Rank your response to each question from 1 (low) to 5 (high). Beside each, write a brief statement explaining the reason for your ranking and/or the effect of that element on the presentation.

1. Was the type of presentation appropriate and effective?
2. Was the length of the presentation appropriate? Were time limits adhered to?
3. Was the rate (speed) of delivery effective?
4. Did the introduction establish an adequate context?
5. Was the presentation well organized?
6. Was the conclusion effective in emphasizing the major point of the presentation?
7. Was there sufficient (and direct) eye contact?
8. Did the speaker:
   - Speak loudly enough?
   - Vary pitch (intonation)?
   - Use voice to emphasize important points?
9. Was body language purposeful and appropriate?
10. Were hand gestures meaningful and appropriate?
11. Were visuals:
    - Appropriate (to the content, purpose, and method of presentation)?
    - Independent (adequately labeled)?
    - Interdependent (referenced and used in the presentation)?
    - Well designed and professional in appearance?
    - Informative?
12. Was the medium for the visuals (PowerPoint slides, etc.) used effectively?

FIGURE 6.7 Criteria for evaluating conference presentations.

CHAPTER 7

Writing Research Proposals

7.1 The Role of the Proposal in Science

As is no doubt clear by now, the quest for research funding is a central activity in science. Just as journal editors and conference organizers exert control over what information is made available to the community, so funding agencies influence what kinds of research are undertaken in the first place. Berkenkotter and Huckin (1995) illustrate the interrelationships of these gatekeeping processes in a diagram we've reproduced in Figure 7.1. As the diagram indicates, peer review plays a critical role in funding decisions, just as it does in decisions about the publication of journal articles. We saw in Chapter 1 that in denying funding to cold fusion researchers, the U.S. Department of Energy dealt a blow to ongoing investigation in the United States as well as the credibility of the research. Because these all-important decisions are based on reviewers' assessments of the quality and persuasiveness of the proposal document, many scientists consider proposal writing the most important writing they do.

Like the professional associations that sponsor journals, funding agencies have specific interests; most will accept proposals only on specified topics and may limit their funding to projects with certain types of applications (e.g., industrial, educational, or environmental). Consider, for example, two proposals written by the Burkholder team for their research on toxic algae, both of which were awarded funding. One proposal, for basic research on the algae's place in the estuarine food web, was submitted to the National Science Foundation's Biological Oceanography division. Another proposal described a more applied project, the development of gene probes to help detect the organism in water samples. This project (included in Chapter 10) was submitted to the National Sea Grant College Program in response to a specific call for proposals in the area of marine biotechnology. Before sitting down to write a proposal, researchers select

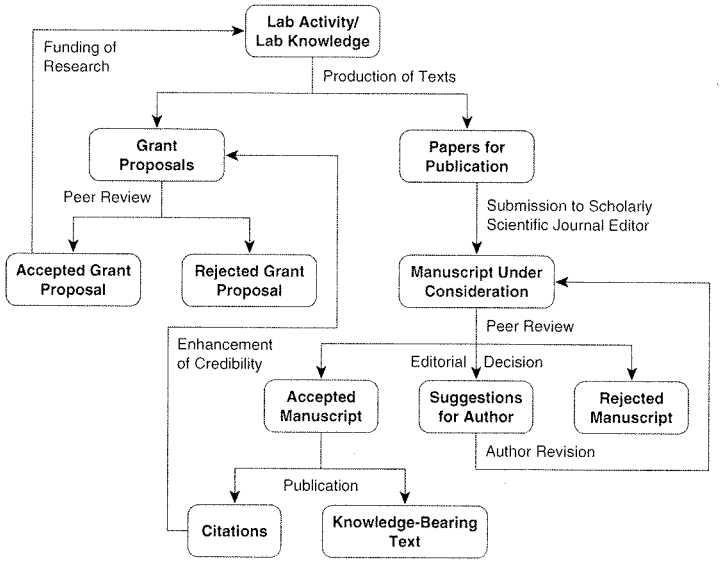

FIGURE 7.1 Life cycle of lab knowledge in scientific publication system, from Berkenkotter and Huckin (1995, p 62).

a target agency carefully and become thoroughly familiar with its funding history and preferences. In this chapter we'll take a close look at how scientists create proposals to address their target agencies' interests as well as their own research agendas.

Throughout this book we have taken the position that scientific texts are not just informative but also persuasive documents. This persuasive dimension of scientific discourse is nowhere more obvious than in the research proposal. When writing reports and journal articles, researchers present and defend a particular interpretation of the prior research, of their new findings, and of the relationship between the two; the research report aims to convince readers that the work is valid and important. When submitting a grant proposal to a potential funding agency, however, the researchers must go a step further. Now they must convince readers not only that the work will be valid and important but also that the readers should pay for it!

In a classical rhetorical framework, the proposal may be classified primarily as a *deliberative argument*. Aristotle distinguished three types of argument: forensic, epideictic, and deliberative, which can be described as arguments of fact, of value, and of policy, respectively. Most types of writing contain elements of more than one argument type. In research reports the overriding goal is forensic: the authors try to convince readers to accept a set of "facts"—the results of their study. However, because the introduction and discussion sections assess the current state of knowledge, and argue at least implicitly about the value and limitations of that knowledge, the report has an epideictic dimension as well. And the discussion section's recommendations for future research or policy are deliberative. Similarly, the research review serves a forensic function in that it presents a summary of previous research, but its implicit goal of identifying those studies that are most pertinent or valuable to the field's understanding entails an epideictic dimension. The proposal is distinguished from both these genres in that, although it too contains forensic and epideictic elements, its purpose is primarily deliberative: the proposal argues for a specific research plan as well as a general research direction.

The stakes become clear when we think about the number of scientific questions that could potentially be explored; the amount of time, effort, and money that would be needed to support all these explorations; and the resources actually available for scientific research. The National Science Foundation funds roughly one-quarter of the 40,000 proposals it receives each year (NSF 2008a). The success rate is slightly lower at the National Institutes of Health, which funded 10,100 or 21.3 percent of the 47,455 proposals received in 2007 (USDHHS 2008). The proposal document plays a critical role in how these scientific resources are allocated.

Research proposals are written for a variety of audiences and purposes in science: they are submitted to funding agencies to solicit financial support for new research, to academic departments to request approval of dissertation projects, to research facilities to gain access to equipment and resources, and to other parties whose approval must be secured for research to proceed. For example, in Chapter 11 we have included the brief proposal that Jelle de Boer and John Hale sent to the Greek government to request permission to remove rock samples from the ancient site at Delphi. Though the present chapter will focus primarily on proposals for research funding, the goal in addressing any of these proposal audiences is to convince the relevant gatekeepers that a particular problem is significant enough to justify the costs and consequences of exploring it, whether those costs be in terms of money, time, or risks to participants or resources. To succeed, a research proposal must present a well-reasoned and carefully documented argument that persuades its decision-making audience that the potential benefits of the research outweigh the costs.

The U.S. Department of Energy's grant application guidelines summarize the content of the proposal as follows:

> The application should present the objectives and scientific significance of the proposed work; the rationale for selecting the proposed approach to achieve the objectives; qualifications of the principal investigator and the applicant organization; and amount of funding required. Since the application will compete with others on related topics…it should present the scientific merit of the proposed project clearly and convincingly and should be prepared with the care and thoroughness of a paper submitted for publication. (DOE 2008)

This definition highlights the two primary persuasive goals of the research proposal:

- To convince your scientific audience that the problem you propose to investigate is important and worth exploring
- To convince them you will explore the problem in a sensible way

Thus, your proposal must convince readers not only that the research problem is significant but that your research approach is likely to succeed. Proposal reviewers will need to ascertain whether the methods you propose to use represent the most efficient and most worthwhile use of their agency's resources. They also will need to determine whether you are well qualified for the job. Funding agencies will request a description of your track record as part of the grant application, usually in the form of a *curriculum vitae*, an "academic résumé" that lists your research training and experience. But this ancillary material comes later in the application package; it is not the primary focus of readers' attention as they read and evaluate your project description. The text of the proposal itself also must demonstrate that you know what you're doing.

Recall that a text creates a professional *ethos*; it projects a character. Readers will form an impression of you based on the competence revealed in your proposal: Does your review of research demonstrate a thorough knowledge of the field? Have you exercised good judgment in the design of the study and the choice of materials and procedures (and are you therefore likely to exercise good judgment in other phases of the study, such as in recording and interpreting data)? Does your description of methods demonstrate the technical competence needed to carry out the project effectively? Thus, while your proposal contains an explicit argument for the importance and validity of the study and its design, it also contains an implicit argument for your own research competence (Myers 1985). It is important to note that even superficial features of your presentation may enhance or detract from the professional *ethos* created in the proposal. The NIH cautions that "Your presentation can make or break your application. Though reviewers assess science, they are also influenced by the writing and appearance of your application. If there are lots of typos and internal inconsistencies, your score can suffer" (NIAID 2008a; http://www.niaid.nih.gov/ncn/grants/cycle/part04.htm).

EXERCISE 7.1

Read De Boer and Hale's proposal to the Greek government to remove samples of stones from Delphi, (p 324–325). In granting permission for this project, Greece's Ministry of Culture specified three conditions: (a) the size of the rock samples is 15 centimeters, and samples will be taken from areas already excavated; (b) the samples "will come under the supervision…of the Ephoreia for Prehistoric and Classical Antiquities in a timely manner"; (c) the results "will be made known to the Ephoreia and to the Conservation Authority for their archives" (Hellenic Ministry of Culture 1997). From the government's standpoint, what are the costs of allowing this research to proceed? What are the potential benefits? Where and how do De Boer and Hale address these costs and benefits in their short proposal?

EXERCISE 7.2

In Chapter 12 we have included a proposal that Stephen Reynolds and colleagues submitted to NASA's Chandra Observatory Research Program (p 358–365). Read this proposal, paying special attention to the *ethos* it projects. What clues are there to the authors' experience and expertise? What have you learned about the researchers themselves from reading their proposal?

7.2 Multiple Audiences of the Proposal

Most granting agencies use peer-review mechanisms that are similar in principle to, though typically more elaborate than, the peer-review systems used by journal editors. Because most agencies fund research in many different areas and must allocate the agency's resources among these areas, the typical proposal document is reviewed by in-house "generalists" as well as outside specialists and thus must be comprehensible and persuasive to a broader range of readers than is typical for journal articles. In-house reviewers are program officers and other agency staff who read proposals from a number of related topic areas; though educated scientists, readers at this level are not likely to be specialists in the particular topic area of a given proposal. The in-house readers will solicit reviews from specialists in pertinent scientific communities, as many as 3–10 in the case of the National Science Foundation (NSF 2008d).

The logistics of the proposal review process vary from agency to agency. NIH, for example, incorporates outside reviewers through a system of review groups and study sections (CSR/NIH 2008). Grant applications received by NIH's Center for Scientific Review are first read by a CSR Referral Officer, who assigns the proposal to an Integrated Review Group (IRG) in an appropriate research area. The IRG assigns it to one of its study sections, consisting of 20 or more outside experts. Each proposal is reviewed by three study section members, who lead discussion of that project when the study section holds its two-day review meeting. (See http://cms.csr.nih.gov/ResourcesforApplicants/PolicyProcedureReview+Guidelines/OverviewofPeerReviewProcess/ for a full description of this process.) In this first stage of review, panels are charged with evaluating proposals for scientific and technical merit. In a second review stage, the study section's recommendations are summarized and sent to the appropriate NIH institute or center where they are evaluated in light of the institute's program goals and priorities. NIH's standing review groups include representation from a fairly wide range of fields, which underscores the importance of pitching a proposal at a more general level than is necessary for journal articles and other technical reports. As a case in point, a study section on AIDS-associated infections and cancer includes members representing departments of genetics, pathology, veterinary molecular biology, infectious diseases, biochemistry, pediatrics, and other areas (CSR/NIH 2006). Given the size of these groups and the breadth of expertise represented, NIH's Institute of Allergy and Infectious Diseases (NIAID) urges researchers to keep in mind that the application "has two audiences: a small number who are likely to be familiar with your techniques or field and the majority who are not" (NIAID 2008a).

In sum, research proposals will be read and evaluated by readers with varying types and degrees of experience and expertise, some of whom will know more about your research topic than will others. This multiplicity of audiences clearly complicates the writing process, for the proposal must address all these readers at once. Given the variety of audiences to be addressed and the multiple agendas to be accomplished, writing the research proposal is one of the most challenging—and most important—tasks scientists engage in.

EXERCISE 7.3

Choose a research topic in your field and identify a funding agency likely to support research in this area. (Review Exercise 5.2, page 134 on identifying topics.) Obtain a copy of the agency's proposal guidelines. In most cases, guidelines and calls for proposals will be posted online. For example, visit NSF at http://www.nsf.gov/funding/, the NASA funding site at http://nspires.nasaprs.com/external/, or the Department of Energy at http://www.science.doe.gov/grants/. Or, visit Grants.gov, a federal clearinghouse established in 2002 that provides access to information about more than 1000 grant programs across federal agencies (http://www.grants.gov). Once you've located the guidelines, find the section(s) that describe the review or evaluation process. Based on this information, write a paragraph describing the mixed audience for a proposal on your topic and your readers' likely areas of expertise. Follow this with a paragraph describing ways in which you might adapt your proposal for those readers.

7.3 Logic and Organization in the Research Proposal

Whether you are responding to a specific request for proposals or submitting an unsolicited proposal to a general program, your proposal must meet the specific guidelines established by your target funding agency. In addition to examining the main argument or project description, funding agencies will request an abstract or summary, a table of contents, a complete budget, biographical information about the investigator(s), and other supporting material pertinent to the type of research being proposed, for example, information about the treatment of laboratory animals, the protection of human subjects' rights and confidentiality, the handling of hazardous materials and other worker and environmental safety issues, or provisions for sharing research data. The scope, form, and ordering of these ancillary materials will vary across research fields and funding agencies.

The components of the main argument in a proposal are, however, fairly consistent. All proposals are designed to do the following:

- Introduce the purpose, significance, and specific objectives of the proposed research.
- Explain the background and rationale for the project by surveying previous research, summarizing the current state of the field's knowledge on the topic, and showing how the proposed project will further that knowledge.
- Describe the methodology to be used in the proposed study, and explain the rationale behind these methodological choices.

Where these goals are accomplished in the proposal document will differ from one proposal to another. For example, in their Sea Grant proposal to develop gene probes to detect *Pfiesteria* (Chapter 10; see Table of Contents, p 285), Burkholder and Rublee combine their introduction and background under one major heading and describe their research objectives in a separately labeled section for that purpose. Reynolds and colleagues, in a proposal to the *Chandra* guest observer program (Chapter 12), embed their background discussion in subsections under the "Introduction" heading, with objectives discussed more explicitly with an overview of methods in Section 2., "Summary of Proposed Work." Their proposal also includes a separate "Technical Feasibility" section in response to the specific information needs of the *Chandra* program. Burkholder and Rublee have divided their extensive methodology section into seven subsections describing the different elements of their research design. The arrangement and labeling of sections and subsections in a proposal will depend in part on your funder's guidelines but also on your own writing style and the nature and logic of your research topic.

7.4 Introducing the Research Problem and Objectives

In some respects, the proposal introduction is similar in structure and content to the introductions found in most research reports. The three moves Swales (1990) observed in report introductions provide a useful heuristic for proposal introductions as well (see Figure 4.3, p 99). In both the report and the proposal, your goals are to introduce the research topic; identify the research gap, question, or problem that motivates the study; and announce the purpose of the study.

But within this general framework, emphasis and development may differ considerably in the two genres, due to the different audiences these texts address and the purposes for which they are written. In the research report, the introduction serves to quickly establish the context for the study and announce its purpose. Unless you are writing for a multidisciplinary journal such as *Nature* or *Science*, the journal audience consists of specialists in your field, and the stance is one of expert to expert; you are reminding fellow marine biologists or physicists or pathologists of the state of the field's knowledge on your topic, showing them which specific issues or previous findings you consider most pertinent to your study, and highlighting the gap your study responds to. In other words, you are guiding them through a review of information that is at least generally familiar to them, refocusing the discussion to situate the new results you are reporting. Because most of your report audience shares your specialized knowledge to some extent, this review can be accomplished rather quickly, sometimes in a single paragraph.

The proposal, however, carries a greater burden of proof and must therefore provide a more fully elaborated introduction to the project at hand. We noted in

Section 7.2 that proposal readers are a diverse group, including specialists in your field and "generalists" with other areas of expertise. The significance of your line of research will not be obvious to all the members of this group; therefore you will need to make a stronger case than would be necessary in a journal article. Some of your proposal readers will also need to be educated about the general topic before they can make an informed judgment about the merits of your project. Lastly, keep in mind that you are asking more of your proposal readers than of a journal audience—you're asking them not just to entertain your ideas but to invest in them.

Thus, one of the primary goals of the proposal is to convince this audience of the significance of the proposed work. It will not be enough to assert that a problem exists, or that a question has not been answered. The researcher must convince proposal reviewers that the problem is important enough to spend money on, that answering the question will be worthwhile. What readers consider "worthwhile" will be largely a function of the goals and priorities of the agencies they represent. Just as research journals differ with respect to the topics and types of research they are interested in publishing, funding agencies also have distinctive research agendas and preferences. The first step in writing a successful proposal is to choose an appropriate agency to submit it to.

A funding agency's general priorities are well known to experienced researchers in the field, but they are also explicitly stated in the agency's proposal guidelines or requests for proposals (RFPs). Most funders accept proposals in their areas of interest on an ongoing basis but also issue RFPs to solicit proposals on particular topics for which they have set aside special funds. (The NIH uses the term *RFA*: request for applications; NASA uses *NRA*: NASA Research Announcement.) RFPs typically announce a new initiative in a carefully delimited research area. Researchers responding to RFPs must demonstrate that their proposed research fits within these parameters and will significantly further the announced goals. For example, Burkholder and Rublee's proposal in Chapter 10 was submitted in response to an RFP from the National Sea Grant College Program soliciting proposals for research on marine biotechnology. We have reproduced sections of the RFP on pages 278–281. The need for this type of research and thus the rationale for this RFP are clearly laid out in the document's "Background" section:

> A national commitment to research and development in marine biotechnology will help respond to societal needs by (1) increasing the food supply through aquaculture, (2) developing new types and sources of industrial materials and processes, (3) opening new avenues to monitor health and treat disease, (4) providing innovative techniques to restore and protect aquatic ecosystems, (5) enhancing seafood safety and quality, and (6) expanding knowledge of processes in the world ocean. (See p 279.)

Throughout their proposal, Burkholder and Rublee carefully explain how their research will address goals in this list, culminating in their final "Application" section, which states these connections directly: "This work, addressing several key targets identified by a national Sea Grant initiative for research in Marine Biotechnology, will yield applications of both immediate and long-term value" (see p 302). The section then proceeds to summarize the project's projected implications for improving the safety of aquaculture facilities and processes, for safeguarding human health, and for assessing environmental quality in natural estuarine ecosystems—all critical concerns expressed in the RFP.

As this example illustrates, successful proposal authors leave nothing to chance. In discussing the significance of their research, they carefully highlight the specific ways in which the proposed work will further the goals and interests of their target funding agency. In so doing, the researchers are appealing to the agency's *values*. The appeal to values is one type of classical rhetorical argument. Aristotle described three types of rhetorical appeals: those based on the logic of the subject matter (*logos*), those based on the character of the speaker (*ethos*), and those based on the emotions and values of the audience (*pathos*). Most arguments contain all three types of appeal, and each can clearly be seen in the proposal genre: successful proposals present a logical, well-supported line of reasoning; project a professional *ethos* of competence and knowledgeableness; and clearly address the values and concerns of the funding agency.

These values are both articulated and implied in the RFP or proposal guide. Each agency has a fairly well-defined research domain that gives it a distinctive character or identity. For instance, the NSF was initially established in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense..." (NSF 2008e). The agency describes itself as "the premier Federal agency supporting basic research at the frontiers of discovery, across all fields, and science and engineering education at all levels" (NSF 2006). This concern with the nation's science infrastructure and education is revealed in a number of critical places in the NSF Grant Proposal Guide, most notably in the discussion of review criteria. NSF's two primary review criteria place as much emphasis on the development of infrastructure and dissemination of results as on the intellectual merit of the proposed research (see Figure 7.2).

A funding agency's values may also be revealed in the diction or word choice of other sections of their proposal guide. For example, an examination of NSF's description of who is eligible to submit proposals also clearly underscores the agency's stated mission. Go to the NSF's Grant Proposal Guide at http://www.nsf.gov/pubs/policydocs/pappguide/nsf08_1/gpg_1.jsp#top and scroll down to Section E: Who May Submit. Note the values communicated in the diction ("national," "Federal," "nation," "U.S."), as well as the recurrence of agents such as "scientists, engineers...educators" throughout the section. Even the categories of who may submit, and the order in which they appear, underscore the NSF's overarching concern with the infrastructure of American science and education: (1) universities and colleges, (2) non-profit, non-academic organizations, (3) for-profit organizations, (4) state and local governments, (5) unaffiliated individuals, (6) foreign organizations, (7) other federal agencies (NSF 2008b). According to this list, proposals that do not appear to further these goals (e.g., research at foreign institutions or proposals from professional societies *not* "directly associated with educational or research activities") are rarely

NSF Merit Review Criteria

What is the intellectual merit of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? . . . To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

FIGURE 7.2 Merit review criteria, NSF Grant Proposal Guide (NSF 2008d; NSF 08-1, section III.A.).

funded. Funding agencies spend time, money, and effort carefully wording their proposal guides in order to clearly indicate the kinds of research they will and will not consider. These guidelines can be an invaluable resource in selecting an appropriate agency for your proposal and in developing the significance argument for that audience.

The introduction does not have to build the case for significance all on its own, of course; this is the purpose of the full proposal. In most cases the introduction serves as a preview of issues to be discussed further in other sections of the document. The introduction identifies the problem, but specific research objectives are often elaborated elsewhere, for example, in the background or methods sections or in a separate section altogether, as in the Burkholder and Rublee proposal. Similarly, the introduction overviews previous research and the questions that motivated the study, but a more extensive discussion of prior research and explanation of the research problem are generally presented in a background section. The introduction also identifies the methodological approach to be used in the study, but a detailed description of methods is saved for the methods section. In some cases, the significance argument may be elaborated in a separate section as well, as in the Burkholder and Rublee proposal (see "Expected Results" and "Application"). These sections, appearing at the end of the document, provide a neat conclusion to the proposal argument as a whole, leaving readers with a strong sense of the importance and potential value of the proposed work.

In short, the introduction orients readers to the topic, purpose, and significance of the research, providing a framework or scaffold for other sections of the proposal to build on.

EXERCISE 7.4

As noted above, the Burkholder and Rublee proposal (p 282–306) combines the introduction and background sections. As you read this section, look for the three standard introductory moves (establish topic, establish the need for the new research, introduce the new research). Are these moves recognizable in this elaborate introduction, and, if so, where is each move made? In one or two paragraphs, describe the structure and logic of this section

EXERCISE 7.5

Read the RFPs we have included from the National Sea Grant College Program (Chapter 10, p 278–281), from NASA's *Chandra* program (Chapter 12, p 352–357), and from the U.S. Department of Energy's National Institute for Climatic Change Research (Chapter 13, p 378–379). Describe the values and goals of each agency as revealed in these documents. Compare and contrast the values and goals of these programs. Now look at the proposals that were submitted to these programs: where and how do the authors demonstrate that their research addresses the values and goals of their respective funding agencies? What do you learn about the identity and priorities of these agencies by reading their proposal guidelines and the arguments created in response to them?

7.5 Providing Background

Most proposals contain a separate background section or sections where the authors can present a more extensive explanation of the research problem, grounded in a thorough review of previous research. This section serves different purposes for the two segments of your audience. Your discussion should bring program officers and other generalists up to speed on the nature of the problem and the reasoning behind your specialized project. At the same time, it provides an opportunity for in-field readers to judge how familiar you are with the current state of knowledge in the field and how well you understand the issues and constraints involved in conducting research of this sort. With regard to this second purpose, one NIH institute explains that "[r]eferences show your breadth of knowledge of your field. If you leave out an important work, reviewers will assume you're not aware of it" (NIAID 2008b).

As this statement indicates, the way in which you review the literature significantly influences the professional *ethos* projected by your text. Readers will want to know not only that you understand what other researchers have done but also that you appreciate the contributions their studies have made to the developing knowledge in your research area. Situating your work in this context is essentially a cooperative gesture as opposed to a competitive one.

While oversights and methodological limitations must be taken into account in interpreting the results of individual studies, the primary goal in a review is to highlight what has been learned by the field so far (see Chapter 5). In the proposal, the review of research shows how far the previous research has gone and where it still needs to go. Once this groundwork is established, you will be in a position to explain how your proposed study will take the field forward.

Chapter 5 provides some general guidelines for structuring research reviews and citing sources. You'll see in the sample proposals in Chapters 10 and 12 that subheadings are a useful device for organizing the background section and are usually needed because of the length and complexity of these discussions. Notice that, as in the research report, the major headings in the proposal are *functional* headings (introduction, background, methods). But subheadings within sections are *topical;* that is, they identify the topic to be discussed in the section rather than simply announcing the function the section serves. We noted that Reynolds et al. combine the intro and background sections in their 2005 proposal. Notice that the major headings are functional (1. Introduction, 2. Summary of Proposed Work), but that subsections within the introduction are topical (1.1 SN Ia Progenitors, 1.2 Nucleosynthetic Products). Topical subheadings provide important cues to help readers navigate your background argument. (Announcing this sequence of topics at the start of the section can be an effective opening strategy.)

As you develop the background section, keep in mind the overall purpose of your proposal. You are reviewing research in order to introduce your study and show how it will further the field's knowledge and the agency's goals. You'll want to be sure to tie the background research clearly to the proposed research, especially as you bring this section to a close. Notice, for example, that Burkholder and Rublee finish their "Introduction and Background" section by describing "Progress to Date on Gene Probe Development" in subsection C, followed by a restatement of their research goals and hypotheses in subsection D, in which they explain how they will extend that progress (p 290–293). Another way to connect the background argument to the proposed study is to follow this section with a list of specific research objectives (Pechenik 2007), a strategy also illustrated by the Burkholder and Rublee proposal. Once readers have read the background section, they are well prepared to understand and

EXERCISE 7.6

Choose a sample research topic in your field, perhaps one suggested in the discussion section of a research report you've read recently. List the research areas that would need to be reviewed in the background section of a proposal for this project. Design sample subheadings for this section.

appreciate the specific goals of your study. Another advantage of placing the specific objectives here is that they can serve as a preview of the methods section, enhancing the coherence of the overall proposal argument.

7.6 Describing Proposed Methods

The methods section of a research proposal is distinguished from that of a journal article in two respects: the proposal generally contains fewer details but more explanation of rationale. Fewer details are to be expected, given that the research being proposed has not yet been conducted; but the need for rationale is more a function of the deliberative purpose of the proposal. This section must do more than describe how the study will be carried out; it must explain why this approach, as opposed to others, was chosen. The researcher must articulate and defend the methodological decisions he or she has made in such a way that the diverse readers in the proposal audience will be able to understand and appreciate those decisions. Remember that your target agency is being asked to pay for these activities. Its program boards must be convinced that this approach represents the best possible use of their limited funds.

As a consequence, the description of methods in the proposal tends to be heavily documented. In effect, it is an extension of the background discussion and serves a similar dual purpose. This extended explanation of materials and procedures helps your generalist readers understand what's needed to accomplish this research and allows your in-field readers to determine whether *you* understand what's needed for this research. The NIH has cautioned:

> While you may safely assume the reviewers are experts in the field and familiar with current methodology, they will not make the same assumption about you....
>
> Since the reviewers are experienced research scientists, they will undoubtedly be aware of possible problem areas, even if you don't include them in your research plan. But they have no way of knowing that you too have considered these problem areas unless you fully discuss any potential pitfalls and alternative approaches. (NIH 1993, p 6)

Of course, you will describe your proposed methods in future rather than past tense, but otherwise the basic guidelines presented in Chapter 4 (Section 4.5) can be followed in developing this section. See Section 4.6 for advice on incorporating figures and tables. As in the background section, subheadings are common in this section of the proposal. As illustrated in the Burkholder and Rublee proposal, headings and subheadings help readers keep track of the basic components of your methodology. In some proposals, the research objectives introduced earlier may become subheadings for organizing the methods section. In sum, the proposal must convince readers that the project is significant and that it will be conducted expertly. Each section of the proposal document plays a role in building this case.

EXERCISE 7.7

In either the Burkholder and Rublee (1994) proposal (Chapter 10) or the Reynolds team's (2005) proposal (Chapter 12), look for places where the authors include a brief or extended rationale for a methodological choice. What kinds of decisions have they chosen to explain? Why do these issues warrant further explanation? What role do citations play in these explanations? Look for examples of each of the three levels of procedural explanation described in Chapter 4: routine procedures, procedures established in previous studies, and new procedures or substantial modifications (see Section 4.5, p 101).

EXERCISE 7.8

Examine De Boer and Hale's proposal to the Greek government for permission to remove rock samples from the Delphi site (Chapter 11, p 324–325). The researchers' proposed methods are mentioned in several places in this brief proposal, particularly under the "Request" and "Laboratory" headings. In contrast to proposals to funding agencies, in which methods must be described to withstand scrutiny by expert scientists, De Boer and Hale's plans were also evaluated by officials of the Greek government concerned with cultural preservation. What methodological details have the authors included to reassure this audience that their resources will not be abused and that the tests have a high probability of success?

7.7 The Research Proposal Abstract

The proposal abstract or summary is likely to serve a number of purposes and reach a number of audiences: it may be used at the start of the review process to help program officers sort proposals and select appropriate reviewers; it will be used by reviewers during the process as a preview of the larger document; and it may be used in reporting or publicizing an agency's funding decisions after those decisions are made. Thus, the NSF's proposal guidelines specify that the proposal summary should be "suitable for publication" and "informative to other persons working in the same or related fields and, insofar as possible, understandable to a scientifically or technically literate lay reader" (NSF 2008c).

The general shape of the proposal abstract reflects the shape of the proposal itself and thus includes a synopsis of the research problem, goals, and methods. Specifications for abstracts vary. A limit of one page or 200 to 300 words is common, but some agencies will accept more elaborate summaries, as illustrated in the Burkholder and Rublee proposal (p 283–284). The National Institute for Climatic Change Research (NICCR), which funded Chambers and Hurtt's research on hurricane impacts, requires an abstract of 400 words or less containing

five specified paragraphs: (1) project objectives, (2) specific hypotheses or questions, (3) location of research activities, (4) outline of methods, and (5) "a statement of what the research is intended to accomplish, including expected deliverables" (NICCR 2008; http://www.tulane.edu/%7ENICCR/rfps.html). The Chambers and Hurtt abstract is included in Chapter 13 (see p 380).

Whether brief or elaborated, the overview of methods in the abstract or summary must, of course, be "promissory" in that it describes what you *will* do. But the discussion of the research problem and goals is expected to be informative rather than descriptive (review these terms in Chapter 4, p 117); it must provide a clear, concise summary of what the project is about. Most, if not all, of your readers will read the abstract; some will read only the abstract (Olsen and Huckin 1991). The NIAID guidelines explain that although all proposals receive a careful reading from the assigned primary reviewers who will represent the project in the review committee discussion, most members of the committee will "read just your Abstract, Background and Significance, and Specific Aims" (NIAID 2008c; http://www.niaid.nih.gov/ncn/grants/cycle/part08.htm#f6). Given the vast number of proposals to be reviewed and the real-life constraints under which reviewers work, the abstract may well be the most important section of the proposal document.

EXERCISE 7.9

Read the abstract written by Chambers and Hurtt (2006) for their study, "Hurricane Impacts on Structure and Functioning of Southeastern Forests" (reprinted on p 380). Also review NICCR's specifications for abstracts, earlier in this section. Unlike NSF, NICCR's guidelines do not specify that the abstract be "understandable to a scientifically or technically literate lay reader," but abstracts of funded projects are later posted at the NICCR website and thus available to the public (http://www.tulane.edu/%7ENICCR/projects.html). Which parts of this abstract are most understandable to non-specialists? How would you revise this abstract to address a public audience?

EXERCISE 7.10

Write a 200-word abstract for the Burkholder and Rublee proposal, using their one-page project summary as a starting point (p 283–284). What parts of the summary did you use, and what parts didn't you use? Why?

7.8 How Scientists Write Research Proposals

As discussed in Chapter 4, research scientists, like all writers, follow a wide range of writing processes and preferences. This variation applies equally to the processes of writing and revising research proposals. Individual scientists may

prefer one drafting method over another; research teams may develop preferred patterns of collaboration that enable them to produce and revise documents efficiently. Authors may vary their methods of composing and collaborating from one occasion to the next. The one constant in all this variation is an overriding concern with audience in developing the proposal. A critical dimension of the proposal writing process is the assessment of the potential funding agency's interests, values, and goals.

The goals of most funding agencies are widely known and are articulated in RFPs, but many researchers also actively seek out new information about their target agency and establish a dialogue with program staff well before they submit proposals. Many funding agencies encourage this sort of early contact and information exchange. Program staff are readily available by phone and email for such consultations. It is in the agency's interests to provide this guidance in advance to ensure that the proposals it receives fall within its program guidelines and include all the information needed in the review process. In a study of the funding process, Mehlenbacher (1994) found this give-and-take among researchers and program staff to be quite common. The prominent researchers Mehlenbacher interviewed consistently described the proposal process as a long-term, interactive process.

If a proposal is not accepted on its first submission, the dialogue generally continues. Most agencies will send copies of reviewers' comments to the proposer and will continue to consult with the researcher as he or she revises the text for resubmission. In an extensive case study of this revision process, Myers (1985) found that proposal arguments changed significantly as researchers evaluated and responded to reviewers' concerns. Changes were effected on several levels, from the shape of the argument, to the amount of explanation, to the tone and *ethos* established in the text. But significantly, basic content remained relatively unchanged. Steve Reynolds reports that their proposal for *Chandra* observer time was accepted on the third try; the team had submitted proposals twice before, modifying and improving the document each time (personal correspondence).

In sum, the proposal writing process is a complex, long-term endeavor that involves the participation of many. Given the high degree of interaction among researchers, program staff, and reviewers—and the continuing interaction among members of a research team (some of whom may be geographically separated)—it is no wonder that researchers in Mehlenbacher's (1994) study cited management and organizational skills as essential components of the research process.

EXERCISE 7.11

Some funding agencies provide extensive advice for grant writers. For example, see NIH's Grants Process Overview (http://grants.nih.gov/grants/grants_process.htm) and NSF's Grant Proposal Guide (http://www.nsf.gov/pubs/policydocs/pappguide/nsf08_1/gpg_index.jsp). Take some time to familiarize yourself with these resources, and/or those of other agencies likely to fund research in your field. Given the advice you find in these guides and in this book, and considering your own writing habits and preferences, think about how you would write a grant proposal of your own. Draft a set of writing steps and a tentative timeline for preparing a grant proposal for submission.

7.9 How Reviewers Evaluate Research Proposals

The proposal review process exerts a powerful influence on the direction of research in scientific fields. In issuing RFPs on specific topics, funding agencies encourage research in some areas and not others; proposal guidelines ensure that researchers who work in these areas address the agency's goals and priorities; and in responding to reviewers' comments in the revision process, researchers may further tailor their research to fit within the parameters established by the targeted research program.

This degree of control makes some scientists nervous. As with the journal article review system, there are always worries about potential abuses such as favoritism, censorship, breaches of confidentiality, or misappropriation of ideas—concerns that may be enhanced by the political context in which these organizations operate; federal funding agencies such as NIH and NSF depend on congressional approval of their budgets and thus may be subject to the economic tug of political priorities. An additional concern in the granting process is the role that non-specialists play in the review process, as, for example, in NIH advisory councils (Cohen 1996). In response to such concerns, the NSF and other agencies have initiated changes in the review process designed to give proposers more "say" in the choice of reviewers and to provide authors of unsuccessful proposals more complete information about the reasons for the rejection. Like the peer-review process used by journal editors, the proposal review process may perhaps best be described as an imperfect system that nevertheless provides careful scrutiny of thousands of proposals every year.

Proposal guidelines and RFPs routinely include a list of the criteria reviewers will use in evaluating new applications. The review criteria for the Sea Grant program to which Burkholder and Rublee submitted their 1994 proposal are presented in Figure 7.3. NASA's review criteria for the *Chandra* observer program, in effect for the Reynolds team's 2005 proposal, are presented in Figure 7.4. Notice that these criteria clearly reflect the different goals of the two programs as represented in their respective RFPs (p 278 and 352).

A comparison of Figures 7.3 and 7.4 also will reveal some common concerns that reflect the generic goals of the research proposal. Both evaluation guides highlight the relevance of the study to the agency's goals or mission, the scientific merit of the proposed work, and the capabilities of the investigators. This chapter has argued that while there are specific places in the proposal document to establish the relevance of the study and the scientific merit of the design, the professional competence of the researcher is indirectly demonstrated throughout. As these review criteria indicate, the researcher's professional *ethos* plays a critical role in the evaluation of his or her work.

Criteria for Evaluation of Proposals

The following criteria will be used to evaluate the proposals.

1. *Rationale*—the degree to which the proposed activity addresses an important issue, problem, or opportunity in marine biotechnology, and how the results will contribute to the solution of the problem.
2. *Scientific Merit*—the degree to which that activity will advance the state of the science or discipline through use and extension of state-of-the-art methods.
3. *User Relationship*—the degree to which users or potential users of the results of the proposed activity have been brought into the execution of the activity, will be brought into the execution of the activity, or will be kept apprised of progress and results.
4. *Innovativeness*—the degree to which new approaches (including biotechnological ones) to solving problems and exploiting opportunities will be employed or, alternatively, the degree to which the activity will focus on new types of important or potentially important issues.
5. *Programmatic Justification*—the degree to which the proposed activity will contribute an essential or complementary unit to other projects, or the degree to which it addresses the needs of important state, regional, or national issues.
6. *Relationship to Priorities*—the degree to which the proposed activity relates to guidance priorities in this document.
7. *Qualifications and Past Record of Investigators*—the degree to which investigators are qualified by education, training, and/or experience to execute the proposed activity and past record of achievement with previous funding.

FIGURE 7.3 Review criteria, National Sea Grant College Program (1994), "Statement of Opportunity for Funding: Marine Biotechnology." No page number. Reviewers of the Burkholder and Rublee proposal in Chapter 10 were guided by these criteria.

Evaluation of Research Objectives

The criteria used in the Stage 1 evaluation are listed below in order of importance.

1. The overall scientific merit of the investigation and its relevance to the *Chandra* science program and capabilities. This includes addressing the scientific objectives of the *Chandra* mission and achieving the goals of the most recent NASA strategic plans. For observing proposals, the degree to which the objectives have been satisfied by one or more previous observations will be evaluated....
2. For observing proposals, the suitability of using the *Chandra* X-ray Observatory and data products for the proposed investigation and the need for new X-ray data beyond that already obtained; the feasibility of accomplishing the objectives of the investigation within the time, telemetry, and scheduling constraints; and the feasibility of the analysis techniques. For programs incurring a large expenditure of observatory time relative to exposure time (multiple short exposure or grid scans), the total observatory time required will be considered....

(continued on page 193)

FIGURE 7.4 Review criteria, *Chandra* X-ray Observatory (CXO) Research Program (2007, p. 41). Other excerpts from this RFP are reproduced in Chapter 12. The reviewers of the Reynolds et al. *Chandra* proposal were guided by these criteria.

3. The competence and relevant experience of the Principal Investigator and any collaborators as an indication of their ability to carry the investigation to a successful conclusion. Past performance in scientific research, as evidenced by the timely publication of refereed scientific papers including those on previous *Chandra* programs, will be considered.

FIGURE 7.4 *(continued)*

EXERCISE 7.12

The National Institute of Allergy and Infectious Diseases (NIAID), one of the Institutes of Health, has compiled a list of the most common reasons given by reviewers for rejecting a proposal. We have reprinted these in Figure 7.5. Consider this list carefully.

A. Which of these reasons are related to the researcher's projected competence or professional *ethos*?
B. How and where in the proposal argument should each of these potential concerns be anticipated and addressed?

Common Problems Cited by NIAID Peer Reviewers

- Problem not important enough.
- Study not likely to produce useful information.
- Studies based on a shaky hypothesis or data.
- Alternative hypotheses not considered.
- Methods unsuited to the objective.
- Problem more complex than investigator appears to realize.
- Not significant to health-related research.
- Too little detail in the Research Plan to convince reviewers the investigator knows what he or she is doing, i.e., no recognition of potential problems and pitfalls.
- Topic scientifically premature.
- Over-ambitious Research Plan with an unrealistically large amount of work.
- Direction or sense of priority not clearly defined, i.e., the experiments do not follow from one another and lack a clear starting or finishing point.
- Lack of original or new ideas.
- Investigator too inexperienced with the proposed techniques.
- Proposed project a fishing expedition lacking solid scientific basis, i.e., no basic scientific question being addressed.
- Proposal driven by technology, i.e., a method in search of a problem.
- Rationale for experiments not provided, i.e., why they are important, or how they are relevant to the hypothesis.
- Experiments too dependent on success of an initial proposed experiment. Lack of alternative methods in case the primary approach does not work out.
- Proposed model system not appropriate to address the proposed questions.
- Relevant controls not included.
- Proposal lacking enough preliminary data, or preliminary data do not support project's feasibility.
- Insufficient consideration of statistical needs.
- Not clear which data were obtained by the investigator and which reported by others.

FIGURE 7.5 Most common reasons cited by NIAID reviewers for rejection of proposals (NIAID 2008a; http://www.niaid.nih.gov/ncn/grants/cycle/part04.htm#e3).

7.10 Accountability in the Research Process

Public trust in science rests on the assumption that all parties involved in research—from the researchers themselves to the reviewers and program officers who pass judgment on their work—are competent and trustworthy. This basic assumption shapes the nature of the relationship between researchers and granting institutions, as exemplified in the NASA policy statement reproduced in Figure 7.6.

In this statement, prominently displayed in the introduction to their *Guidebook for Proposers*, NASA (2008c) clearly identifies itself as an agent of the American citizenry, charged with facilitating work that is in the public's interest and thus worthy of public funds. The professional conduct of that research is thus NASA's responsibility, yet as the policy statement indicates, the agency exercises minimal oversight, placing their trust, as all funding agencies do, in the integrity of the research participants. We've explored the ethics of research reporting at greater length in Chapter 3, but it is important at this point to acknowledge the mechanisms through which such trust is maintained in the granting process.

In addition to the checks and balances inherent in the peer-review systems used to evaluate research proposals, funding agencies also rely on internal controls at the researcher's home institution. Most agencies require that proposals be accompanied by verification of approval by an institutional review board (IRB) at the home institution. Such boards are typically composed of researchers from a variety of departments on campus who review the proposed study design to ensure compliance with good research practice, as well as with federal regulations on such issues as the ethical treatment of human subjects and laboratory animals and the use of materials that may be hazardous to researchers, research subjects, or the surrounding community and environment. As noted in Section 7.3, funding agencies also may require special declarations on such issues as part of the proposal package, in addition to documentation of IRB approval.

NASA's Partnership with the Research and Education Communities

Funding for NASA-related research and development projects is a privilege accorded to qualified science, engineering, and educational personnel by NASA acting on behalf of the citizens of the United States through Congressional and Executive action. NASA's proposal and selection procedures work only because the various research communities and NASA Program Offices together maintain the highest level of integrity at all stages of the processes. As a general rule, recipients of NASA research awards largely manage their own research projects with minimal oversight by the Agency. Throughout the entire process—starting with the identification of program objectives, the preparation and peer review of submitted proposals, the conduct of the research itself, and, finally, the exposition of new knowledge through publications, public outreach, and education—NASA sees itself as a partner with the scientific, engineering, and educational communities in making its programs relevant and productive.

FIGURE 7.6 NASA general policy statement (NASA 2008c, p P-2).

Once a grant is awarded, researchers are expected to keep the agency informed of their activities, usually through annual reports summarizing their progress to date. For example, in the case of multi-year projects, NASA "requires that a brief progress report be submitted to the Program Officer 60 days before the anniversary date of the award, in order to allow for the timely recommendation for a continuation of funding" (NASA 2008c, p F-3). At the end of the grant period, a final report is required, including "substantive results from the work, as well as references to all published materials from the work" (NASA 2008c, p F-3). The focus in such reports is on showing how the research team is accomplishing the goals that the researchers and funder agreed upon through the proposal approval process.

In Figure 7.7 we've reproduced the reporting requirements set by the National Institute of Allergy and Infectious Diseases for the projects they fund. Notice that in addition to certifying that they're behaving ethically and that they're making sufficient progress, researchers are also responsible for managing their finances and keeping careful records of their spending. This reporting requirement brings us back once again to the additional challenge that grant proposals pose: your readers must be convinced that their funds will be wisely invested in a project that is important, well conceived, and likely to succeed.

Your Reporting Requirements

Once your project is underway, you and your institution have ongoing requirements, described below:

- Quarterly reports
- Financial status reports
- Invention reports
- Progress report
- Audit requirements

In some cases, you may have additional requirements.

- For example, if you are working with human subjects, you need to get your certification of institutional review board approval re-approved every year of your award.
- If you're working with research animals, you need to get your certification of institutional animal care and use committee approval re-approved every three years.

As PI [Principal Investigator], you play a large role in preparing the reports, though you don't actually submit them. You give information to your business office so it can send us the reports.

Along with the reports described above, your institutional business official will need to submit an *Annual Report on Possible Research Misconduct* to the Office of Research Integrity. ORI will impose a bar on your award if it does not receive this report.

FIGURE 7.7 Reporting requirements for projects funded by the National Institute of Allergy and Infectious Diseases (NIAID 2008d; http://www.niaid.nih.gov/ncn/grants/cycle/part11a.htm#e).

Activities and Assignments

1. Berkenkotter and Huckin (1995) outlined the "life cycle" of research in general terms in the diagram reproduced in Figure 7.1. Create a life cycle diagram for a specific project in your field, in which you identify the journals and funding agencies that served as "gatekeepers" for this line of research.