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Demystifying the Academic Research Enterprise

Becoming a Successful Scholar in a Complex and Competitive Environment

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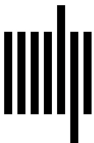
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Diving into the Pool: Research Proposals, Evaluation Processes, and Project Management

Chapter Overview and Learning Objectives

Obtaining funding for research and creative activity almost always involves writing and submitting a grant proposal. This chapter details the steps within the proposal process, from formulating and developing ideas, plans, and budgets to submitting the proposal, obtaining funding, and successfully managing projects once funding has been granted. Additionally, it overviews the proposal evaluation process, discussed in greater detail in chapter 7, along with key considerations to bear in mind for developing competitive grant proposals that adhere to expected standards. After reading this chapter, you should be able to

- Explain the structure and elements of a research grant proposal;
- Know the importance of describing your work in a grant proposal to a technically competent but nonexpert audience;
- Understand how costs of research frequently are shared between funder and recipient;
- Explain facilities and administrative costs (F&A) in comparison to other costs that support research;
- Understand the varied missions, philosophies, and processes of funding organizations;
- Describe the steps involved in peer/merit review of proposals and how they differ among funding sources; and
- Know how to apply best practices for managing a research project once funding has been obtained.

6.1 Structure and Value of the Research Proposal

In chapter 2, we discussed a variety of topics regarding funding for research and creative activity, including the wide array of sources available, how

priorities are set, mechanisms available to locate funding, historical trends, and more. Suppose now you have a good idea, a strategy for how you plan to study it, and options for funding. How, then, do you go about actually obtaining funding so you can perform the research and creative activity?

In almost every situation, the process involves something known as a grant proposal. Proposals are formal, written documents created by the individual(s) proposing the work, typically led by a principal investigator (PI). Proposals describe the idea to be explored or the problem to be solved, approaches, methods, and tools to be used, resources available, and the timeline to be followed. Sometimes, alternative approaches are offered in case those proposed do not work as envisioned. Proposals also contextualize the planned work in terms of work performed previously, including that by the PI and others involved, list expected outcomes and impacts, describe costs in a detailed budget (often extending over one to five years), and justify personnel and other resources needed. Because the structure and content of proposals varies substantially across funding organizations, table 6.1 presents a list of generic components typically required in proposals.

Table 6.1

Generic components typically required in research grant proposals (variation exists among funding sources)

Component Description
Project/executive summary
Technical summary of intellectual contributions and significance
Lay summary of intellectual contributions and significance
Summary of broader impacts
Project description (motivation/opportunity, results from prior work, goals, progress to date, research/work plan, methods used, alternative approaches, expected outcomes, relevance and value, congruence with funding organization mission or program requirements, partnerships, collaborators)
Project management plan
Project evaluation plan
Data management plan
Mentoring plan
Sustainability plan
Plan for disseminating products and outcomes
Broader impacts
Qualification of investigators (description and curriculum vitae)
Investigator current and pending support
Investigator conflicts of interest
Facilities, equipment, and other resources required
Budget and justification
References cited

Writing grant proposals is a notably challenging and time-consuming task, and the associated skills and art of communication are best learned through practice.¹ The process requires an ability to convey one's ideas, hypotheses, strategies, and methods of interpretation in clear and compelling ways to those who will be reading the proposal and making recommendations as to whether it should be funded. In some cases, most or all of the proposal reviewers are experts in the field of the investigator(s), and thus jargon and deeply technical explanations are appropriate (section 11.4). In other cases, especially if the proposal topic involves multiple disciplines (chapter 13), say engineering, art history, and law, the challenges in writing a proposal are substantially greater because the material must be understandable to experts in all of these areas. In such cases, one has to strike a balance between technical depth and general notions that allow all reviewers to comprehend what is being proposed and understand the context for it. The moral to the story is to know your audience!

As overviewed in section 6.3 and described more fully in chapter 7, most review of proposals is based upon the merit (intellectual, creative, historical) of the idea being presented. However, other factors do enter the review process, depending upon the funding organization. For example, in the case of some nonprofit foundations, the research track record of the PI, and perhaps the strength of a previous research relationship between the foundation and investigator, are *the* most important factors in determining whether the proposal will be funded. And of course, also vitally important for nonprofit foundations is the extent to which the proposed work aligns with the organizational mission. Although PI track records are important to federal agencies as well, the research relationship between agency personnel and PI or other investigators on the project is less important. In fact, the review process is designed specifically to avoid creating conflicts of interest that might afford an unfair advantage.

Most organizations that seek external funding, especially research universities, have excellent resources to assist with proposal development (chapter 1). However, many do not, especially institutions working to enter or become more active in externally sponsored research and creative activity. This deficiency increasingly is becoming more recognized, as noted in section 1.6, and efforts now are being directed nationally toward providing the administrative resources needed at such institutions to support faculty and student scholarship (section 12.3).

If your institution does not have such resources, speak with your advisor, department chair, dean, or senior research officer about your needs and how the institution can best meet them. One option is for the institution to hire professional consultants to assist with proposal development and project management until such capabilities can be established more permanently. Additionally, you may wish to collaborate with individuals at institutions having such

resources, which will allow you to become a local resource for others in your own institution.

Apart from the obvious value of proposals as mechanisms for obtaining resources, the process of developing proposals has additional value. For example, proposals require the PI and others on the project to think through and design a clear plan for the work to be done, including alternative approaches should the chosen strategy prove to not be viable. This is true for all fields, not only STEM disciplines. In some disciplines where hypothesis testing and statistical methods are employed, such as in experimental research within the social and behavioral sciences, proposals document a very specific strategy that can be altered only under certain circumstances as the work proceeds. This helps prevent the implementation of changes, such as making inappropriate alterations to thresholds on statistical significance, which could lead to more desirable results. The issues of reproducibility of research results, and research integrity, are addressed in chapters 4 and 9, respectively.

In fields such as the arts and fine arts, the scholarship to be accomplished sometimes involves creating a work (e.g., painting, sculpture, composition), the pathway toward which may be clear at the outset but may be modified as the research proceeds. In such cases, the modifications are completely appropriate and as valuable to knowledge creation as the work itself, often leading to new lines of creative endeavor.

In addition to the components described above, research proposals typically contain a project summary written specifically for the general public. This document is exceptionally important, especially for federally funded projects, because it conveys the purpose and value of the work to the taxpayers funding it. It also is important for communicating the importance of scholarly activity in nontechnical language, and for educating the public about important advances within all disciplines and their positive impact on society.

Finally, all funding organizations have a mission, and thus you should understand the mission of the agency or foundation relevant to your work prior to submitting a proposal. The term “mission agencies” frequently is used to describe federal government agencies, such as those within DOD and DOE, which typically do not seek to fund research projects based upon curiosity-driven ideas of researchers.² Rather, they solicit proposals on specific topics that meet well-defined agency programmatic requirements, such as the development of a certain device, capability, or process. In the terminology discussed in chapter 1, this is known as applied research and development. If the PI does a good job and delivers results as expected, the agency often goes back to them, as a now trusted resource, with additional funding to meet other agency requirements. Funded relationships along these lines can last for years to decades.

Often it is said NSF is not a mission agency in the sense just described. However, it does in fact have a clear mission of funding the bulk of nonclinical/medical fundamental research in the US. As noted in chapter 3, federal agencies such as NEA and NEH also have missions. NEA brings the arts to all Americans and provides leadership in arts education, while NEH supports research, education, preservation, and public programs in the humanities. As noted in chapter 2, all federal agencies and nonprofit foundations have websites describing their mission, the array of programs and funding available, and detailed instructions regarding proposal content, submission, and review processes. Many also provide actual sample proposals from which you can learn.

6.2 Research Project Budget and Sharing the Costs of Research

Although every aspect of a grant proposal is important—especially the project description, intellectual merit of and methods to be used in the work to be performed and impacts broader than direct outcomes from the research itself—the budget, and its associated justification narrative, also are quite important because they detail all of the costs associated with performing the work, as well as the rationale for them. When the proposal is funded and the budget finalized, the approved budget must be followed, though some flexibility exists to transfer money among budget categories so long as the bottom line amount is not exceeded.

Budgets have several components and usually are structured in ways specific to requirements of the funding organization. In the case of federal agencies, efforts are underway to harmonize budget structure so as to avoid unnecessary multiple formats and confusion for researchers. Additionally, instead of detailed budgets, some agencies allow the submission of a simplified budget at the proposal stage. This strategy provides sufficient information to reviewers for assessing whether the budget is appropriately structured and sized relative to the work proposed, while reducing the administrative workload (section 10.6) on the part of the PI and collaborators in developing the proposal. If the proposal is judged to be meritorious during the review process, then a much more detailed budget is submitted.

In the case of private foundations, grant proposal budgets tend to be substantially simpler than those for proposals submitted to federal agencies. Indeed, some foundations require only a relatively brief (two- to five-page) narrative of the rationale for and description of the work to be done, how it aligns with the foundation mission, a consolidated budget specifying the principal costs and justification, and expected outcomes.

The most common components of a grant proposal budget (table 6.2) include the following: salaries and wages, which include those of the PI and other senior or professional researchers, postdoctoral researchers, technicians, programmers, graduate and undergraduate students, and administrative and clerical personnel. For senior personnel, such as faculty, the bulk of their salary typically is paid by their home institution, and thus only a portion is requested in the grant proposal (usually for funding during the summer if they are on a nine-month academic year contract). For the others listed, full salary often is requested. In addition to salaries and wages, fringe benefits—in support of health care and retirement, can be included in grant proposal budgets.

The proposal budget also can include funding for equipment, such as instruments, computers, audio and video recording equipment, and lighting and sound systems, along with national and international travel to support participation of project personnel at professional conferences. Funding also can be requested to collect data or artifacts, and collaborate with researchers at other locations. Finally, the budget can include materials and supplies, costs for publishing journal articles and books, computer software, equipment maintenance contracts, student tuition, and the participation of others who are not part of the core project team.

The determination of what can and cannot be included in a proposal budget is spelled out by detailed federal guidance (2 C.F.R. 200, or Title 2 of the US Code of Federal Regulations, Part 200), created in 2017 by OMB, and by guidelines

Table 6.2

Items for which funding typically is requested in research proposal budgets (variation exists among funding sources)

Item Description
Salaries and wages (principal investigator, coprincipal investigator, other senior personnel, postdoctoral researchers, technicians, and support staff)
Stipends for graduate and undergraduate students
Fringe benefits for all personnel
Materials, supplies, and services
Publication/dissemination costs
Equipment
Consulting services
Special computing services
Domestic and international travel
Special facilities utilization
Subcontracts
Participant support costs (e.g., subjects to be interviewed)
Facilities and administrative costs (F&A)

from the organizations providing and receiving the funding. In cases where some of the work cannot be performed by the organization submitting the proposal, subcontracts are issued to other organizations for meeting the need.

As described previously, research grants provide a benefit to both the funding organization and the organization performing the work—the so-called mutuality of interest principle (recall this is not true for contracts, which provide a benefit principally to the funding organization). Consequently, the costs of research likewise are shared between the organization providing the funding and the organization receiving it. This is known as cost sharing.

Cost sharing has been around for decades and is pertinent to all disciplines, sometimes implicitly, as in the case of prestigious faculty fellowships in the humanities. For example, the Fulbright and American Council of Learned Societies Fellowships (section 2.1) support faculty salaries for a period of time, with the institution paying individuals (e.g., adjunct faculty) to temporarily assume the teaching load of the fellowship recipient. In many cases, full salary is not provided for the fellow, and thus the institution must make up the difference (i.e., as cost sharing) in order to accept the fellowship.

Cost sharing for grant proposals takes many forms and is provided by the organization requesting the funding. It can involve the provision of cash as well as in-kind resources such as space as well as personnel time committed to the project but paid by other resources from the submitting organization. In some cases, funding organizations require a one-to-one cost share. That is, for every dollar provided by the funder, the receiving organization that submitted the proposal must provide a dollar as well, either cash or in-kind.

The problem with this approach is that organizations having relatively limited resources are disadvantaged owing to their associated inability to provide cost sharing, thereby resulting in an unlevel playing field across the research enterprise. This is especially concerning to MSIs and ERIs as they seek to become more active in externally sponsored research and creative activity. NSF, which funds the bulk of nonmedical curiosity-driven research in the US, prohibits cost sharing in all but a few specific programs for which such sharing is foundational to programmatic goals. In this manner, NSF allows all organizations an equal opportunity to seek funding for research. Unfortunately, although it was hoped other agencies would follow NSF's lead, none have.

All of the aforementioned budget items (table 6.2) are lumped into a category known as *direct costs*. That is, they represent costs tied directly to and enumerated specifically within the project being proposed. However, the costs of performing research extend well beyond direct costs.

For example, if the PI on a grant proposal is a faculty member, their position relies on their institution's payroll services and benefits offices. Their institution also supports recruiting and placement services for undergraduate and graduate students, which is extremely important when such individuals are funded on external grants. Additionally, buildings housing research personnel must be maintained, utilities must be paid, the central library must be supported, buildings and equipment must be depreciated, and other administrative services, such as those supporting proposal development and grant management, must be funded.

Because these costs cannot easily be linked to a given project (imagine trying to estimate how much electricity usage to charge to a project that shares space with many other projects), they are called *indirect costs*. The more accurate and appropriate term is *facilities and administrative costs* (referred to as F&A; table 6.3). They represent real costs associated with performing research, and in most cases are charged as a percentage of the total grant proposal budget (see below) irrespective of the nature of the project. The percentage is set by federal agencies—which is an important point I return to below—and reflects an aggregation of sponsored program activities across an institution, updated every few years.

Table 6.3

Breakdown of F&A for academic research assistance awards

Category	Description
Facilities	<p>Building depreciation: expenses associated with university-owned buildings, including the expense associated with federal contributions to those buildings.</p> <p>Equipment depreciation: expenses associated with university-owned capital equipment, including federal contributions to such equipment.</p> <p>Interest: interest associated with external debt financing of building acquisition and construction or renovation, less interest income earned on debt proceeds.</p> <p>Operations and maintenance: utilities, janitorial services, and ongoing repair and maintenance of university-owned and leased buildings.</p> <p>Library: operational costs of the university's library system excluding rare books but including staff.</p>
Administration	<p>General administration: payroll, executive and administrative offices, human resources, accounting, etc.</p> <p>Sponsored project administration: offices and personnel responsible for administering sponsored project activity.</p> <p>Departmental administration: administrative costs for each college and departmental or school.</p> <p>Student administration and services: costs associated with supporting students, such as the office of student affairs.</p>

F&A is a somewhat controversial and confusing concept for a variety of reasons, and as a next-generation researcher, it is important for you to understand and be able to defend the F&A concept.

The first point of confusion exists because the costs associated with F&A often are incorrectly equated with profit by analogy to private companies.³ Such is not the case. F&A represents real costs that must be paid by universities and other organizations receiving grant funding to support the associated research. Unfortunately, some federal agencies set arbitrary limits on how much F&A can be included in a grant proposal, which means the institution receiving the funding has to make up the difference (a form of cost sharing). This is ironic because the federal government determines the F&A percentage allowed to be charged by the institution in the first place. This difference, known as unrecovered F&A, amounts to several billion dollars per year and represents a significant financial burden to institutions, especially because the administrative component of the F&A rate (table 6.3) has been capped since 1991. Although most private foundations do not allow the full amount of F&A to be charged to a grant proposal budget, they utilize other approaches in the budget to account for at least some of the costs.

A second point of confusion regarding F&A concerns how it is applied in a grant proposal budget. Without getting too far into the weeds, which is something you should do as part of the exercises at the end of this chapter, F&A is charged as a percentage of the cumulative costs of a proposal (i.e., the direct costs noted previously). More specifically, the federal government assigns an F&A *rate* to funding recipient institutions, such as a university, every few years. To compute the *total budget* of a grant proposal (direct costs plus F&A), one multiplies the direct costs by the F&A *rate* and adds that sum to the *direct costs* to obtain the *total budget*.

For example, suppose the direct costs⁴ of your proposal are \$100,000 and the F&A rate at your university is 50 percent. The total budget of the grant proposal therefore is $\$100,000 + \$100,000 \times 0.50 = \$150,000$. Many individuals, especially lawmakers, incorrectly assume that a 50 percent F&A rate means one-half of the total budget is allocated to F&A expenses (table 6.3). Our example clearly shows this is not the case. Rather, a 50 percent F&A rate means that one-third, not one-half, of the total proposal budget is allocated to F&A.

F&A rates at institutions can vary from 25–30 percent to more than 80 percent, depending upon the nature of the institution, its research portfolio, and facilities and other resources. University faculty almost uniformly, and understandably, prefer low F&A rates because this allows them to allocate more money in a proposal budget to supporting direct project costs (e.g., students, equipment, travel, supplies).

When a grant proposal is funded, it becomes an award issued to the organization that submitted it—and that award can take many forms, such as a grant or contract. This leads to a final confusing point about F&A.

When research on an award begins and money is expended, the award recipient, such as a university, actually pays F&A up front, out of its own coffers. When award money is sent to the university by the funding organization, the F&A is thus reimbursed to the university. Consequently, this reimbursement can be used for items such as equipment, personnel, faculty start-up funding, internal incentive programs, and buildings, provided appropriate policies and laws are followed. Yet some, especially lawmakers and policymakers, have the mistaken impression this reimbursement has to be used directly to pay for items composing F&A, such as the library, building depreciation and maintenance, and personnel services. Such is not the case. Although this topic seems a bit esoteric, it is extremely important, and because of it, billions of dollars are at stake.

To illustrate the confusion, suppose you wreck your car and your insurance company agrees to buy you a new one. You purchase a new car using money from your savings account, and then a few weeks later, a check arrives in the mail, from your insurance company, in the amount of the car you just purchased. Instead of depositing this check in your savings account to replace the money you withdrew to purchase the car, you take a cruise with it instead. Have you defrauded the insurance company? Of course not! The insurance company simply reimbursed you for costs you already paid, and you therefore are free to use that reimbursement for anything you wish, so long as you don't break the law in doing so. F&A reimbursement works in exactly the same manner.

6.3 Proposal Submission and Evaluation Processes

When all components of a grant proposal (table 6.1) are complete—which, in addition to the aforementioned items, often includes documentation by the submitting organization of institutional conflicts of interest (section 10.2), lobbying certification, drug-free workplace policies, and a research security (section 10.3) program as appropriate—the proposal package is formally submitted. In almost all cases, the submission is performed electronically, with a variety of automated checks to ensure completeness. Only a limited number of individuals at academic institutions are allowed to submit proposals, usually the senior research officer or their designees, because doing so formally obligates the institution, and thus its governing board (section 1.6), to the terms and conditions of the funding organization.

Exceptions do of course exist, especially for faculty, graduate student, and postdoctoral fellowships, where the grant funding is provided directly to the

individual and not the institution. A good example is the Fulbright Fellowship. However, most institutions encourage researchers to process such submissions through the office of sponsored programs so the academic unit of the submitter is aware of the activity. This is important because, in some cases, cost sharing will be required, and as noted previously, deans and department chairs do not appreciate being surprised when asked to provide such funding without prior notification or approval!

Once a grant proposal arrives at the funding organization, what happens to it? Irrespective of whether the organization is a federal agency, a nonprofit foundation, a private company, or some other entity, the proposal is evaluated, often against others of a similar nature in competition with one another. The process of evaluation depends upon a number of factors, including but not limited to the nature and structure of the funding organization and the specific announcement of opportunity or solicitation. In almost all cases, the merit of the work being proposed is judged against very specific criteria, and thus the process is known as peer/merit review (chapter 7). As noted previously, curiosity-driven research tends to be evaluated principally on the creativity or intellectual merit of the idea and the broader impacts of the work (discussed below), whereas applied research and development are evaluated not only on the idea and approach, but also the manner in which the work meets specific programmatic or mission requirements of the organization requesting or funding the work.

For most US federal agencies, impacts broader than those associated with the work being proposed are included as a review criterion, and therefore are known as broader impacts. This includes but is not limited to promoting teaching, training, and public education, broadening the participation of traditionally underrepresented and underserved populations, and enhancing infrastructure for research and education.

The review process itself also is highly variable (chapter 7), including the time elapsed from proposal submission to funding organization decision. In some federal agencies, such as NSF and NIH, review involving peer researchers is utilized. In this so-called peer review, researchers anonymously evaluate each other's proposals, either individually or in panels, and make recommendations to the funding organization. Ranking often is involved.

At NSF, a five-part scale is used, with program officers having considerable discretion in funding proposals based upon peer reviewer guidance. This discretion is valuable because, for some research which potentially is transformative and could overturn established paradigms and knowledge, great skepticism may exist on the part of the reviewers. Yet, funding such proposals is a necessary part of research to ensure that even seemingly far-fetched ideas

are given a chance, especially if the outcomes could have a significant societal impact.

NIH uses a quantitative system of scoring in which agency program officers have comparatively less discretion. The “payline” of reviewed submissions separates proposals to be funded from those that will not, and usually is applied quite stringently. This too is an appropriate strategy.

The review process at NEA follows a similar process (see chapter 7 for details), except that once the panel review is complete, its recommendations are forwarded to the National Council on the Arts, which then reviews the recommendations in a session open to the public. The chairman of NEA makes the final decision. Although NSF functions in a similar manner through the panel stage, all reviews remain confidential unless released by the PI, and all associated discussions bearing on the decision likewise are confidential (though as noted in chapter 7, the process is periodically reviewed by outside experts to ensure integrity exists throughout the entire process). The processes of other organizations, public and private, may be found on their respective websites.

Although the US proposal merit review system is the gold standard of the world, it contains inherent challenges because it relies on personal and professional judgment. One important challenge is reviewer bias. Various studies have shown that bias, even unconscious bias, exists in the merit review process. Sometimes it is manifest as gender bias while in other cases, it is based upon the names of investigators or even the size and name of their institution. Fortunately, training is available to mitigate many forms of bias, and organizations that fund research and creative activity increasingly are employing it. Yet, more needs to be understood before bias is minimized or eliminated completely. Bias is discussed in greater detail in chapter 8.

The merit review process necessarily considers the proposal budget as a means for determining whether sufficient funding (or too much) has been requested to complete the work proposed. However, the budget itself rarely makes or breaks the final funding decision, which as we have seen is based principally upon intellectual merit or meeting the needs of the funding organization. Once merit has been evaluated, the funding organization may request changes in the budget. If such changes are sufficiently large in terms of reductions (rarely is the budget requested to be increased), the project may need to be reduced in scope to accommodate the smaller funding level.

If the reviews of a proposal are less than stellar and the proposal is not selected for funding, one should not despair! The success rates of competitive research grant proposals range from the single digits in some parts of federal agencies to around 25 or 30 percent in others. Percentages also vary widely for private companies and foundations. This means one needs to keep trying,

using reviewer comments to improve the proposal (see chapter 7) so that, in the process, the PI and others involved become better at developing their ideas and communicating them effectively in proposals. First-time investigators may need to submit a proposal multiple times, or submit multiple proposals on different topics, to be funded. Once an award is made and the work produces important outcomes, a track record is established that will improve one's competitiveness next time. Perseverance is the name of the game!

6.4 Managing a Research Project

If you are fortunate enough to receive funding for a grant proposal as the PI, you now enter a new realm of responsibility as the project director (PD). In this role, you not only are responsible for making sure the entire project succeeds (e.g., that research is proceeding as planned, communication is effective, collaborations are healthy, students are being advised and mentored appropriately, outcomes are being communicated, and the overall research environment is diverse, inclusive, welcoming, and free from bias and harassment), but you also are legally responsible for making sure all applicable rules and laws are followed. This includes rules for spending money, hiring and evaluating personnel, making purchases, and reporting progress to the funder and perhaps your own institution. It also includes following rules related to involving human subjects and animals in research, the use of select agents, carcinogenic chemicals, and certain strains of bacteria, and the use of items that cannot be accessed by certain persons, or removed from the country, without appropriate licenses owing to export control rules and regulations (chapter 10). See Burroughs Wellcome Fund & Howard Hughes Medical Institute (2006) for practical guidance. It is important to keep in mind that, although funding usually does not go to the PI directly—in the case of a university, for example, it goes to the institution—the PI is *personally responsible*, from a legal standpoint, for all aspects of the project.

Fortunately, most institutions have resources to assist with virtually all of the compliance topics just mentioned, and then some. For those which do not, options exist for needs to be met and it is up to the researcher to identify and take advantage of them.

On the brighter side, research projects yield a wide array of outcomes in the form of reports, refereed publications, performances, exhibitions, technologies, processes, algorithms, software, lectures, and engagements with K–12 education and the public that are both very important and personally fulfilling. Indeed, the main purpose of research and creative activity, as noted in chapter 1, is to add to the body of existing knowledge. As also noted in chapter 1, fundamental or curiosity-driven research results may not yield practical benefits for

years or decades, yet they nevertheless are important as the foundation for future research and innovation and improving quality of life.

As a researcher, it also is important for you to convey the purpose and value of your work beyond formal mechanisms within the research community; that is, to nonexpert audiences (chapter 11). Doing so is not an easy task because of the highly specialized nature and distinctive attributes of today's disciplines, and their use of terminology unique to the work within them. Numerous resources are available to assist you (e.g., those at the Alan Alda Center for Communicating Science [<http://aldacenter.org>]) in learning how to explain your work to nonexperts in venues such as public lectures, TED (Technology, Entertainment and Design) talks, interviews, social media, visits with lawmakers, and presentations to civic organizations. Such outreach is extremely important so those not involved in research, or in your area of expertise, understand its value and appreciate the need to support it.

For most individuals having a career in research, landing a grant or contract is only the beginning. In the midst of an existing project, it is important to look over the horizon and begin thinking about the next proposal or set of proposals. Most grants and contracts last only a few years, and that time frame usually is insufficient for answering all of the questions associated with a problem you wish to solve or an idea you wish to explore. And in most cases, it is not sufficient to fund a graduate student through their entire degree program.

Thus, even before one grant is finished, work needs to begin on new proposals either to continue or extend the work now underway, or to explore new ideas. Those funded entirely on research projects cannot, of course, plan their lives on a two- or three-year cycle of known salary, and thus continuity is important to keep a research program going and in fact to grow it over time. Consequently, it is important for you, as a researcher, to focus not only on the next grant or contract, but also on the long view of what you wish to accomplish, say over a period of ten to twenty years. In that manner, proposals serve as mechanisms to achieve intermediate goals without losing sight of one's overall dreams to understand the world in which we live.

Assess Your Comprehension

1. What is a principal investigator on a grant proposal?
2. Writing a grant proposal is valuable for a number of reasons. List and describe several of them.
3. List and describe several components of a research proposal budget.
4. What is the mutuality of interest principle and what is its relevance to grant proposals versus contracts?

5. Describe cost sharing and the forms it can take in grant proposals.
6. How can cost sharing create inequity in the research enterprise?
7. What are facilities and administrative costs (F&A) in a grant proposal?
8. List the two categories of F&A and some of the items contained within them.
9. Why is F&A controversial and often misunderstood?
10. What is peer review?
11. What should you do if your research grant proposal is not funded the first time?
12. What are some of the key responsibilities of a project director in overseeing a grant proposal once it is funded?

Exercises to Deepen Your Understanding

Exercise 1: Using the <https://www.grants.gov> website, compare and contrast proposal structure and submission requirements in calls for proposals—in your field of study or fields of interest to you—for any of the following federal agencies: National Science Foundation (NSF), National Institutes of Health (NIH), National Endowment for the Arts (NEA), and National Endowment for the Humanities (NEH). Discuss the range of requirements with regard to content, format, and merit review process and criteria, and suggest ways in which these funding organizations might modify their requirements to improve their processes and reduce administrative workload of principal investigators.

Exercise 2: Follow the instructions in exercise 1, though now applied to a few private nonprofit foundations. Also, describe the manner in which such foundations differ from federal agencies in all of the attributes noted above. Lists of foundations can be found online, and one particularly useful source is the Open Education Database (https://oedb.org/ilibrarian/100_places_to_find_funding_your_research/).

Exercise 3: Using the <https://www.grants.gov> website, compare and contrast cost-sharing requirements in calls for proposals—in your field of study or fields of interest to you—for any of the following federal agencies: NSF, National Aeronautics and Space Administration (NASA), NIH, US Department of Energy (DOE) Office of Science, National Institute of Standards and Technology (NIST), NEA, and NEH. Discuss the range of cost-sharing requirements and the extent to which you feel such sharing may limit or disincentivize participation by certain organizations and individuals, (e.g., institutions having smaller budgets and less flexibility in discretionary funding). What policies might you suggest to create a more level playing field?

Exercise 4: In the link below, you will find a research project description and associated budget and budget justification for an NSF Early Career proposal, courtesy of Professor Ankur Desai at the University of Wisconsin-Madison. Using this material as an example from which to learn, develop a budget and associated justification for the project you outlined in exercise 4 of chapter 2. Include items in all relevant budget categories and assume the F&A rate is 60 percent of modified total direct costs. Once you complete the form, answer the following questions:

- How does the bottom-line budget figure change if the facilities and administrative costs (F&A) rate is only 50 percent? 10 percent?
- Do you understand why some agencies limit the F&A rate?
- Do you understand why some researchers protest F&A, or want substantially lower rates, even though it is a legitimate and necessary cost for performing research?
- Suppose you are told by the funding organization that you must reduce your budget by 30 percent. Where will you impose cuts, and how did you make those decisions? What impacts will those cuts have on the project goals/scope?

Project summary: https://mitp-content-server.mit.edu/books/content/sectbyfn/books_pres_0/14740/Career-Summary.pdf

Project budget and justification: https://mitp-content-server.mit.edu/books/content/sectbyfn/books_pres_0/14740/Career-Budget.pdf

Exercise 5: F&A is not well understood by many people, ranging from faculty to members of Congress. As a result, every few years, proposals are put forward to modify how F&A is computed, cap it, or restructure the reimbursement system entirely. For this exercise, examine the history of F&A and identify key points of controversy around it. Utilize congressional hearings, reports, and media to form your own opinion about the role of F&A in America's research enterprise and steps that might be taken to clear up the confusion around it. In your search for references, note that F&A also is known as overhead and indirect costs.

Exercise 6: Contact your office of sponsored programs, which typically resides within the office of the vice president for research or vice chancellor for research, and tell them you wish to experience the process associated with submitting a fictitious grant proposal to a federal funding agency as a means for preparing yourself to submit an actual proposal in the future. If your university has no such office, speak to your advisor, department chair, or dean to determine the appropriate office to engage. Select a federal agency

relative to your area of research or creative activity, visit their website to evaluate procedures for submitting a proposal, and then develop a blank, mock proposal containing the necessary sections and work your way through the process used at your institution. Be certain to ask your office of sponsored programs about available training aids, such as videos or short courses, to assist your learning about institutional and agency processes. What surprised you the most about the overall experience? Did you find helpful the assistance provided by your institution? What changes would you suggest to improve the experience?

Exercise 7: Working with a faculty mentor, select an appropriate external funding source for your research and develop a sample proposal by following the guidelines on the source's website. This is a considerable task for which you should allocate several weeks of time. You may wish to complete only parts of the required sections (e.g., project summary, project description, budget, budget justification, facilities required, qualifications of the investigator[s]) to get a flavor of what is required and the writing style to be used. Note that many funding organizations provide sample proposals from which you can learn.

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