you to the resources on your campus, namely your Research Administrators. This chapter is nowhere near comprehensive, but in reviewing proposals, some common issues and misunderstandings have shown up in common patterns.

Understand how to submit

Many of the proposal elements that cover administrative rules will not be covered here. This is where your research administration professionals can help you the most. Sometimes the office is called Research Administration, sometimes it is called the Office of Sponsored Programs or Sponsored Research. Whatever it is called, these professionals have an important duty: making sure the university (and you) adhere to the rules around having grants, particularly federal grants. Did you know that someone has to guarantee that your institution is a “drug-free workplace”? Here, we will not show you how to fill out the online forms for Project Performance Sites, etc. You may not ever see that part of Grants.gov, FastLane, or the foundation’s proposal portal because your research administrators may handle it for you.

That said, I strongly recommend taking some time to look at the submission portal to be sure you understand what will be required. For foundation submission portals, upload dummy documents as you step through. Why? Sometimes you find required elements not listed in the instructions. Sit down with your research administrators at least a month ahead of the deadline to make sure they know that you plan to submit and can help you be aware of and address every required proposal element. Respect your research administrators and the job they do. Ask them what they need by when and give it to them on time.

Resource or Data Sharing Plan

Most federal agencies require a resource or data sharing plan. At the NIH it is called the Resource Sharing Plan. At the NSF it is referred to as the Data Management Plan, but it should properly be named as Data Management and Sharing Plan. Librarians, who are expert at curating information, have created tools for their investigators for organizing the Data Management Plan, but remember that one size does not fit all. The kind of data you may gather from the Chandra telescope in space would be very different from what might be produced in an evolutionary biology project gathering physical samples in the field. The key elements to include how the data is stored, how it would be made available,

any necessary agreements or attributions for the person or group you share data or resources with, and so on. And I suggest you read the FAQ.[104]

Fortunately, the University of California Curation Center of the California Digital Library has an online tool for Data management plans: https://dmptool.org/ If your institution has a subscription, it will help you create an NSF-style Data Management Plan. The link may be found on your library's web site.

For the NIH, any resource that would be created in the course of the project—databases, key reagents, cell lines, transgenic animals, etc.—must be shared. There is also an increasing expectation that data will be shared. These things do not have to be made available the moment you create them, but you should articulate a clear plan for how they would be made available to other investigators.

If you have any concerns about writing this section, your library may have templates, and your tech transfer office may also have standard language. The online Data Management Plan tool, above, is a good place to start.

Letters of support

In many cases, you will need letters documenting support from other people. The purpose of the letter is to convey to the reviewers and the funder that you have everything you need to carry out the project. For programs, or for education portions for NSF CAREER proposals, a letter from the group you plan to work with is essential. I cannot stress the importance of documenting access to everything not directly part of your sphere of control.

Letters may guarantee access to reagents, equipment, or space. They may document agreements for consulting or collaboration. But they must be specific.

I recommend providing a draft to anyone from whom you need a letter of support.

- The letter should begin with their agreement to collaborate or provide access, or whatever it is you want from that person—their role in the project.
- State why they are qualified to carry out that role. For people who do not provide biosketches, don't forget to include why you want them on your project.
- Wish you success with your exciting project.

Many letters do the opposite and start with words of praise for the project. Many reviewers discount such praise automatically. It's better to put the most salient information first. Why is this person included? Then the positive words have more meaning.

As noted in Chapter 9, it can also serve you to name your collaborators and consultants in the discussion of the project plan. That way the letters carry more meaning, and the reviewer doesn't have to back-track to figure out why the person is pledging support. This

[104] https://www.nsf.gov/pubs/2018/nsf18041/nsf18041.jsp Retrieved September 21, 2021

technique of providing information in the project plan becomes crucial for proposals such as the NSF CAREER or other parts of the NSF, where the only letter of support permitted has a single, prescribed format: “If the proposal submitted by Dr. [insert the full name of the Principal Investigator] entitled [insert the proposal title] is selected for funding by NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment and Other Resources section of the proposal.”

For many applications, you will have more leeway with the content of the letter. I recommend you write the first draft of the letter yourself. Offer it to your collaborators as a draft, which you hope will make it easier for them, and invite them to make any changes they like. Nothing in the letter should surprise them; it should document your ongoing agreements.

Describing your Other Support

For the most part, describing your other support can be very straightforward. The forms have often simply had you fill out the details of the other support, often both current and pending, and remember that the current application should be included under Pending. The instructions usually provide clear guidance on how the information is presented, perhaps in a form page, and you may be required to write a statement on the relationship of the funded project to the current proposed work, sometimes called the “overlap statement”.

In 2021 the NIH and the NSF both announced changes to the biographical sketch and other support documents. You are now required to be clear about other support, even if it is not directly financial. For example, if you have in-kind support, such as free access to technology, that must be discussed in the other support documents. The policy changes include describing support of any kind. As noted in the notes on the biographical sketch, a recent change includes the instruction to disclose every appointment and source of support. There is additional discussion of this in the context of the biographical sketch, such as disclosing positions that do not include direct compensation. This question of other support is meant to clarify how you benefit from your other associations, as well as what specific grant funding you may have. Please work with your research administrators.

NIH-specific sections

The NIH has better information online than I can summarize for you here. For Vertebrate Animals and Human Subjects, see the following:

Vertebrate Animals

See the NIH web sites for the vertebrate animals worksheet.
https://grants.nih.gov/grants/olaw/VAChecklist.pdf

See also NIAID resources.
https://www.niaid.nih.gov/grants-contracts/research-vertebrate-animals

Human Subjects

The NIH has recently changed the definition of a clinical trial, such that it broadly captures most work with human participants. The new online forms for applications with human subjects are not simple. For a clinical trial, it can take a person experienced with clinical trials but new to these forms nearly two days to fill them out. Allow plenty of time to complete this part of your application to the NIH. The online forms required now were designed, in part, to improve reporting of results. More consistency of reporting will also permit more secondary analysis of data from different trials, ideally.

The current instructions say there should be no overlap between the detailed description in the online forms and the Research Strategy. Reviewers may need some information within the Approach section, but as with every other part of the proposal, focus on why you need to do whatever is described in the Human Subjects section.

Note also that the online forms have character limits in some places that correspond to several pages of text. Because these are web forms, no special characters are allowed. If you created the text in Word, I strongly recommend putting it in a .txt file and reviewing it before pasting into the online forms. Then review the proposal image of the online forms to make sure no special characters were rendered as "?".

See the NIAID resources.
https://www.niaid.nih.gov/grants-contracts/human-subjects

Also, be aware that Human Subjects criteria are now part of the score for Approach.

Authentication of Key Biological and Chemical Resources

Because of issues related to reproducibility, the NIH now requires that you include a plan for how you would determine that your key resources are indeed what you think they are. This actually is an important point, because you would not want to waste your time and money examining a cell line that was not, in fact, from the tissue you assumed it to be. Similarly, antibodies and other reagents that could vary from laboratory to laboratory need to be authenticated. The discussion of the authentication plans does not go in the Approach as part of Rigor and Reproducibility (a common mistake); the plan is uploaded as a separate document of about one page.

The page should be titled Authentication of Key Biological Resources. The document should take about one page.[105] It should contain the plan for ensuring that any reagent

[105] https://nexus.od.nih.gov/all/2016/01/29/authentication-of-key-biological-andor-chemical-resources-in-nih-grant-applications/ Retrieved September 18, 2021.

that could reasonably vary will be what you think it should be, not documentation that you've already authenticated your reagents and cells. Focus your efforts on cell lines, antibodies, and peptides—anything that might vary from laboratory to laboratory or with time and storage—not buffers or other standard chemicals.

Many journals now require documentation that you have authenticated your reagents. You can use the journal guidelines as guidelines for this page in your application to the NIH.

Create headings based on the kind of biological reagents you use and provide the plan for validating them. When you write your proposal to the NIH, I recommend you create a document as your first draft of the Authentication of Key Biological Resources. As you mention a cell line or antibody in the Approach, make a note in a draft document for Authentication that you will need to state how you plan to assure the resource is what you think it is. If you finalize the proposal, you can finalize this document.

The key point here is that you describe a plan. Some of the early discussions on this point brought up the issue of Good Laboratory Practices, the systematic approaches to managing laboratories to ensure reliability and reproducibility. For example, do you have a logbook to track the number of passages for cell line? How often do you check your cultures for mycoplasma? Will you use a service to assure that your cell lines are what you think they are, still, after multiple passages? Will you have peptide reagents validated by mass spec? Will you genotype your mice? Do you know how often an aliquot of antibody has been frozen and thawed, or do you create single-use aliquots?

You do not need to discuss anything related to standard reagents, such as your chemicals. This applies only to reagents or cell lines that could potentially change over the course of time.

Cover Letter and Assignment Request Form

The cover letter used to be required at NIH, but if the information only repeats what is in the Assignment Request Form, you can leave it off. On the Assignment Request Form, you can indicate the Institute(s) or Center(s) to consider your proposal for funding. You can also identify the Study Section(s) you would prefer, but the Scientific Review Officers make final determination for the science and approach proposed. SROs see thousands of applications and have the perspective about the fit of applications based on the review guidelines and the nuances therein. No reviewers see the Cover Letter or Assignment Request Form, and it should be written in a very straightforward way.

The cover letter is addressed to the Division of Receipt and Referral unless otherwise directed in the FOA. It should list:

- The title of the application.
- The title of the FOA.
- Requests for assignment (see note above).

Depending on your circumstances, the cover letter can also include:

- Explanations for late submission.
- The reason for late submission of a changed or corrected application (must also include all information on the original cover letter).
- Explanations of sub-award budget components not active for all budget periods.
- Statement the attached agency approval to apply for more than $500,000 a year
- Information about intention to submit a video with the application.
- How you plan to comply with the NIH Genomic Data Sharing Policy if your project would generate large-scale human or non-human genomic data.

The Assignment Request Form is very straightforward.

1. Paste in the FOA number and the FOA title.
2. There is an opportunity to list up to three "Awarding Component" names, meaning the Institute or Center which you would like to consider your proposal for funding. You can also request that you not be assigned to up to three awarding components.
3. You can then request up to three study sections. You can also list up to three study sections to which you would not want your grant proposal assigned for review. Use the official study section abbreviations. To facilitate finding them, you will find a link from the form page directly to study section information. We recommend using the NIH Assisted Referral Tool.[24]

Appendix materials and post-submission materials

Appendix materials may only be submitted with permission. Appropriate appendices can potentially include survey instruments or patient recruitment materials. However, as one Scientific Review Officer said, "The Appendix policy is not bendable by anyone."

Do not include a paper in press. If a paper under review at the time of submission moves to *in press* or publication, you can inform the reviewers but not send a copy of the paper. However, at the 2016 NIH Regional Grants Conference in Chicago, October 2016, an NIH policy officer was more thorough in the description.

- Prepare a letter, on letterhead. Address it to the Division of Receipt and Referral (DRR) and the relevant SRO. It should state that the purpose of the letter is to inform the review panel that the applicant has a new publication. Include the application cover page so they can easily locate the right proposal.
- Give the title of the publication, the name of the journal in which it was published, and the publication date. No other information should be included, and particularly no editorializing about how the paper is important to the proposed project.
- This letter should be signed both by the applicant and by the signing official for the applicant's organization.

Only the citation is shared with reviewers, so do not send a copy of the paper, just the information in the bullets above. Other post-submission materials include pre-prints, patents, or changes that relate to a change of institution.[106]

[106] https://grants.nih.gov/grants/guide/notice-files/NOT-OD-19-083.html Retrieved September 27, 2021.

Chapter 15: Resubmitting proposals

If you ever get an academic tattoo, consider inscribing the words, "Revise & Resubmit". If only about 1 in 10 proposals result in awarded grants, resubmission should be in your planning process. Where I have seen the data for the NIH and the NSF, the chances of a resubmitted proposal being funded are generally twice the chances of funding on first submission. Not every agency publishes their data, but the anecdata seem to fall in line with the published data—most applicants have to resubmit proposals.

Consider the data from the NSF Biological Sciences Directorate, 2008-2012. In that time period, 14% of proposals were funded. Hidden in that number are some important statistics: 72% of funded proposals had been declined once before award, 19% had been declined twice, and 9% had been declined three times before award.[107] By a back of the envelope calculation, the funding rate for first submission was just over 3%. Resubmission is the norm across the Foundation. "Third Time's the Charm", said astrophysicist and former NSF program officer Dr. Michael Briley.[108]

Data from the NIH for 2020 gave an overall success rate of 20% for R01-equivalent applications, but another analysis indicated that 16.5% of R01-equivalent applications were funded on first submission, and 33.1% on resubmission.[109]

But, as NIH program officer Dr. Rebekah Rasooly pointed out in in a grant writing presentation, resubmission is not a frequentist proposition, but a Bayesian one. In other words, just putting the same proposal back in without addressing the reviewer comments doesn't increase your chances and might even be returned without review. Instead, you need to "change your priors". If what you thought was a good idea, well communicated, did not find favor with reviewers, then you need to learn from the reviewer comments. And the reviewers are usually right, for certain values of "right".

My purpose in this book is to give you skills and approaches to communicate as clearly as possible in your grant proposal, but *what no book can tell you is which ideas the reviewers will find interesting and worthy*. Most reasonable training in grant proposal elements

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[107] Integrative Organismal Systems.Preliminary Proposal Pilot. April 4, 2014. Retrieved September 23, 2021 from https://www.nsf.gov/attachments/130168/public/MPS_AC_Presentation_Silverthorne_Final.pdf The purpose of the presentation was to convey data from IOS's use of pre-proposals, but the particular breakdown of results from open submissions conveys a compelling picture.

[108] Briley, M. THIRD TIME'S A CHARM; NSF RESUBMISSION OF A DECLINED PROPOSAL. Retrieved September 23, 2021 from https://www.aascu.org/grcinfo/_13W/Presentations/Sat/1000ab/Michael_Briley.pdf PDF of the PowerPoints from a presentation found online. Worth perusing for NSF applicants!

[109] NIH RePORT Retrieved September 21, 2021 from https://report.nih.gov/catalog/DisplayReport.aspx?rId=570

will contain advice to get feedback. Your peers and colleagues are your best resource for vetting your idea—the problem you identified and the solution you propose.

So, what do you do with a score outside the funding range and feedback from reviewers? Start with the comments from the reviewers.[110]

1. Look at it once, get mad, then put it away for a few days.
2. Highlight every positive comment.
3. Talk with your experienced colleagues to make sure you understand "reviewer speak".
4. Talk with the program officer to gauge their opinion on whether the proposal should be resubmitted.
5. Create a document that groups the reviewer comments by theme.
6. Decide whether to resubmit, or to submit it somewhere else.
7. Decide what you think you can and should fix: changes, clarifications, or justifications.

The process is not as linear as I make it sound here. For example, you may decide not to resubmit immediately based on the first reading of the tone and content of the reviews you receive. You may quickly realize you need to target a different funder.

Every federal agency has different rules and conventions about resubmission. Some agencies only issue one-time FOAs, and even if the same or similar FOA is re-issued, and you re-apply, all proposals are considered 'new'. The NSF guidelines encourage resubmission of a declined proposal only if the resubmitted application has been extensively revised. For programs at the NSF with rolling submissions (no fixed deadline), a proposal may not be resubmitted until one full year from the original submission. The Department of Energy's high-energy physics program refers to "recurring applications" instead of resubmissions. Almost all agency documents, however, say something like the following:

> Previously declined applications may be submitted to this FOA if they have undergone substantial revision.[111]

They also say that unchanged proposals may be returned without review.

If the agency considers resubmitted proposals the same as new submissions, make no reference to reviewer comments in the body of the revised proposal, unless the solicitation specifically requests that you do so. Many FOAs and FAQs from various parts of the NSF say that you can respond to prior review in the body of the proposal. They almost always follow with a statement implying it might not be a good idea to do so. For example, you can submit to the NSF CAREER program a total of three times, but I would encourage you not to refer to prior review in the resubmissions.

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[110] If you were not sent the reviewer comments, ask for them. Some agencies only give the reviewer comments on request. Some foundations will never share the comments with the applicant.

[111] FY 2022 RESEARCH OPPORTUNITIES IN HIGH ENERGY PHYSICS. Retrieved September 23, 2021 at https://science.osti.gov/-/media/grants/pdf/foas/2021/SC_FOA_0002546.pdf

If the agency allows or requires a response to review, such as the NIH Introduction to the Revised Application, put all specific reference to reviewer comments in the response. Let the revised application stand on its own unless the FOA requires you to note changes in response to review where those changes were made.

The NIH has a formal resubmission policy, with only one revised application allowed, but you can submit a third time as a “new” application. Be sure you understand your funder’s resubmission policies.

Understanding your review

The list above of what to do with a declined proposal applies whether you write a response to review or simply revise and resubmit in response to the reviewer comments. Let's unpack the list.

1. Read the review

The first time you read through the review, you may only register comments that seem "out of bounds" or where you think the reviewers missed something. Never react in any public way, such as an email to your program officer, to a review you have only read once.

It's okay to get mad. Most of us would like to receive a thoughtful, tactful, intellectually honest review. In my experience, the majority of reviewers take a very professional approach to grant review. Ideally, they follow the golden rule: "Review as you would wish to be reviewed." You may not like what they say, but for the most part, they have endeavored to be fair. Don't stay mad at someone who was doing their job.

Sometimes, though, review seems truly unfair. Sometimes reviewers make no effort to speak with any tact or sensitivity. Someone shared a review with me that contained this sentence, and little else: "This proposal did not pique my interest." On one hand, it helps to know that the reviewer is not excited by the proposed project. On the other hand, the reviewer gave no explanation of why they found the project uninteresting.

I've heard tales of reviewers calling into question the PI's contribution to her own publications; of reviewers saying, "There is no X", proving they missed the 1.5 pages with subheading X; of reviewers making egregious personal remarks; of reviewers demanding experiments far beyond the scope (budget) of the potential award. Sometimes reviewers do get it wrong. And sometimes, as my colleague Michael Spires says, "It's just Reviewer #3 being upset that they hadn't quoted more of Reviewer #3's papers." Those are not things you can anticipate or affect.

Often, reviewers have a point, even if you don't like hearing it, and sometimes they write reviews with the goal of helping the applicant. Once you've exercised being mad or just disappointed, move on to step 2.

2. Highlight every positive comment

On a printout or a copy of the review, find everything the reviewers said that was positive and highlight it. During this exercise, do not dwell on the criticisms. There are two reasons to take the time to consider everything the reviewers liked. First, we have a bias toward the negative, and sometimes do not even notice when something positive or complimentary was said. Second, if the reviewers liked something, don't change it!

Focusing on the positive can also help our creativity. When we recall what they liked and found valuable about the proposed project, we can be more inclined to synthesize from the criticisms and create effective responses to improve the proposal and project.

3. Talk with your experienced colleagues to make sure you understand "reviewer speak"

Sometimes it can take experience to interpret reviewer comments. A young professor once brought me her reviews, saying that she thought the reviewers generally liked her proposal, and brightly said, "They said it was ambitious!" She did not understand that "ambitious" means that the proposed project would not be possible within the "box" of the time and resources of an awarded grant. It was too big, overly ambitious.

If you can find a colleague who, in the past, served on the kind of review panel that reviewed your proposal, their experience can be invaluable. For the NIH (and to some extent USDA), where review panels have some level of standing or overlapping membership year to year, the different panels develop cultures and unspoken expectations. Feedback from someone who has served on the panel in the recent past can help you interpret your comments. I would never recommend you talk to someone currently serving on a panel, or who you discovered was in the room when your proposal was reviewed, because then you create a conflict of interest. In fact, reaching out to panelists or people you suspect were reviewers is inappropriate and can be reported as potential misconduct. Respect the anonymity of peer review.

Phrases like, "enthusiasm was dampened" imply a stronger negative reaction than the mild phrasing would indicate. Your colleagues who have been in review panels can help you understand what reviewers likely mean if you are unsure about a particular comment.

4. Talk with the program officer to gauge their opinion on whether the proposal should be resubmitted

In some cases, the funder's policy does not allow you to talk with the program officer. However, where you can, I would strongly recommend that you do so. Generally, program officers are in the room when proposals are discussed. The tone and content of that discussion, however, needs to be straightforward and based on the science.

For NIH applications: Program Officers within the Institutes and Centers of NIH may attend review panels, but during the Study Section meeting, they may not speak. Often the PO has relevant proposals under review in more than one Study Section, and they may not hear the discussion of your proposal. That said, they have a lot of experience you may not have. After NIH review of your application, do not call the Scientific Review Officer, rather call the Program Officer listed on your summary statement with any questions about the review of your application or how to improve your application.

"Contacting the PO to 'sell' your application or to express differences in scientific opinion related to the reviewers' comments will not affect the likelihood of funding."[112]

Do not cold call the PO. Send an email requesting an appointment. Prepare for the discussion by writing down your questions. What do you ask the program officer? If you did not talk to them before submission to identify whether your idea fits the program priorities, that should be your first question. Is the proposed project relevant to their portfolio? Do they even want to see a resubmission? Resubmitting a fundamentally flawed or inappropriate project wastes everyone's time—yours, the PO's and the reviewers'. Try to gauge their enthusiasm for your project, and if they suggest sending it to a different potential funder, listen.

The second question would be if they have anything to add from the panel discussion that is not in the written reviews. (For most agencies, the PO convenes the panels and runs, or co-runs, the meeting, although not at the NIH. See Chapter 2.) You *cannot* ask them to divulge anything specific about who was in the room or what was said about your proposal. You can ask questions about emphasis in the discussion. For example, I once asked a PO which of the eight points in the paragraph giving the summary of the discussion had taken the most time during the meeting. It turned out that just one of the eight points reflected more than half of the discussion time. With that information, I knew what was most important to address in the resubmission.

You can also ask program officers to help you interpret cryptic comments, although you should do your homework by first asking colleagues who have served as a reviewer. If you still aren't sure what a phrase or sentence is meant to convey, ask the program officer.

At NIH, there is a formal process for appealing your review. The appeal must be routed to the Program Officer, who then routes it to the Review group. If the PO advises against appealing a review, I strongly advise you don't do it The SRO writes a response, that is then evaluated by the funding council. Appeals rarely prevail; only submit an appeal with the support of a program officer. Otherwise, it creates a lot of work for you, the PO, and the SRO and you lose a cycle when you could have resubmitted.
The only successful appeal I have ever seen was a reviewer who didn't like the non-mammalian mode organisml being used. The review basically said, "Doesn't have fur; can't be important." The other reviewers were strongly positive.

[112] Found on the previous version of this page, but since removed. https://grants.nih.gov/grants/next_steps.htm That said, a former NIH staffer advises that if your proposal score is close to the NIH payline, be your own advocate, but strictly on the science. Send the program officer an impact statement—why your research is compelling and therefore considered for funding —and follow up with a phone call. Sometimes, especially at the end of the fiscal year, there are excess funds to be spent at the discretion of the Director. Your application that was close could be one that gets funded.

We strongly recommend you do not argue with the PO about the reviewer comments. Pointing out gross errors of fact or egregious remarks in reviews should be done in the most dispassionate way possible. Note that I said gross errors of fact. If a reviewer seems unaware of a single figure in a paper your subfield and makes an otherwise reasonable assumption, do not harp on this detail.[113] Reviewers are recruited from the general field and review from that context.

You can discuss (note I did not say "appeal") a clearly biased review, but the accusation of bias must rest on fact. Proceed with caution and test your discussion with colleagues you trust to tell you the truth. Do not press 'send' on an email requesting a discussion with the PO without having it reviewed for tone and content. If you do have a discussion with the PO, do not expect it to change the outcome of the funding decision, but it can sometimes be useful for the PO to identify truly problematic reviewers. That said, they read the reviews before sending them to you. You need to stay calm in the discussion,[114] and be prepared that the PO may not agree with you.

Complaining about reviewers will rarely serve you. For most funding agencies, the PO recruited the reviewers. Calling a reviewer by disparaging terms implies that the PO makes bad choices. Stick to the facts and stick to the substance. The PO can also help you understand how the various reviews were weighted. Perhaps the wildly inappropriate review wasn't the most important part of their decision to decline the proposal.

Program officers may suggest that you not resubmit or submit to another program or funder. We generally recommend that you listen to them.

5. Create a "themed comments" document

Identify whether the reviewers made consistent comments. Open the review of your proposal and open a new document. For reviews from the NIH and the IES, where reviewers give individual criterion scores, make a table of scores by reviewer to judge variability in review. For proposals scored with a numerical rubric, make a table to see how many points were assigned to each section by each reviewer.

Sample layout for a table of scores. For reviews with specific scores for each criterion (NIH, IES), a quick table can help you gauge uniformity of review. If your proposal was scored by a rubric of points per section, make a similar table if you have reviewer-specific points assignments. If you write a response to review, only include the table if it provides information. If the reviewer rankings were fairly uniform, leave it out.

Reviewer	Significance	Investigator	Approach	Environment	Innovation
1					
2					
3					

[113] If the point made by that figure was critical to the argument and not commonly known, it was the applicant's job to make it clear in the proposal.

[114] I once asked a colleague if they had ever talked with the PO about a very problematic review they had received several months prior. "Not yet," they said. "I'm still mad."

Find the themes in the review. Did all the reviewers comment on the same aspects of the proposal, and were their opinions generally in accord? Copy and paste the reviewer comments by theme under an informative heading. I recommend color-coding the reviewer source as you paste in the text, such as Reviewer #1 in blue, #2 in green, #3 in purple so you can see the trends in review. (Don't use red to indicate a reviewer because red text means you may unconsciously give that reviewer's comments extra salience when you look at the document.) This organization strategy will also help you see where a single reviewer had issues in an area the other reviewers did not.

Use this document to decide where you most need to focus in revising the proposal.

Now that you have a sense of the uniformity of review, look for these kinds of potential issues:

- Did one reviewer "sink" the proposal? Sometimes a single negative review can reduce the enthusiasm of the other reviewers. Did the most negative reviewer identify problems that were not mentioned by the more positive reviewers?
- Did the reviewers not like the idea? Do the reviewers think that you have identified a truly significant problem?
    - What do they say to justify their lack of enthusiasm? Can you address their concerns?
    - Do reviewers think that you are simply "drilling down" into the details of the system and only doing incremental work?
    - Do they think your intervention won't work?
- Is the problem in the approach? (That is the most fixable element.)
- Do the reviewers think the approach is not sufficiently innovative?
- Did the reviewers not find sufficient proof of feasibility?
- Did the reviewers question your past performance?
    - For research proposals, an easy reviewer heuristic is to count papers or look at the impact factor of the journals.
    - For program proposals, applicants sometimes forget to discuss their past successes, which set the stage for the success of what you propose to do.

6. Decide whether to resubmit, or to submit it somewhere else

As noted at the beginning of this chapter, proposals are generally twice as likely to win an award on the second submission than the first. Why? Because the second submission should be a revised application that takes into account the reviewer comments and be thereby improved.

The creation of the document with the reviewer comments grouped by theme will also help you decide whether to resubmit to the same agency or to some other funder. If the reviewer comments consistently indicate that they did not think the problem was important, it may be that your idea isn't yet strong enough. It may also be that the group of reviewers assembled by your funder have a different viewpoint. Many applicants to the NIH will tell stories of the proposal that scored poorly in one review group and found

favor with a different one. Dissecting the content and tone of the reviewer comments can help you make the determination to resubmit a revised application, change funders, or even change projects. And, as always, consult your peers and colleagues.

If you have an encouraging conversation with the program officer, revise the proposal to address the reviewer concerns and update every part of the application. If not, consider finding another potential funder.

7. Decide what you can and should fix

With step 4, you get a sense of reviewer expectations, the commonalities of the criticism and also places where a single strong negative opinion likely influenced the entire review process.

- If one reviewer "sunk" the proposal, can you address their concerns?
  - If you must write a response to reviewers (e.g. the NIH one-page introduction to the resubmitted application) and their concerns were unfounded, can you counter argue without being defensive or aggressive?
  - For other resubmissions, such as to NSF, you may have completely different reviewers who do not share that negative reviewer's concerns. You can still use the information gleaned from the negative review as you revise your proposal to present an improved argument.

- If the reviewers simply do not like the idea, or think the problem is insignificant, determine if they do not understand it, or if they will simply never find your idea interesting.
  - Have you made a clear statement of the projected impact of the work? If you make such a statement, do your peers and colleagues think that it improves your argument?
  - Did you get input from your peers and colleagues before submission? If not, ask them now.
  - Remember that sometimes an idea that fails at one funder can succeed at another.

- Sometimes reviewers question the approach because the original proposal didn't have sufficient proof of feasibility.
  - Sometimes reviewers question the approach because you do not have a published track record. Are there any papers published in the meantime, or that you can move into the pipeline?
  - Do you have a collaborator with a strong track record?

- Sometimes reviewers simply disagree with the approach you have chosen to take.

While **NIH** has formal resubmission policies and procedures, you are not required to call a revised submission a resubmission. For proposals that were "streamlined", or not discussed, there are usually enough issues to fix that you can submit the revised application as a new application. You can still benefit from the reviewer's comments, but you should never refer directly to the comments or prior score. If you do, the application will be withdrawn without review.

Note also that you have a 37-month window to submit the revised application at NIH. I would argue that after that long, your work and the field would have progressed that the application will be substantially different, and I would recommend submitting as "new".

    - Did you adequately justify your choice, or do the reviewers have a point and you need to shift the approach?
    - If they want experiments that you are not equipped to do, you may want to consider finding a collaborator with the skill sets required.

- If the reviewers think the approach is not sufficiently innovative, that can be a matter of opinion.
    - Did you make a clear argument for innovation? As noted in chapter 8, Innovation is the most subjective of all of the review criteria and you can help your reviewer by presenting context.
    - Conversely, perhaps you have an innovative concept and the appropriate approach would be "gold standard". Did you make this argument?
    - Would a collaboration bring a new approach to the problem and increase the perception of innovation?

- There are several things you can do to address reviewer concerns about feasibility.
    - What have you developed in the time between submission and review? Six months may have passed between submission and receipt of your reviews, and the work should have moved forward. How is it more clearly feasible now?
    - For research projects, if you do not have sufficient preliminary data, does it make sense to apply for pilot funding?
    - Did you have letters from your partners and collaborators guaranteeing their participation in the project?

- Can you address concerns about past performance?
    - Have you published with the method since submission?
    - For program proposals, can you point to past successes?
    - For research and program proposals, can you document the strength of any partnerships necessary to the work, such as through strong letters of support or documentation of prior collaboration?

Errors in grantsmanship, in the packaging and presentation of the idea, are fixable. The more necessary issues lie in the criticisms of approach and the reviewers' perceptions of the importance of the problem. Sometimes these are fixable by improving the presentation through clearer arguments, clear context, clear discussions of why and how. Sometimes the reviewers will never be enthusiastic about your proposed project. If that seems to be the case, pivot and rethink.

When you revise the proposal

Do not commit the cardinal error of resubmitting the exact same proposal. Yes, you will hear or may have stories of proposals resubmitted and awarded with fairly small changes—one new piece of preliminary data or a single added paragraph making a clarifying point. I would argue that in those cases, the additions or clarifications likely solved a major point of feasibility or provided necessary context that the first submission lacked.

Pay attention to reviewer comments, even when you do not agree with them. You do not have to address every nit-picky comment, but you do need to consider the comments and criticisms. It is called peer review. The reviewers are just as smart as you are and may have much more experience. They certainly have different experiences and write reviews from their unique perspectives. As you make decisions about what to change, use those different perspectives to enrich your own view of the project you propose. Again, resubmitted proposals are awarded at a higher rate than first submission because the proposals and projects are better, thanks to input from peer review.

Update everything you included in the unsuccessful proposal. Letters of support will need fresh dates, at the very least. Biosketches need updating with new publications, promotions, other awards. Budgets need to reflect current costs. And regulations change. For example, the biosketch format you used last year may have been revised.

You may have new information to include as your work has progressed but remember the field has not stood still, either. Make sure your literature is up to date, that your research ideas and plans take into account the most recent work in your field.

I strongly recommend having your peers read your proposal before submission and especially before resubmission. If at all possible, have a peer or even someone from your Research Development office take a look at the reviews and your revised application to help you be sure you've responded appropriately.

In the body of the proposal, do not make any reference to prior review. For many agencies, the review panel may consist of completely different reviewers from the prior submission. Let them see your proposal as it is; they have no context for how it was.

Writing a response to prior review

For some agencies, you have the opportunity to respond to prior review. For the NIH, the response goes in a separate Introduction to the Revised Application, with a 1-page limit. For resubmission to certain NSF solicitations, such as the Long Term Ecological Research (LTER) program, a Response to Prior Review section is required in the body of the proposal. When you are required to respond to prior review, rest assured that the reviewers assess the quality your response.

For **NIH** proposals, demonstrate that you have read and paid attention to comments. You do not need to change your proposal in response to every comment. If you do not agree with a criticism, it is appropriate to clarify and justify your position in a neutral non-defensive tone. You do not want to come across to reviewers as dismissive or snarky. The quality of response to prior review is considered in the NIH Overall Impact score

When writing a response to review, be succinct and direct. Also, be thorough. Respond to anything the previous reviewers identified as a weakness. It is also appropriate for your response to be a clarification or justification of your choices. The document grouping reviews by theme from step 4 will help you here. "All reviewers expressed concerns with..." by

contrast with "One reviewer indicated…" or "Reviewers 1 and 3 gave conflicting comments on…"

Avoid defensiveness. “One reviewer failed to notice the description of a key method, which we clearly included in Aim 3, and the information is again on page 11 in the revised proposal.” When they read a sentence like that, they can hear you gritting your teeth. Take ownership. “A lack of clarity on a key method was noted by one reviewer, and we have enhanced the discussion in Aim 3.”

Use lean language but provide context. If you simply say what was changed without saying why, it provides no useful information for reviewers. But don't go overboard. Contrast these two sentences in response to review of a neuroscience proposal.

> “We appreciate the reviewers’ positive comments on our approach to identifying the underlying anatomy and have taken steps to address the concerns about related mechanisms in the circuit. Specifically, we have…” (31 words and the change still isn't clear.)
>
> “Reviewers noted strengths in the anatomical approaches but had concerns about mechanism. We now include electrophysiology for circuit analysis in Aim 2.” (23 words, and the point is made.)

By providing context, even new reviewers will understand what change was made, and why.

Don’t give up!

About 20 years ago, a tenured professor of mathematics told me they had submitted an NSF grant proposal once, 10 or 15 years prior. “It wasn’t funded, so I gave up.”[115] One submission, one rejection, and they gave up on the whole idea of grant funding. Perhaps they didn’t need resources to do their work, but they could have supported students, could have gone beyond their departmental resources. Grant funding makes new ideas possible.

Build resubmission into your planning process. That doesn’t mean that you should submit less than your best on the first submission! Think about what you can spin out of the proposal process. Can you repurpose text and figures into your next publication? Could you take part of it for an internal pilot application? Both of those—a new publication and some resources—will help improve the next iteration of your proposal.

> For most, success comes from persistence and practice.[116]

Learn from every proposal rejection. Do reviewers disagree with the approach, or is the field moving in a different direction and reviewers aren’t excited by your idea? Are there

[115] I kept a straight face, but it wasn’t easy.
[116] This was originally found on https://grants.nih.gov/grants/next_steps.htm, around 2017, 2018, maybe, but the website has changed since.

elements of a rejected proposal you can recycle into something else? Can you use it as a blueprint for your work in the next year, or share it with a potential collaborator to set the stage for working together? You worked hard on that proposal; try to make the work count twice.

Chapter 16: Notes on Writing

> The purpose of language is threefold: to communicate thought, volition, and emotion.[117]

In a grant proposal, the reader needs to know your conclusions and how you arrived at them (thought), what you want to do (volition), and why it is important (emotion). Most of us do not want to think about the role of emotion in the grant application process. For program grants, non-profits providing services and the like, you can easily see the need for an emotional appeal. In an academic research project, the idea of an emotional element may seem off-putting, but you need your reviewer to feel excitement about your project. Your excitement needs to come through in the writing by using a straightforward logic that translates your own *Isn't this exciting?!* to a reviewer's *Wow! That's exciting!*[118] If the reviewer has little enthusiasm for your proposed work, they will not decide to champion your proposal in the review process.

> We can all agree that substance should trump style.… Yet, in order to communicate ideas those ideas must be put into words. If an author is unable to do so the reader must put the pieces of an argument together him- or herself, with much effort and possible misunderstanding.[119, 120]

Almost every technique discussed in the previous chapters should help you clearly convey your ideas to your reader. The rubrics provide ways for you to order your ideas and sentences so the reader can follow your thought processes. Reviewers tend to like proposals they understand. You want them to feel smart. Clear organization of concepts, ideas, sentences, and words within sentences can contribute to the reader's understanding. Always ask yourself, *What does the reader need to know, and when do they need to know it?*

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[117] Sister Miriam Joseph, The Trivium: The Liberal Arts of Logic, Grammar, and Rhetoric. 2002. Paul Dye books. Page 12.

[118] Do not use exclamation points in a grant proposal to convey your enthusiasm.

[119] From a chapter titled *Advice on Writing* from Social Science Methodology: A Primer, by John Gerring and Dino Christenson, Cambridge University Press, forthcoming (as of June 2018). Accessed June, 2018 from http://blogs.bu.edu/jgerring/files/2014/10/Advice-on-Writing.pdf Link is gone, and I cannot find the book. It may be Applied Social Science Methodology: An Introductory Guide, which was published in 2017.

[120] I want to add commas in key places to this quotation, or even just re-write it away from the fluent academic-ese: "Few of us would argue against substance over style, but to communicate ideas we have to put those ideas into words. If an author's style requires effort by the reader to assemble the pieces of an argument, the reader may misunderstand the author's idea." (44 vs 49 words of the original; straightforward language requires fewer words.)

There are many books and helpful websites on writing for academics, but to gain skills you must practice. Simply write on a regular basis and ask your colleagues to give you true feedback. You can even hire editors who will both edit your work and discuss why they made their editorial suggestions so that you can employ their techniques. Your institution probably has a technical writing course, or you could take the NIH online course on Plain Language.[121] Find an approach that helps you improve. The time invested now will save you later in less time spent agonizing and re-writing.

Writing style matters but reading about writing doesn't help you gain the fluidity you need. Only practice helps. Most of you have encountered the standard writing advice on "use" vs. "utilize" and other simplification techniques (and if not, I point you toward Dr. Katharine Hartmann's excellent post on the website Edge for Scholars, The Write Rules[122]). Even so, I feel the need to dispense advice.

1. ***Find your voice.*** Many of us copy the style of our previous mentors, often because of their extensive use of the red pen or the virtual red pen of Track Changes when we were training. Writing in academia rarely follows conversational styles, and yet most of us convey ideas more easily by talking.
    a. Try reading your prose aloud or have your screen reader read it back to you. Does it flow? Does it sound like "you"?
    b. Consider using dictation software. I often use Dragon's Naturally Speaking Professional version. My version had alveolar rhabdomyosarcoma, right out of the box, although the algorithms weren't yet weighted to expect it. The software can be trained from your documents as well as through voice. The investment in the software and training time has been worth it for me.
    c. Try writing in the first person, active voice. Acceptance of the first person (I or we) may vary by the norms of your field. Dr. Helen Sword's book, Stylish Academic Writing, includes a quantitative figure on the use of style attributes across disciplines. In the chapter titled Voice and Echo she writes:

    > Referring to our actions in the first person ("*I* think," "*we* discovered") comes naturally to most humans; suppressing our own agency, by contrast, requires considerable syntactical effort and ingenuity.[123]

    In other words, the prose that others find harder to read may in fact take more work to write. Finding your own voice comes over time, but when you have a clear sense of your own style, writing can become less of a chore and more of a conversation. Some of the notes below might help you to develop your own style.

2. **Become aware of all instances of "to be".** Of course, passive voice requires "to be", as in "students were surveyed" or "measurements will be taken". Surveyed

[121] NIH training on clear communication https://www.nih.gov/institutes-nih/nih-office-director/office-communications-public-liaison/clear-communication/plain-language/training (put *NIH plan language training* in your search engine)
[122] https://edgeforscholars.org/the-write-rules/ Covers all the key points in 10 rules.
[123] Sword, H. Stylish Academic Writing. Harvard University Press, 2012, pp 43-44.

by whom? Measured by whom? Remember the rule about passive voice: if you can follow the verb with "by zombies", you identify the instances of passive voice.[124] Active voice is usually shorter. (Protein purification was achieved by zombies. Zombies purified the protein.) But there are more issues with using "to be" variants than passive voice. The following is an unscholarly discussion of the approaches I use.

a. What about *We are planning*, vs. *We plan*? This example shows the present continuous (or active present) vs. the simple present tense. The shorter version results in more confident, robust prose, and takes less space.

b. Using "is" language implies identity and classification when you may not mean it. Quite often in academic writing, showing relation or action can communicate more precisely than defaulting to identification.

    i. Relation: *That idea is ridiculous*. vs. *I find that idea ridiculous*. You can write about your relation to the idea rather than assigning an essential quality of ridiculousness to it. This approach can help you avoid invoking someone else's emotions, especially if your reader finds the idea brilliant and takes your statement that it *is ridiculous* as a personal insult (consciously or no).

    ii. Action: *The students are lazy*. vs. *The students have not turned in their homework in a month*. The first gives a value judgement and the second states a fact based on the students' (in)action.

    Complete avoidance of "to be", known as writing in E-prime,[125] can sometimes result in stilted prose. However, other than the examples above, I have written this chapter mostly in E-prime. Becoming aware of instances of "to be" has helped me to develop more precise habits of writing. As my colleague and spouse Dr. Joel White said about writing in science and academe, "It's not enough to be accurate. You have to be precise."[126]

c. Avoiding "to be" can help convey ideas more directly. Compare

    The mistake writers often make is failing to weed out jargon.

    Writers often make the mistake of including too much jargon.

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[124] Johnson, R. [@johnsonr]. (2012, October 18). *I finally learned how to teach my guys to ID the passive voice. If you can insert "by zombies" after the verb, you have passive voice.* Twitter. https://twitter.com/johnsonr/status/259012668298506240?lang=en Retrieved October 4, 2021

[125] There are many resources for E-Prime, but you can start with the rationalwiki.org page at https://rationalwiki.org/wiki/E-Prime, Retrieved October 4, 2021 I find that potentially fraught emails always work better in E-Prime.

[126] He says he heard it from Dr. Michael Meredith, his thesis advisor, but Dr. Meredith claims not to remember having said it. I recalled hearing it from Dr. John Kauer, Dr. White's postdoctoral advisor, but he doesn't remember saying it, either. We have collectively agreed to attribute it to Dr. White. Also: I could have used a semicolon in the quotation because the sentences together form a single point, but I thought they had more impact as two short, sharp sentences. This illustrates also one of my viewpoints on the semicolon: If you have the urge to use one, sit on your hands until the urge goes away. The semicolon can serve you well in some circumstances, but you can usually get by without it.

These examples convey two ideas about writing, one on the use of "to be" and one on writing positive vs negative statements. Both sentences make the point about jargon. I find the second version more readable.

3. **Engage your critical thinking skills.** If writing captures your thoughts on the page, then writing and thinking should be inseparable. Somehow academics can produce reams of text that only contain reports on what other people did or thought. Dr. Raul Pacheco-Vega addresses this point with a terrific compendium of resources in a blog post titled "Distinguishing between description and analysis in academic writing".[127] The Background sections of grant proposals tend to contain little more than descriptions of the previous work. The section should also contain your analysis. How do previous papers compare to each other or your preliminary work? Do you find the evidence in the published work credible, based on well designed and well executed approaches? What additional insights can you add? The "report" sentences can set up the "thinking" sentences, but you should always know your point in writing a reporting sentence. (see also Chapter 8.)

4. **Be aware of the genre.** I recall a cartoon by Sipress, decades ago, showing someone at a cocktail party saying, "I'm a fiction writer in the grant-proposal genre." Grant proposals should not contain complete fiction, but they should contain *possibilities*. In a proposal, you describe what you want to do, what you think will happen when you do it, and the projected impacts of having done the work. You want to persuade the reviewers that you have a great, high-impact idea, and an effective plan for executing it.
    a. Your audience generally consists of your peers, people trained to be skeptical and to resist emotional appeal. So, what do you do? Use the techniques and rubrics in this Handbook to display clearly the logic of your idea. Show the reader how you arrived at the idea and how you made the decisions for the methods to pursue it.
    b. Put your proposal draft away for a week while you work on the other aspects, such as the budget, facilities page, etc. After a week, re-read your proposal as if you were the reviewer—tired, squeezing in the review among competing priorities. Write the review as if you have 10 other proposals to read. Use this process to improve your draft.

5. **Understand what you want to convey (and remove everything else).** I love the quote attributed to the writer E. M. Forster, "How do I know what I think until I see what I say?"[128] The act of writing or speaking about a topic can help clarify your thinking. Writers often make the mistake of failing to weed out the writing that helped them understand their own point. The reader does not need to

[127] http://www.raulpacheco.org/2017/05/distinguishing-between-description-and-analysis-in-academic-writing/ I highly recommend going back through Dr. Pacheco's blogs and following him on Twitter @raulpacheco. As of this writing, he is compiling these posts into a book. I will buy it.

[128] The phrase was spoken by a character in a novel. It has been argued that Forster meant this sarcastically. However, I find the process of linearizing thoughts into language to play a key part in clarifying my thinking. See this post on discovery writing: https://rjheeks.wordpress.com/2011/04/13/discovery-writing-and-the-so-called-forster-quote/ Retrieved September 24, 2021.

see the gyrations that led to the clear idea you want to convey. When you understand your point, edit out everything that distracts from it.

6. **Respect the reviewers' efforts and make their job easy.** Reviewers will plow through dense prose and confusing figures in a journal article because they want to. They read grant proposals because they have to. Learn every technique for creating clear layouts and readable prose. If a reader must re-read a sentence to understand it, you have wasted their attention and increased their cognitive load.

7. **Read books on writing to learn more techniques that might resonate for you.** I recommend Helen Sword's Stylish Academic Writing and Randy Olsen's Houston We Have a Narrative. The first book may suit humanities and social scientists and the second targets STEM researchers. These books focus primarily on scholarly publications, but the principles of clear communication apply both to publishing results and proposing projects.

The classic article on scientific writing by Gopen and Swan contains the following statement:

> It does not matter how pleased an author might be to have converted all the right data into sentences and paragraphs; it matters only whether a large majority of the reading audience accurately perceives what the author had in mind.[129, 130]

Anyone who writes about writing is responding to the frustration of the struggle to find the point, a point, any point, buried in dense, tangled prose. I would echo Dr. Sword: There is no one correct way to write something. It depends on your field, your subject, your audience, and your voice. Ideas are the currency of academe, and the more clearly you can convey your ideas, the more people can see the value of your work. As Drs. Gerring and Christianson note in the quote that opens this chapter, the author must present their ideas clearly.

To quote the polymath John Ruskin (1819–1900):

> Say all you have to say in the fewest possible words, or your reader will be sure to skip them; and in the plainest possible words or [they][131] will certainly misunderstand them.

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[129] Gopen, G. and Swan, J., The Science of Scientific Writing. American Scientist,1990 and 2018. https://www.americanscientist.org/blog/the-long-view/the-science-of-scientific-writing (the URL moves, so search on the title) I don't agree with every part of it, but it's useful. Retrieved September 24, 2021.

[130] I would split that into two sentences. I understand they likely chose the semicolon to indicate that the two sentences together form a complete thought. However, a semicolon followed by a lower-case i (…**;** **i**…) means four items for the retina to process rather than the two items of a period and capital I (…**.** **I**…). Would such a tiny increase in processing effort make or break a proposal? Of course not! But I look for every way I can make the reviewers' job easy. In this case, making it two sentences would not diminish the meaning and would also break up a long-ish sentence.

[131] The original said "he", usage of the time. If you can use the semicolon as elegantly as John Ruskin, you can have it back.

Sometimes prose that seems readable on the surface contains writing errors. In Chapter 13, on the sample NIH biographical sketch, I re-wrote one of the paragraphs in the Contribution to Science section (see notes in blue on page 131). On the next page you will find the original with my somewhat sarcastic (3/5) notes and my edited version following the notes. The notes on writing apply to any part of your proposal.

Original:

My early publications* directly addressed the fact that substance abuse is often overlooked in older adults. However, because many older adults were raised during an era of increased drug and alcohol use, there are reasons to believe that this will become an increasing issue as the population ages.** These publications found† that older adults appear§ in a variety of primary care settings or seek mental health providers to deal with emerging addiction problems. These publications document‡ this emerging problem but guide primary care providers and geriatric mental health providers to recognize symptoms, assess the nature of the problem and apply the necessary interventions. By providing evidence and simple clinical approaches, this body of work has changed the standards of care for addicted older adults and will continue to provide assistance in relevant medical settings well into the future. I served as the primary investigator or co-investigator in all of these studies. (136 words)

* Chronology is less important than subject here. What is this about?

** This statement is unsupported, and no one reviewing a grant proposal particularly cares what you believe. Also, "increased" as compared to what?

† The publications did not find anything; the authors did. Watch for these anthropomorphisms. Rule of thumb: Do not assign volition and action to things that cannot think or act.

§ They just appear, like Apparating in the Harry Potter books?

‡ See †. The publications did not document anything; the authors did. Why would you want to diminish the fact that these are <u>your</u> contributions by assigning the results to the report, not the person who made the report?

Edited:

Substance abuse in older adults Substance abuse is often overlooked in older adults. We found that older adults seek help to deal with emerging addiction problems both through mental health providers and in primary care settings. In the publications listed below, we document this emerging problem and provide guidance for primary care and geriatric mental health providers to recognize symptoms, assess the nature of the problem and apply the necessary interventions. By providing evidence and simple clinical approaches, this body of work has changed the standards of care for addicted older adults and will continue to provide assistance in relevant medical settings well into the future. I served as the primary investigator or co-investigator in all of these studies. (122 words)

I hope you can see where the second version solves the complaints I expressed in the footnotes on the first version. I left the anthropomorphism in the following phrases: "...this

body of work has changed standards of care…and will continue to provide assistance…" I made this choice because while the contributions should focus on your contributions, readers may not like the implied arrogance of a statement like, "We changed standards of care."

As a final note, I can only paraphrase a few key points.

- Write often.
- Get feedback on your writing from people who will tell you the truth.[132]
- Almost all advice on writing includes the phrase, "Know your audience." Think about who will read your grant proposal (someone who does not share your brain), how (under non-ideal conditions), and why (because they have been assigned to read it).
- Get out of your own way and finish it.
- Set yourself a deadline so you have time to revise.
- Take the advice of the novelist Neil Gaiman:

> The best advice I can give on this is, once it's done, to put it away until you can read it with new eyes. …print it out, then put it in a drawer and write other things. When you're ready, pick it up and read it, as if you've never read it before. If there are things you aren't satisfied with as a reader, go in and fix them as a writer: that's revision.[133]

[132] "We need very strong ears to hear ourselves judged frankly, and because there are few who can endure frank criticism without being stung by it, those who venture to criticize us perform a remarkable act of friendship, for to undertake to wound or offend a person for their own good is to have a healthy love for them." Michele de Montagne, 1533 -1592. (changed to non-gendered usage)

[133] The FAQ on Neil Gaiman's web site. http://www.neilgaiman.com/FAQs/Advice_to_Authors#q3 Whenever I've seen him speak about writing, he usually leans over the microphone at some point and intones, "Just. Finish. It." Good advice for any writing.

Chapter 17: Summary

Know your audience

Who reads your grant proposal? This may seem like a fair amount of work for a rarefied audience of perhaps only three people who will read the entire thing, and the 17 to 30 more who will read only the Specific Aims/Overview page or the abstract. Most reviewers are chosen because they have a lot of experience and are themselves funded investigators. Few if any of them, however, will have specific expertise in your field. This brings us to a key point: *write for the reviewer and not for yourself*.

Many of the specific techniques we discussed in this book are designed to make the reviewer's job easy. The preceding chapters contain tools and rubrics for presenting your ideas and the key information reviewers need to judge your capacity to carry them out. Many reviewers do not sit with a pile of grants to review first thing in the morning on their second cup of coffee or tea. Reviewers already have full-time jobs and may be reviewing proposals whenever they can spare a minute. Techniques like the use of clear subheadings make it easy for the reviewer to find their place if they pick up your proposal after an interruption by a student or sometime after their commute home and dinner. Techniques like always starting with why—giving the reason for the specific experiment or step—provide a framework for your reviewers so that they can better understand the details of your experimental design.

Remember that your reviewers are likely tired and not particularly attentive. They like proposals they understand. The tools of good grantsmanship help you focus the reader's attention to the key elements that will help them more easily understand your proposal and evaluate it based on merit.

Proposals are tools

View the grant writing process as a tool to clarify your ideas. If you do so, grant writing can become integrated with your overall scholarly and academic work. Some people view writing grant applications as an imposition on their time. They write proposals that reflect their lack of engagement and thereby fail to engage reviewers. Some of your colleagues may say that they love to write grant applications. Ask why. I bet they'll say they use the process to think and extrapolate and plan—intellectual play time. Their proposals are generally much easier to read because they share their thought processes with the reviewer and always tell them why.

About the Author:

M. S. (Peg) AtKisson earned a PhD in neuroscience from Tufts University, and in 2001 began a career as a grant writer and editor for proposals across the spectrum of research and scholarship. She grew the research development function of Tufts University to a full-fledged office, and in 2010 joined Grant Writers' Seminars and Workshops full time. In 2017 she founded AtKisson Training Group on the idea that a competitive grant proposal must have a strong idea in the setting of a solid research and scholarly enterprise, that grantsmanship alone was insufficient for funding and career success. In her spare time, she sails, directs musical theater, and writes fiction. She does not write fiction in grant applications, nor should you.

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