Handbook

for

Preparing and Writing Research Proposals

by C.P. Patrick Reid, University of Arizona

International Union of Forestry Research Organizations
Special Programme for Developing Countries
Vienna, Austria

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Univ.-Prof. Dr. C. P. Patrick Reid
Tuscon, Arizona, USA; 1999

Foreword

IUFRO's Special Programme for Developing Countries (IUFRO-SPDC) is dedicated to expanding and fostering forestry research capacity in developing and economically disadvantaged countries. One essential way for us to do so is through the development of training manuals. We have produced two other training products in the past, *FORSTAT*: *A Self-learning Course in Basic Statistics for Forestry Researchers* and *A Self-learning Course: Planning and Managing Forestry Research*, both designed to be used as texts for training courses or as self-learning manuals. This manual, *Handbook for Preparing and Writing Research Proposals*, follows this trend and is the latest of our efforts.

Influenced by my experiences in Africa and Asia while assessing research needs it became clear to me that a manual on grant writing and proposal development was greatly needed. It was at the critical juncture of revising IUFRO-SPDC strategic plan that Dr. C.P. Patrick Reid called me asking if there might be an opportunity to work together while he was on sabbatical leave from the University of Arizona, Tucson, Arizona, USA. The timing was perfect and I suggested the idea of this handbook to Dr. Reid who was very enthusiastic about the possibility. Fortunately, our sponsorship from the Japanese Ministry of Foreign Affairs' Official Development Assistance Program allowed us to finance both Dr. Reid's stay in Vienna and the publication costs for the handbook. The University of Arizona provided Dr. Reid's salary. This handbook is the result of his hard work while he was in Vienna drafting its contents.

Rather than simply sending the draft out for review we decided that the best way to ensure its usability was to use the draft as the basis for a training workshop. We were fortunate that both the International Foundation for Science and the African Academy of Sciences were interested in cooperating with us in the development of the manual and agreed to co-sponsor the initial workshop on research proposal writing in Kadoma, Zimbabwe, October, 19-22, 1999. The workshop instructors were Drs. C.P. Patrick Reid and Kent Reid (no relation). Dr. Peter Wood assisted us by giving a section of the course on the logical framework (also contributed as an appendix to this handbook) commonly used in proposals throughout Europe.

IUFRO-SPDC is extremely indebted to the International Foundation for Science and its Forestry Programme Officer, Dr. Per Ekman, for taking charge in the organizational arrangements and IFS for providing most of the financial resources for the workshop. We wish to express our thanks to Dr. Iba Kone of the African Academy of Sciences for his cooperation in coordinating AFORNET participation (African Forestry Research Network) and for his efforts in assessing training needs for African scientists. Our thanks are also extended to the Forestry High Commission of Zimbabwe and in particular Dr. Enos Shumba for their support and assistance in making the workshop a success. Without these partnerships we would have been unable to develop this handbook.

Dr. Robert C. Szaro
Coordinator, IUFRO-SPDC
May 2000; Vienna, Austria

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1.0 Introduction

This handbook is specifically designed to assist research scientists to seek and successfully acquire research funding in support of forest research. It provides guidelines and suggestions for the development, preparation, and submission of proposals to funding organizations and donor agencies (often simply referred to as "sponsors"). Background is provided on the concept of scientific research and its relationship to technology development and science education (Chapter 2), and the process to identify significant and important research problems (Chapter 3). Additionally, considerations concerning the sponsor's perspective in funding of research are presented from the view of a funding sponsor (Chapter 4). However, emphasis in the handbook is given to the actual process to plan and write a successful research proposal (Chapters 5 - 9).

The needs and demands for forestry research continue to increase on local, regional and global scales. Yet, the resources for this research are almost always limited and must be aggressively sought after, often outside of the researcher's home institution, organization, or country. Although many potential sources of research funding exist to an individual research scientist, e.g. governments, non-profit foundations, and private corporations, the competition for such funding is exceedingly high, and only well-conceived and well-packaged research proposals are likely to be successful. Poor research ideas are not likely to be funded, regardless of how aesthetically pleasing a research proposal appears. But on the other hand, good, relevant research ideas may fail to get funded if the proposal package doesn't convince the reviewers because it is poorly presented.

The contents of this handbook are intended to help you improve the conceptual, developmental and writing skills that are important to put together succinct, focused and significant research proposals. As you proceed through the topics you will find specific examples and tips on addressing specific components of a research proposal.

Purpose of the Handbook

This collection of topics is designed to provide a systematic approach to the development of focused and significant research projects, considerations to identify and approach funding sponsors, and the tools to prepare and write a well-designed research proposal.

Intended Audience

The material here is specifically designed for scientists in forestry research and educational organizations that wish to enhance the resources for their research programs. Although the handbook may be especially useful to newly appointed and early career research scientists, it will provide a valuable reference document and refresher for experienced scientists. It should also be valuable to research managers and directors, university department heads, and other research supervisors who may wish to call the handbook to the attention of forest researchers in their organizations.

Since this handbook is based upon general principles of research proposal development, the handbook may also appeal to a wider audience, including researchers outside of forestry.

2.0 The Need for Scientific Research

Objectives

- To review the basic components of scientific research
- To examine the scientific method in practice.
- To examine the relationship among research, technology and production.
- To consider the value of the research endeavor to education

It is very likely that you have been involved in activities related to forestry research, and that you already have some appreciation for the value of scientific research. However, it may be useful to review some of the underlying principles that provide the foundation for scientific research, and to understand why the scientific method is the only one available to us for discovering **reliable knowledge** about nature. Reliable knowledge is knowledge that has a high probability of being true because its veracity has been justified by a reliable method (*i.e.,* the Scientific Method) (Schafersman, 1997).

In today's environment, the need and demand for a better understanding about almost all aspects of forestry are exceeding the resources available for research required to provide this understanding. We are confronted with a host of problems and needs in forestry, that range from the local to the global scale of importance. There is little doubt that research is needed in many different aspects of forestry and forest products, and in relation to social dimensions of communities and economies.

With large demands for forestry research, yet limited resources to support such activities, it is extremely important that the research that is done is of highest quality and of immediate or potential significance. A sound scientific methodology at least assures that the results of the research have a high probability of being true. It will be up to the investigator, as influenced by stakeholders, scientific colleagues and others, to determine the relative significance and importance of the research.

Changes in the relationship between science and society create new challenges for scientists. In addition to the shortfall in available resources to support trained researchers, research enterprises are becoming more complex, creating new kinds of situations and relationships among researchers. Although forestry researchers must provide the scientific understanding of the forest environment and related activities, they must also be able to convince a community of peers that their concepts are, in fact, correct. This requires an intimate knowledge of methods, techniques and social conventions of science.

Guiding Principles of Scientific Investigation

The scientific method, whether it's applied to forestry research or astrophysics, is a proven method that has three basic components. These components are: 1) use of empirical evidence, 2) practice of logical reasoning, and 3) possession of a skeptical attitude. These same components also apply to critical thinking.

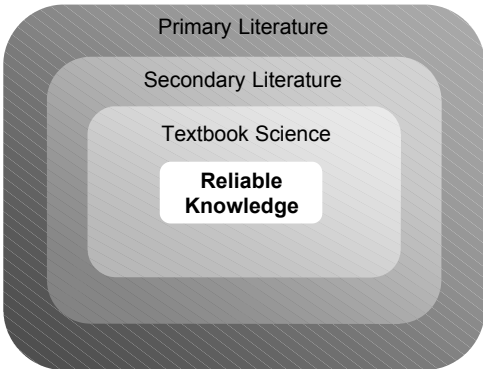
A goal of the scientific method is to facilitate the independent verification of scientific observations. **Empirical evidence** (observations) is the only type of evidence that you can experience, is repeatable, and can be experienced by others under the same experimental circumstances. These attributes allow observations to be verified and determined reliable. Empirical evidence is something that one can see, hear, touch, taste, or smell. Therefore, empirical evidence is contrasted with heresay evidence, testimonial evidence, or revelatory evidence (attributed to a supernatural power). Emotional evidence can result from one's subjective feelings, it is often repeatable, but it cannot be experienced by someone else and therefore cannot be a basis for reliable knowledge.

Basic Components of the Scientific Method

- Empirical Evidence
- Logical Reasoning
- Skepticism

A common alternative to empirical evidence is authoritative evidence. This is what is transmitted to others by people in authority (*e.g.* authors, medical doctors, politicians, magazines, TV, *etc.*). If the authority is reliable, often the evidence can be reliable, but many authorities are not reliable sources. In education, and to some degree, in research, we often rely on authoritative evidence. In education we generally consider teachers and professors to be reliable sources. Also, textbooks are considered to be highly reliable because they represent numerous steps of review and validation by the scientific community.

Bauer (1995), in his discussion on ethics of science, distinguishes among the terms primary, secondary, and textbook literature. **Primary literature** is that body of science that exists primarily as original research articles in scientific journals. It is science that is highly objective, generally reviewed by peers in the particular discipline, and often less personal than what goes on in an individual research laboratory or activity. Primary literature is not entirely consensual because it contains many competing, and often contradictory, ideas and theories. Further research, repetition, and testing may modify or reject conclusions and theories presented in the primary literature. What survives in the primary literature, after the scrutiny by the scientific community, becomes **secondary literature**. This is the research that becomes cited in other scientific articles, and eventually, in review articles. It is considered more consensual and more useful knowledge than the body of primary literature. With added scrutiny, more use, and further modification, some knowledge in the secondary literature will be incorporated into textbooks. **Textbook science** is considered to have been carefully cleansed of personal bias, error and dishonesty.



Empirical evidence, a keystone to the scientific method, eventually becomes reliable, consensual knowledge through this "knowledge filter" of peer review and the passage of time. This process, coupled with the scientific method of discovering empirical evidence, is the basis of modern civilization which has used the discoveries of science for application (technology) to human purposes (Schafersman, 1997).

Another important aspect of the scientific method is the use of **logical reasoning**, not unique to scientists, but an integral part of science. The use of logic to reason is a skill that allows determination of truth through a sequence of steps that are separated from emotional and hopeful thinking. Logic provides a set of rules to reason. Reasoning allows us to infer or conclude new pieces of information from existing information.

Good scientists and critical thinkers constantly question evidence, arguments and reasons for beliefs. **Possession of a skeptical attitude** is a key attribute in science that helps to avoid self-deception and deception by others. Scientists must repeatedly and rigorously examine the truth and reliability of both the knowledge claims from others and the base of knowledge they hold themselves. One test is to determine if the logical consequences of your current beliefs match objective reality, as measured by empirical evidence. If they do, it suggests a high probability that your beliefs are true. A skeptic is not closed-minded but rather holds beliefs tentatively, and is open to new evidence and rational arguments.

The Scientific Method in Practice

Practice of the scientific method, and thereby science, is built on a foundation of trust. Society trusts that research results reflect an honest attempt by scientists to describe the world accurately and without bias. Science is inherently a social enterprise, and with few exceptions, scientific research cannot be done without drawing upon the work of others or collaborating with others. Science inevitably takes place within a broad social and historical context, which gives substance, direction, and ultimately meaning to the work of individual scientists (NAS,1995a).

A thorough understanding of the steps to apply the scientific method will provide considerable value in preparation of a research proposal,

since these steps are fundamental to choose researchable problems, formulate testable hypotheses, test hypotheses (with appropriate tools), construct conclusions, and modify scientific theory (adapted from Schafersman, 1997) (**Figure 2.1**).

Step 1. *Identify a significant problem or ask a meaningful question in such a way that there is a conceivable answer*.
For many scientists, this step will be driven by a sense of curiosity, and the enthusiasm and passion for discovery. For others it may be ambition, or the pressing needs imposed by others to find a solution to a specific problem. The pursuit of science and the identification of research questions may be influenced by many cultural, social, political, and economic factors. Regardless of the motivation, any attempt to gain knowledge must begin with this step.

Step 2. *Attempt to answer the question posed in step 1 by gathering relevant information and making observations.*
Initial observations might be data obtained by a search of current scientific literature, information from the scientist's own experience, or from trial experiments. These observations should be empirical in character, *i.e.*, sensible, measurable, and repeatable. Correct observations must be made in the proper manner, which requires ingenuity, hard work, and considerable training in methods and techniques of data collection and analyses.

Step 3. *Propose a solution to the problem or answer to the question as a scientific hypothesis.*
This is a statement of the research objective in such a way that it can be tested. By definition, a scientific hypothesis is an informed, testable, and predictive solution to a problem that explains a natural phenomenon, process, or event. If the proposed answer or solution is not testable, it is essentially useless for further investigation. Many proposed answers are likely to be false and further investigations will almost always be necessary to determine validity.

Step 4. *Test the hypothesis to allow corroboration and establishment of validity.*
There are basically two ways to do this "conducting an experiment", or make further observations. Experimentation is very prevalent in scientific research but many natural problems are not amenable to

experimentation. Since every hypothesis presents consequences, one can make certain predictions about the process or phenomenon under investigation, and determine how well the predictions agree with new data, further insights, new patterns, or specified models. This latter type of testing also involves logic and empirical evidence.

Step 5. *Accept, reject, abandon, or modify the hypothesis.*
If modified, the hypothesis must be tested again. If a hypothesis passes the appropriate tests, it is considered corroborated, *i.e.,* a hypothesis whose predictions have been verified. At this stage the results can be published and subjected to testing and verification by other scientists. If further corroborated by subsequent tests, the information becomes reliable knowledge.

At this point, a comment about "proof" is in order. In a strict sense, a hypothesis cannot be "proved", since this is legitimately found only in mathematics and logic, disciplines in which all logical parameters and constraints can be defined. The term "corroborated" is preferable to "proved". A highly corroborated hypothesis (*i.e.,* repeatedly tested and verified) becomes a **scientific fact**.

> ***"Perfect as the wing of the bird may be, it will never enable the bird to fly if unsupported by the air. Facts are the air of science. Without them a man of science can never rise."***
>
> – Ivan Pavlov

Step 6. *Construct, support, or cast doubt on a scientific theory.*
A theory is built of reliable knowledge and its purpose is to explain major natural processes or phenomena. A theory can be defined as a unifying and self-consistent explanation of fundamental natural processes or phenomena that is totally constructed of corroborated hypotheses. In biological research (in its broadest sense), the formulation of scientific theory will often be elusive, especially in research that involves complex systems or collections of many biological species, as in the discipline of forest ecology. The accumulation of highly corroborated reliable knowledge that leads to scientific facts is often

a long-term and protracted process. Yet, the goal of all scientists should be the formulation of scientific theory, regardless of whether the research is fundamental or applied.

The Scientific Method in Practice

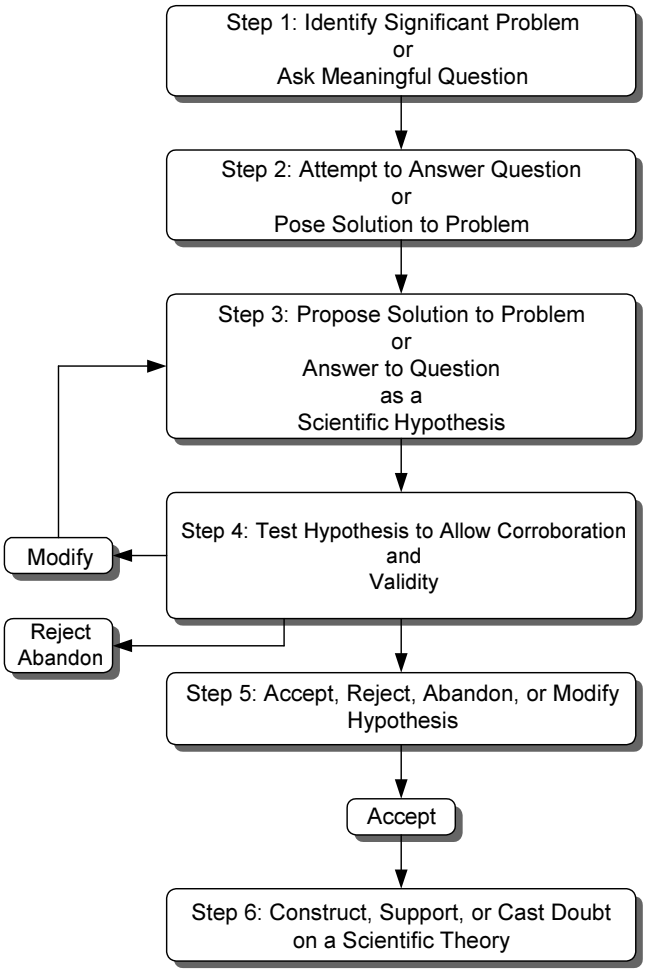


Fig. 2.1 Steps in the Scientific Method

Research, Technological Development and Production

The discovery of new reliable knowledge has been discussed above in the context of scientific research, i.e., the activity of science. But what is the relationship of research to technology and the production of new products? One way of defining technology is to do so in the context of the discovery of new knowledge. **Technology** can be defined as ***the systematic application of scientific knowledge to practical tasks***. By definition, science is a separate activity from that of technology. This is not to say that one can't conduct research relative to technology, as long as the research meets the requirements laid out above for the process of scientific research. For example, one could hypothesize (pose a question) on the impacts of a particular technological process, conduct empirical experiments or make observations, and then test the hypothesis for validation or rejection, which could then lead to a generalized theory relative to the process.

It is important to be able to distinguish between scientific research and technology. In many cases there are distinct advantages to consider possible technological developments as research problems that need to be addressed. A "linear theory" approach to science and development has often been used in highly developed countries, *i.e.,* the concept that pure research leads to technological development. However, José Goldenberg (1998) argues that a more realistic model for most countries is one where pure research, technological development, and production and marketing have substantial overlap in time. The direct involvement of scientists in consideration of potential technological solutions to problems at the local level often provides a sense of obvious research needs and priorities that are grounded in real problems. Even when technologies exist, they may require research for adaptation to local or regional circumstances, if imported from other areas. It is becoming increasingly rare where research is done simply out of curiosity and for the love of discovery. Requests to funding agencies and organizations for research support must clearly establish the benefit of the research to some segment of society. But regardless of how fundamental a research project might be, it is always personally gratifying to know that the products of one's research will have some foreseeable potential application to a societal need or problem.

Forestry research can be very important to the sustainable development of a community, region, or country. This implies the need for research

to contribute to technological innovation and eventually the production of new materials, products or processes for the management and use of forest resources. Even if the research is successful and leads to new technologies, they may have limited value if not properly marketed to end users. Dissemination of new knowledge and technologies must occur and may need to involve many levels of the scientific community, government and private industry. New technologies may also require changes in government policies to allow optimum utilization.

Research and Education

The research enterprise can provide many opportunities for the education and training of personnel in scientific skills and to provide a comprehensive awareness of the current state of knowledge and techniques in a particular field or discipline. However, the extent to which such education should be incorporated into a research project or program depends very much on the mandate of the research organization and the requirements of the sponsor. In universities, it is customary in most fields of science for a master of science candidate or doctoral candidate to be invited to work as a research assistant on the project of a faculty member, a practice that is very much part of the educational structure of higher education institutions. This practice can be a very effective way to prepare bright and motivated people for careers in research, but it is not without some potential problems (NAS, 1995b).

Research assistants who are simultaneously studying for advanced degrees have the opportunity for supervised hands-on research. Not only does the research often serve as part of their thesis or dissertation requirement, but the assistantship provides financial support for them as well. Both the institution and the faculty member benefit from this practice of incorporating advanced study students into research projects by having motivated research personnel at relatively low cost, allowing incentives for graduate enrollment by providing graduate students with support, and by the resulting increased capability for research through the combination of research students and outside funding support. Additionally, the education program can often be strengthened by the incorporation of the latest developments and new science into the curricula from the research activities. Current, high-quality education is prerequisite to a well-trained work force needed for technology development (Goldenberg, 1998).

However, the research assistantship model can result in some less desirable consequences, as well. The completion of the graduate education program of a student may be delayed if schedules and accomplishments are dictated by the research project. Furthermore, the emphasis on production of new research results and goal-oriented work on specific research projects can skew the graduate education program away from other important aspects of graduate education, including independent exploration. The principal investigator must also recognize that a research project that has exceptional merit in its educational component in training new scientists, may not necessarily impress the reviewers of a research proposal who are charged primarily with judging the scientific merit of the proposed work.

Researchers who reside at research organizations that do not have a primary mission in graduate education should not dismiss the potential for training new scientists, and should consider the possibility that the research project could provide training opportunities for personnel even if not part of a formal graduate education program. Many research organizations often have the chance to cooperate with educational institutions and to institute partnerships that allow graduate students to work with research organization scientists.

3.0 Identifying and Prioritizing Research Needs

Objectives

- To appreciate the need for determining in advance the resources needed to conduct a research project
- To understand the need and approach for defining realistic research problems
- To recognize the need for stakeholder input into identifying research problems

Before writing a research proposal, the investigator must first establish the important research needs that are appropriate for his or her research organization. The prioritization of research problems will be very dependent on a number of factors, including the significance of the problem or need, the capability of the researcher or organization to address the need, the existing or potential availability of resources to carry out the research, and the perception by the general public, the government, or other organizational entities as to the importance of the problem and the likelihood for products and benefits to be derived from the research. This identification and prioritization of research includes consideration of the mission and strategic plan of one's organization, the input by stakeholders, and a realistic assessment of resource capabilities and needs.

Defining Problems

It may seem obvious that the first step in preparing a research proposal is to define a problem or set of problems that will be the subject of the research proposal. This may be a simple step for experienced researchers who have an intimate knowledge and awareness of their field or discipline and its importance to relevant problems. But even for experienced researchers, the identification and defining of new areas of research requires considerable analysis and the skill of abstraction to transpose ideas about problems into realistic researchable questions. Analysis is an important first step in defining a problem. This might be done by suggesting or enumerating **reasons** why a particular topic is

chosen. These reasons can be collectively summarized as a number of propositions that can be placed into **descriptive phrases or sentences** (Univ. Hong Kong, 1998). For example, one might recognize a problem in insect defoliation of forest trees as stated in **Example 3.1**.

Example 3.1

Statement of the Problem:

Insect *Z.z* defoliation of Species *A*

Reasons for choosing this topic:

a) commercial value
b) tree damage
c) percent of species *A* in commercial forests of region
d) recreation impact
e) need for control measures
f) *etc.*

These reasons can then be restated into action-oriented expressions of qualities. Taking the same list in **Example 3.1**, they can be restated as in **Example 3.2**.

Example 3.2

Restatement of the Problem

Reasons:

a) species *A* is a commercially valuable tree species
b) insect defoliation is resulting in growth reduction and death of trees
c) species *A* is the dominant tree species in 45% of the commercial forests in region *Y*
d) defoliation is reducing the recreation value in the parks in the region
e) there are no current control measures for controlling insect *Z.z* on species *A*
f) *etc.*

Another technique for defining problems and stating problems is to use the **A BUT B statement**, where **A** represents a goal or current situation, the **BUT** indicates that the goal has not been met or that there is some limitation on the current situation, and **B** indicates the obstacles that are in the way (Texas Tech Univ, 1998). **Example 3.3** illustrates this.

Example 3.3

An A BUT B Statement:
There is a need to prevent defoliation of large areas of tree species *A* by insect *Z.z* in region *Y*, BUT, there are no effective and economical control measures for this insect.

Thus far, we have only defined a problem, we have not verified that this is a significant problem of importance, nor have we developed researchable questions and hypotheses focused on identified critical aspects of the problem statement. Part of the process to identify the significance and place the problem in a relative priority of research topics is to have excellent communication and interaction with the stakeholders impacted by the problem.

User Input and Stakeholder Needs

Research organizations must either formally or informally consider the constituencies that they represent when they define their mission and develop their overall research strategies. This concept of identification of the stakeholders' concerns and needs is also very important to assist the individual researcher in identification and definition of research problems and issues. ***Stakeholders are defined as people, groups, or organizations that have a claim on the research organization's (and individual researcher's) attention, resources, or output, or are affected by that output*** (Lundgren, *et al.*, 1994). Examples of stakeholders that are important to a research scientist include public officials, governing bodies, interest groups (industry, conservation, cooperatives), landowners, taxpayers, educational institutions, donor and technical agencies, and organizational colleagues and employees. The scientific community, in many forms, e.g. professional societies, research groups, acad-

emies, can also be an important stakeholder group, and in many cases are the most important group because of the role of scientists in the review of new knowledge and verification of reliable knowledge.

Awareness of the needs of the potential end users of research products in an applied context may be much more critical in definition of the importance and significance of problems than dependence on the research community itself. However, the research approach to addressing the problem will certainly be scrutinized, and judged by other scientists.

Lundgren *et al.* (1994) in their IUFRO manual on "Planning and Managing Forestry Research" provide an excellent section on the importance of stakeholders to research organizations. I have condensed much of their material below as it applies to individual researchers. They explicitly identify employees, particularly other scientists, as an important stakeholder group in planning research. Scientists tend to hold organizations, and therefore other scientists, to more exacting scientific and professional standards than do other stakeholder groups.

One must recognize that different groups have very different perspectives and concerns about the outcome of a research program. For example, women may hold different values and concerns than men. The importance of the key role of women in the use of forests and related natural resources in many countries must not be ignored or treated in a perfunctory manner. Likewise, the special needs of religious or minority groups should be given consideration. Many interest groups will be stratified by economic or social categories that influence their perception of research needs.

As commented on earlier, the sponsors who provide funds for research are often looking for research that will address major societal concerns and issues, and it is necessary for a successful research proposal to be firmly grounded in a rationale for the importance and significance of a selected research topic. Therefore, the meeting of key stakeholder needs may be as crucial to the proposal and to the success of the proposal as is the validity of the scientific approach. **Table 3.1** (adapted from Lundgren *et al.*, 1994) provides an example of key stakeholder groups in forestry research.

Table 3.1 - Key Participant Groups and their Functions in Forestry Research

Key Participants in Forestry Research	Functions
Funders and Legislators	▪ Evaluate budget and funding requests for research programs ▪ Provide funds for research
Higher-level Administrators and Policy Makers	▪ Prepare and justify budget requests ▪ Administer laws, regulations ▪ Allocate appropriations
Research Managers	▪ Plan and manage research programs ▪ Prepare and justify budget requests for specific research projects, programs, activities
Research Scientists	▪ Plan and do research ▪ Disseminate research findings
Research Disseminators	▪ Disseminate new knowledge and technologies resulting from research ▪ Provide feedback from users to scientists
Users of Research Results	▪ Adopt and adapt research results ▪ Implement new technologies
General Public	▪ Receive wanted and unwanted effects from the use of research results ▪ Affect funding decisions

One can make a start on analyzing stakeholder needs by asking key questions (Lundgren *et al.*,1994):

1. Who are the organization's (or your research area's) stakeholders?
2. What do they want from the research project?
3. What criteria do they use to evaluate your research?
4. How is your research (or your organization) performing against those criteria?

The first question may be answered by a brainstorming session within your own research group or with other scientists and professional colleagues. Certainly, if your research organization has a strategic plan, it should be consulted to determine if many of the stakeholders have already been identified.

Perhaps an existing organizational strategic plan will provide information on the second and third questions as well. If not, it may be necessary for you to make informed judgements about what stakeholders want and what criteria they might use to judge your research output. This may be quite feasible if you, as the researcher, already have good communication and interaction with stakeholders. Perhaps it will be necessary to ask the stakeholders, through surveys or personal interviews, as to their wants and criteria. It is obvious that this can be a very time-consuming enterprise for a research scientist if his or her parent organization has not already done this analysis of stakeholders. The effort that must go into this will be very much dependent on the type of research problem being considered.

The determination of how your research is performing against stakeholder criteria will require some sort of analysis that allows you to examine performance against specific criteria that have been identified. One tool is to use an analysis table (Lundgren *et al.,* 1994) that simply lists stakeholders, their wants, their criteria, and some estimation as to how the research performance meets the criteria (**Table 3.2**)

Determining Resource Needs

After one has identified and defined a specific research problem or need, it will be necessary to consider the research resources that will be needed as one refines the research problem into a focused approach with specific objectives. Will the necessary personnel, equipment, facilities and other resources be available to realistically address the research problem? If not, will it be possible to secure the necessary resources?

To prepare a research proposal, whether it is a broad, interdisciplinary approach to a problem, or a very narrowly focused approach, the research scientist must "inventory" the resources available and estimate what additional resources will be required. If it is anticipated that the research sponsor will not be receptive to provision of certain types of

Table 3.2 - Stakeholder Analysis

Stakeholder	What do they want from the researcher?	Criteria they use to evaluate the researcher's performance	According to these criteria, how is the researcher performing?
National Government	▪ Research for sustainable forest development ▪ Focus on resource use with protection ▪ Problem solving ▪ Generation of information	▪ Reports ▪ Feedback from other agencies and citizens ▪ Publications	▪ Unknown in this example
Ministry of Natural Resources	▪ Applied research support ▪ Relevant research ▪ Publications	▪ Useful results	▪ Unknown in this example
International Research Donor Organizations	▪ Specific research activities ▪ Reports and results	▪ Progress reports ▪ Evaluations ▪ Publications ▪ Useful results ▪ Well-conducted studies	▪ Unknown in this example
NGOs	▪ Applied research support ▪ Collaboration with scientists and technicians ▪ Frequent collaboration	▪ Useful results ▪ Relevant research results ▪ Publications	▪ Unknown in this example
International Forestry Research Organizations	▪ Participation ▪ Contribution to the scientific literature	▪ Frequency and quality of participation ▪ Quantity and quality of scientific papers ▪ Publications	▪ Unknown in this example

resources, can these resources be gained by collaborations or partnerships with other research groups or organizations? All forestry research requires some minimum level of resources. Experimental research has much different requirements than does a non-experimental approach that may be conceptual in nature and only requires office space, computer resources and qualified staff. Some types of research may require highly specialized equipment or personnel, unique facilities or extensive transportation needs. This estimation of required resources must be given substantial attention. Underestimating critical needs in a research project, even if the research proposal received excellent reviews by scientific peers, can lead to serious delays, unfulfilled expectations, and even failure of the overall project. This results in a waste of resources, and can seriously jeopardize the researcher's reputation and ability to obtain funding support in the future.

Resource requirements can be categorized under at least seven general areas: human resources, facilities, equipment, supplies, funding, institutional support, and special considerations. Each of these should be given consideration to plan and develop a research proposal. A more extensive coverage of resource assessment can be found in Lundgren *et al.* (1994). These categories will be addressed in more specific terms later on when discussing the preparation of research proposal budgets.

Human Resources. The availability of personnel to carry out all aspects of the research is crucial to the success of the research project. This includes not only the scientific personnel, *i.e.,* the principal scientist(s), research technicians, research assistants, but the important support staff as well, *e.g.* administrative personnel, accountants, and field assistants. Will these people be available and at the times consistent with the research schedule? Do they have the necessary and appropriate skills needed for the project? Is there an appropriate supervisory structure in place to manage the personnel involved with the research? The research scientist should be prepared to properly manage the human resources component of the project.

Facilities. The facilities needed to conduct the research must be fully specified. Are special laboratories or unique field sites required to accomplish the research? Are the needed facilities available at the appropriate times during the research? Will the facilities needed be fully committed to other research projects or can they be shared or be

scheduled when needed? If the facilities are specialized or unique, will they require budgetary support for maintenance that may not be covered by the research organization? In preparing a research proposal, often one of the major contributions toward the research that can be shown for the researcher's organization is the availability of the needed research facilities. If support for additional facilities is to be requested from the sponsor, expect to provide considerable justification. Also, one should be cautious and consider the future costs of maintaining new facilities, if not to be provided by the sponsor. Furthermore, consideration should be given to ownership of facilities following completion of the project. Again, collaborative arrangements and partnerships can be a very effective way to meet facility needs.

Equipment. The planning for the use and availability of equipment for the research requires the same consideration as for human resources and facilities. If special, sophisticated equipment is required, it should be clear that the research personnel have the necessary skills to operate the equipment and that the upkeep and maintenance of the equipment can be met. If special training will be required, does the budget or available resources reflect the ability of the research project to meet the costs? Often sponsors will allow the purchase of special equipment within their guidelines, but justification is always required. Purchase of specialized equipment can lead to a waste of valuable resources if the maintenance and repair cannot be readily met to assure continued use. It is important to have a clear understanding of ownership of equipment at the onset of the project.

Supplies. All forestry related research will require supplies, ranging from office supplies to very specialized items for particular research activities. Supplies are usually those items that are considered expendable, although some minor types of instruments and equipment might fall into this category. Often each research institute and funding sponsor have their own guidelines as to what constitutes "equipment" (often defined as an item that exceeds some set monetary value) rather than "materials and supplies." Certain chemicals, other hazardous materials, and biological materials may require special handling, storage and disposal as stipulated by the research organization.

Funding. After assessing what the research organization can provide in the way of the research needs in human resources, facilities, equip-

ment, and supplies, the additional needs will determine the funding request to a sponsoring agency. After all, the reason to seek outside research support is to provide the resources needed for a specific research goal. Request of research support is always a compromise between what ideally the researcher would like to have in support of the research, and a realistic budget that will strike a balance between the research goals and what minimum resources are needed to accomplish the research. It is not unusual for a sponsor to come back to a researcher, following a favorable peer review of the research proposal, and ask if the research can be accomplished with a smaller budget than that requested. If the researcher has developed a realistic research plan and a realistic budget, the response to such a request should be that a reduction in budget will only be acceptable if there is a reduction in the objectives, and therefore a reduction in the expected outcomes or products of the research. It is a courageous researcher indeed who can resist saying yes to a budget reduction if it means the difference between partial support or no support at all!

Institutional Support. It is certainly important that the researcher have institutional support for the proposed research and that the institution is perceived by the sponsor as being supportive. Conversely, the investigator must be cognizant of the obligations that a new funded research project may place on the institution. It is extremely important for the researcher to have an open communication and dialogue with his or her supervisor or research director to insure that the receipt of a funded research project will not have negative consequences to the organization. For example, the funding of research personnel by the sponsoring agency could have serious financial consequences at the termination of the project if the research organization has an obligation to keep the personnel on the payroll. Another example might be the acquisition of major equipment or special facilities that would require substantial maintenance by the research organization, once the outside funding has ended. On the other hand, in many cases the research director or department head may be willing to take the risk and be willing to gamble that the acquisition of new personnel or new facilities will allow expanded research and funding opportunities in the future.

***Special Considerations*.** Some studies will require special permits or authorization. For example, genetically modified organisms (GMOs) or the introduction of exotic pest predators for biocontrol.

4.0 Identifying Sources of Research Funding

Objectives

- To show the importance of understanding the goals, purposes, and perspective of potential research sponsors
- To emphasize the need to determine if potential sponsors have specific requirements for:
  - eligibility to seek funding
  - collaboration and cooperation
  - matching funds
- To stress the need to follow the guidelines and formats of the sponsor

Let's now assume that you have identified specific research needs and determined the areas of research where your expertise and capabilities are appropriate. Who is going to support the research? If you are going to be successful in obtaining funds from outside sources, then the first step is to identify potential sponsors who might be willing to support your particular research interests. It is, of course, possible to first identify sponsors, their priorities and interests, and then define your research project. However, this is somewhat opportunistic and will not be nearly as effective as making informed decisions about research needs, your capabilities and unique qualifications, and then seeking appropriate sponsors.

In the broadest sense, there is a tremendous amount of resources available for research worldwide, as both government and private funds (Community of Science, 1998). There are many non-profit organizations and government agencies that award billions of dollars in grants each year. Additionally, there are many government and private corporations that are also willing to provide funds for contract research. For an initial idea of these sources of funds, examine the annotated listing of grants in international forestry and natural resources provided by Job (1995). Also, the Internet website of The Foundation Center (1998) provides further information on foundation and private corporate giving. The availability of funds for research from many organizations is motivated by their concern with

social problems, injustices, inequities, or economic needs. These sponsors are willing to invest money to address these problems. Many of these sponsors are concerned with filling "gaps", *i.e.,* the difference between "what is" and "what ought to be" (Miner and Miner, 1998). There will be considerable competition for these funds, and to be successful at obtaining grant money, you must understand the "rules of the game". You must understand the sponsor's mission and mandate and reflect that view in your own research proposal. In writing a grant proposal, you must be careful not to focus so much on your own priorities that you fail to match the proposal project to the priorities of the funding sponsor.

Goals and Purpose of Funding Organization

> ***"You must understand the sponsor's mission and mandate and reflect that view in your own research proposal*** "

It will be a waste of your time, and the sponsor's time, to submit a proposal to an organization without fully understanding its mission and purpose for sponsoring research. It is imperative to find out as much about an organization as possible before identifying it as a suitable sponsor for your research. Most government organizations will have well-documented objectives and guidelines available to interested researchers. Obtain a copy of these guidelines, and if possible find out the name of a program officer who you can contact prior to writing a proposal. If it is possible, personal contact, even by telephone, is always preferable over written communication. However, don't contact the person until you have received the sponsor's guidelines and familiarized yourself with the organization's purpose and goals. You can then briefly outline your research idea to the contacted person, placing it in the context of the sponsor's goals, to determine if they would be receptive to receiving a proposal.

Eligibility to Seek Funding

In reviewing the guidelines of a research sponsor, establish if you or your organization is eligible to compete for the organization's funds.

This may require some careful reading of their materials, and if not clear, you may have to contact the organization directly to determine eligibility. Some sponsors may require that your research project be a collaborative effort with a community or non-profit organization, or that you must be a member of a research university. Research supported by industry may require that you cooperate with some entity of that particular industry. Other sponsors may only provide funding to organizations, not individual researchers.

Requirements for Collaboration/Cooperation

To be successful with some sponsors, it may be necessary to have a project that demonstrates strong collaboration and cooperation with a number of groups or organizations. This is certainly the case for large research projects that address multi-disciplinary and complex problems. It is rare for a single investigator to be successful in obtaining large monetary grants for such types of projects. The collaboration should demonstrate the synergism of resources and expertise that can be brought to bear in support of the proposed research. The preparation of these types of projects requires considerable effort and time for planning that must be done well in advance of the actual writing of the proposal (See Chapter 10). Where multiple investigators or multiple organizations are involved in a research project, it is important to clearly describe the role and responsibilities of each collaborator and to specify how the project will be managed.

Requirements for Matching Funds

In accordance with policy, statute or regulation, many sponsors may require that the researcher's organization cost-share or match part of the costs of the research. How these requirements can be met will vary with the sponsor and the research organization. In-kind or non-cash contributions might meet the requirement and should always be considered first. Examples of in-kind cost sharing include the salary contribution of research and administrative personnel, volunteer time, provision of transportation or communication services, materials and supplies, or other services provided by the institution that contribute to the research activity. However, in some instances, cash contributions to the research may be required. This might include the use of gifts given to the unit, salary surpluses recovered from vacant positions, or research incentive awards. Usually funds from other sponsored grants or contracts cannot be used

to meet this requirement. **Cost-sharing/matching funds** are to be distinguished from what is termed **Indirect Costs** (IDC) or "overhead" (NSF, 1998). The latter costs are those that are established by the research organization and are often periodically negotiated with major funding sponsors. IDC can be considered as the "cost of doing business" by the research organization in support of the infrastructure (administration, buildings, utilities, library use, *etc.*) for conducting research. The application of IDC can be flexible and the rate may depend on the source of research funds coming into the research organization. Some sponsors will not allow the research institution to charge IDC on their grants. Be certain that you are familiar with your own institution's policy on IDC rates.

Specific Guidelines and Formats for Proposals

Most sponsors will have their own procedures and guidelines for research proposals, ranging from simple letter-type proposals required by some corporate sponsors, to very specific and extensive forms required by some government sponsors. Make sure to request these guidelines and application forms from the program officer of the sponsoring organization. If appropriate, request a list of past grantees and reviewers (See Chapter 6). A past grantee may be able to provide additional ideas and tips that would assist you in putting together your proposal. Be careful to follow the sponsor's guidelines in every detail (Appendix II).

Fundamental versus Applied Research

Definition of research as "fundamental" or "basic" as compared to "applied" is difficult at best, and often raises considerable controversy. We have earlier defined scientific research as that activity that utilizes the scientific method to gain reliable knowledge. By this definition, the degree to which research is fundamental, or to which it is applied, is somewhat irrelevant to the scientific process. However, some sponsoring organizations tend to place emphasis on more fundamental research than others, with less emphasis on direct application. Often national government research foundations and councils have mandates to support basic science in well-defined discipline areas. Forestry research certainly can range from very fundamental to very applied, but realistically, and primarily because of its professional context, it will often be concerned with direct application of research to problems and issues. The

type of research in which a particular sponsor has interest will certainly influence the way in which a research proposal is written. Many private foundations and corporations will be more interested in research that directly addresses a defined societal or economic issue than will a national science council or foundation, which may seek new fundamental knowledge that may have no current, direct application to an existing problem.

Lundgren *et al.* (1994) point out that it is important to consider how the evaluation of the results of fundamental research and applied research can differ. The results from fundamental research are most likely to be judged on the basis of the utilization by other scientists in their research and how the results add to the body of primary science. Thus, evaluation will consider the extent the results are actually used by scientists and the impact on science. This type of evaluation essentially requires that such evaluation be done by scientific peers and involve value systems from within the scientific community.

If we further consider applied research as being science that produces results that are useful (perhaps directly or indirectly) to land managers, farmers, resource users, and many others that might benefit from change in the way things are done, then this suggests a different strategy for evaluation. The evaluation of the outcomes of applied research can and should involve those who know what the consequences are likely to be from the application of the results to particular practices. Evaluation will include the extent to which research findings are actually adopted in practice and how they impact people, management systems, and the natural environment. Such evaluation may involve a multitude of value systems, both within and outside of science.

Although evaluation of the outcomes from fundamental and applied research (which may vary in degree from very basic to very applied, or be a mixture of both) may require different approaches, the principles that apply to writing a successful research proposal will be the same.

Government, Non-Profit Foundation, and Private Corporation Funding

There are tens of thousands of grant programs that provide support for scientific research. Most countries have national government research

programs that are major supporters of research in their country or region. Additionally, there are local, regional and international non-profit private organizations that give grants to further their interests and causes. Added to this multitude of potential sponsors is the corporate world, where the funding of research is motivated by "profitable philanthropy" the idea that research will bring their company better products, happier or healthier employees, lower costs, or an improved public image (Miner and Miner, 1998). The researcher's approach and appeal to each of these three major groups of potential sponsors is likely to be quite different.

Government granting sources will reflect the policies, societal values and economic systems of the constituencies that are represented. The kinds of research that a national government supports may be quite different than the research supported by a provincial or state government. Probably the greatest latitude of research interests will be found among private foundations, where the reasons for supporting research will range from highly specific purposes for very specific societal groups, to purposes that are concerned with large geographical regions or global problems and issues.

The approach to private corporations may require a very personal approach, since most corporations have a very unstructured application process. Since corporations are in the business to make a profit, your proposal must convince corporate officials that their grant funds are "buying" benefits for their corporation – increased profits, improved image, an improved environment for the employees, or a better product. Establishing a one-to-one relationship between the researcher and the corporate official responsible for industrial sponsorship is extremely important if such support is desired.

5.0 Introduction to the Research Proposal Process

Objectives

- To introduce the major components of a research proposal
- To introduce the important steps leading to the writing of the research proposal

In Chapters 6 - 10, you will be guided through the process to develop and write a research proposal. In way of introduction to this process, this chapter will basically outline what will be involved in completing a sound and well-written scientific proposal for forestry research.

Basic Steps in Successful Fund-Seeking

In Chapter 4, you were introduced to an approach to identify sources of funding for your research project. The *identification of a potential sponsor* for your research is the first basic step in getting started. You will need to select those agencies and organizations that have the highest probability of financing your research. The second step is to *contact key people* who can provide assistance in planning your proposal before you start writing. The final and crucial step is to carefully *write a well-reasoned proposal*. Remember that even good ideas can be rejected (and usually are) when packaged poorly.

Background Documentation

Before you begin to write the final proposal, you will require background information as documentation for the content and basis of the proposal. This background documentation will ordinarily fall into three general categories: concept, program, and expenses (Geever and McNeill, 1997).

The **concept** is what provides the basis for fitting into the philosophy and mission of the funding organization. This is where you articulate the need for the proposed research within the context of your organization and in relation to the mission or goals of the sponsor. Your arguments in support of the concept should be well-documented.

The **program** is what you propose to do. It will provide, in detail, the nature of the project and how the research will be carried out. It will provide a clear sequence of events (a timetable) for the research activities and it will specify both anticipated outcomes and the way in which they will be evaluated. Finally the program will document staffing needs and the way in which they will contribute to the program.

The **expenses** will provide a best estimate of the resources that will be needed to complete the research. It is important to be unambiguous as to the resources provided by the research organization and those needed to be funded by the sponsor as additional resources. In devising the budget for the project, it will be important to judge whether the costs are in reasonable proportion to the anticipated outcomes from the research. Be prepared to adjust the project plan if it appears that costs are prohibitive or unrealistic to the anticipated results.

General Components of a Research Proposal

As pointed out by Geever and McNeill (1997), almost all research proposals will have the following six basic components:

- Executive Summary (or Abstract)
- Statement of Need
- Project Description
- Budget
- Organizational Information
- Conclusion

Although these components may be called something different, depending on the sponsoring organization, they will provide the structure and basis for solicitation of resources from the funding organization for support of your research project. The content for each of these general components will be discussed in much greater detail later on. In some cases, the basic component may be termed differently and actually have several sub-headings.

The **executive summary** is a brief statement of the problem and should include a short description of the project and its benefits. It should also indicate the funding requirements and emphasize the organization's (and researcher's) expertise and capability to carry out the project. This

is the most important section of the entire research proposal because many reviewers may rely heavily on this section, especially if they are limited in time to review the entire proposal.

The **statement of need,** which should be short and concise, presents the best available facts and statistics to support the need. This component should provide a realistic potential for meeting the need and show how the project can serve as a model or useful approach for others. The priority for addressing the need, and why you are best suited to address the need, should be clearly stated.

The **project description** will be the essence and substance of the proposal and must state clear objectives. Objectives must be tangible, specific, concrete, measurable and achievable in the time period of the project. The methods section will be defined by the objectives and should specify the ways to achieve the objectives. The methods will describe *how* (what will occur), *when* (timetable for activities), *why* (the reasons for using particular methods or approaches), and *where* (the laboratory, field or other location). This section should allow the reader to visualize the implementation of the project and convince the reader you know what you are doing. This section should also clearly define who is doing what in way of staffing. An evaluative process to determine the success in meeting the objectives should also be included.

The **budget** should categorize the major types of expenses and include a narrative that explains and justifies the budget categories, and especially unusual items.

The **organizational information** component is needed to present a clear understanding of the mission and appropriateness of your organization to conduct the proposed research. In some cases this might be handled as an attachment or brochure. For some organizations, the appropriateness to conduct the research may be so obvious to the sponsor, that no informational component is necessary.

The **conclusion** is a succinct section of one or two paragraphs that calls attention to the future, indicates broader implications of work proposed, suggests follow up activities, or indicates how the project will continue after the end of the funded project.

It is a good place to reiterate what you wish to accomplish and to make a final appeal for your project. This component is not to be confused with the executive summary which is a comprehensive overview of the whole project.

6.0 Pre-planning

Objectives

- To provide direction for establishment of contact with potential sponsors
- To provide suggestions on specific questions that should be asked to:
  - program officers
  - grantees
  - past reviewers
- To suggest how to refine the focus and concept of the proposal
- To indicate the content of a preproposal

Deciding on the Sponsor

Considerable effort should go into pre-planning before a single sentence is written on the final proposal. In the Introduction to Chapter 4, the identification of a research sponsor was considered the first basic step to research proposal preparation. This important decision on sponsor selection will be made after you have studied and familiarized yourself with the sponsor's mission, goals, and guidelines for application. You may also be well on your way to formulation of a general concept of your proposed research as it relates to the sponsor's interests and your own expertise and capabilities. However, you may still have some unanswered questions about the sponsor's guidelines or the "fit" of your concept to the sponsor's mission. Now is the time to make direct contact with the program officer or other designee of the sponsor to further explore the feasibility for a proposal.

Establishing Contact with the Sponsor's Representative

The individuals who play a decisive role in grant guidelines may have different titles in different organizations, and may be referred to as program officer, scientific secretary, scientific advisor, scientific director, or technical advisor. For the purposes of this discussion, such individuals will be referred to as program officers. In most cases, program officers of sponsoring organizations are very willing to talk with prospective researchers, and actually welcome the opportunity to do so.

It can save considerable time for the staff of the sponsoring organization in outside review if the sponsor's program officer can head off proposals that are not appropriate and receive only those that are relevant to the

sponsor's mission. It is best, if possible, to talk personally with the program officer. But, realize that you should be prepared to be very brief and to the point with your questions. Try to keep your initial contact to less than 10 minutes. You can later schedule more time with the program officer if necessary. Make sure you tell the program officer that you have carefully studied the sponsor's guidelines and that you have additional questions. Don't ask questions that are readily answered by the written guidelines. If you do so, you are jeopardizing your credibility. Use this initial contact as a way to obtain "between the lines" information. Remember, program officers are expected to be fair and even-handed. In framing your questions, don't place them in a position that suggests that you are asking them to give you privileged treatment, different from other applicants.

There are certainly "do's and don't's" in asking questions to the program officer. ***Do not*** ask him/her to judge the merit of your proposal or concept. ***Do*** ask their opinion on the relevance of your proposed research to the sponsor's program, and how it would fit within their priorities. ***Do not*** ask the program officer for copies of other proposals that have been submitted to them. ***Do*** ask about the number of proposals they have received in the past and what is the resulting success ratio. ***Do*** ask if there are any unstated limits or historical precedents about the size of a funding request. ***Do*** ask about the review process and if there are any evaluation criteria that are not stated in the guidelines. Other kinds of questions one might consider asking program officers include (adapted from Miner and Miner, 1998):

- If your project concept does not fall within the sponsor's current priorities, are there modifications in objectives that might better fit? Are there other sponsors that might be interested in the proposed concept?
- What is the sponsor's current budget for the grant program? This may allow you to estimate a reasonable budget for your own project.
- Will awards be made on the basis of special criteria, such as geographic region or type of organization? This may provide an indication of hidden agenda.
- Does the program allow one-time-only support, or will it allow renewals or other funding opportunities in the future? This lets you know if you will be able to go back for future funding support. This might be quite important for projects that require continuous support for long-term goals.

- Does the sponsor have any unannounced programs or unsolicited funds to support your research? Sometimes you may discover unobligated or uncommitted funds that are available.
- What are the most common mistakes you find in proposals submitted to you? The response to this question may be extremely helpful in avoiding the same mistakes in your own proposal.
- What would you, as program officer, like to see given more attention that is not being currently covered well by applicants? This gives the program officer an opportunity to discuss his particular bias and to give him a sense of involvement in the proposal development process.
- Would he/she be willing to review a pre-proposal of two-to-three pages that succinctly develops the research concept? If the program officer will do this, this will be an important opportunity for better matching your proposal to their expectations.
- Would they be willing to recommend a previously funded proposal to read to get an idea of format and style? They may not be willing to provide you the proposal but they might provide you the names of successful applicants.
- Should the proposal be written for reviewers with non-technical backgrounds? Adjust the level of technicality of your proposal to the background of those likely to review your proposal.
- Would they provide the names of past reviewers who might be contacted for their perspective and ideas on proposals for the program? If not willing to do so, ask if they can provide general information on the types of reviewers used - background, training, age, and how they are selected.
- Is there a standard Reviewer's Evaluation Form or Panel's Evaluation Form that is utilized, and if so, can you receive a copy? This type of information can be especially helpful as a checklist against your proposal.

Contacting Past Grantees/Awardees

If you were successful in your contact with the program officer and were able to obtain the names of previously successful grantees, you now have the opportunity to add to your wealth of background material on the sponsor's program. Even if you were unable to receive names directly from the sponsor, you may be able to learn of successful past applicants from your own contacts with colleagues. In making the contact, preferably talk to the person who actually wrote the successful proposal. Indicate why you are contacting them and from whom you

obtained their name. There are a number of questions you might pose to them to learn more about the sponsoring organization. Some suggested questions are (adapted from Miner and Miner, 1998):

- Did you call or visit the sponsor before writing the proposal? This gives you an idea of how much pre-proposal contact was involved.
- Who did you find to be the most helpful assistant on the sponsor's staff ? This could be someone different from the program officer contact that you made previously.
- Did you use any special advocates on your behalf ? This will indicate if outside influence is useful in the proposal process.
- Did the sponsor review a pre-proposal or proposal draft prior to receiving the final proposal? This indicates the receptiveness of the sponsor for pre-proposal contact.
- Were you aware of any hidden agenda items related to the sponsor's program?
- What materials or information did you find most useful in developing your proposal? The response to this should suggest valuable reference materials that you may wish to examine.
- Did the sponsor make a site visit prior to making a decision on funding your project? If one occurred, follow up on what took place and the agenda for the visit.
- How did your initial budget request compare to the final budget awarded? This may give some indication if the sponsor undertakes budget negotiations and under what conditions.
- Even though you were successful, what would you do differently next time? There is always a retrospective view of a process and an opportunity to strengthen a proposal.

Contacting Past Reviewers

If, in your contact with the program officer, you were able to obtain a list of previous reviewers, then you have a further option to gain information on how to tailor your proposal to the sponsor's interests and priorities. The goal in talking with a past reviewer is to learn of the actual process used to review proposals. The time that a reviewer has to review your proposal will provide another indication of how the proposal should be written. For example, if the typical reviewer has only minutes to scan your proposal in a panel setting instead of having hours to study it on his or her own time, it will be especially critical for your

summary and topic headings to be clear and appealing. Some of the questions that might be asked a reviewer are (adapted from Miner and Miner, 1998):

- How were you selected to be a reviewer? The response might indicate that the selection process is very specific and based on a small pool of individuals who have had a history of working with the sponsoring organization, or it may indicate that reviewers are chosen somewhat randomly from a large pool of scientists.
- Did you review proposals at the location of the sponsor or at some other location? This would indicate whether it is a mail review process or a panel review process. The former process may provide a more relaxed situation where the reviewer can review the proposal in a more thorough and leisurely manner. This type of review would favor a more thorough documentation in the proposal. Panel reviews are often under a more restricted time frame which doesn't allow a thorough review by individual reviewers.
- Was a particular evaluation or scoring system used? This may give some indication of what is the weighting or priority of certain sections of the proposal.
- Were you given instructions to look for certain characteristics or specific items in the proposals? This again may indicate certain aspects of the proposal where you want to place particular emphasis.
- Having been a reviewer, would you write proposals differently based on your experience? The response to this question may provide additional clues to areas to emphasize in your preparation.
- In your view, what did you find to be the most common mistakes made in the proposals you have reviewed? This should provide an alert to what to avoid in your own proposal.
- How many proposals were you required to review at any one time?
- And, how much time did you have to review each proposal?

Responses to these last two questions again give you an idea as to how thorough a reviewer might be in reviewing a proposal.

- Was there a staff review by the sponsoring organization following your review? This may give some indication if the sponsor's staff has some discretionary authority in the final decision on a proposal.

It should be obvious from the above discussion, that the opportunity to be a reviewer for a sponsor should not be passed up, especially if it is a sponsor that would be potentially of interest to you as a funding source in the future. If you were to serve as an *ad hoc* reviewer for the spon-

sor, then you would be able to answer the above questions first-hand and from your own experience.

Determining Focus of Proposal

If you have been fortunate enough to have had the time and the good fortune of being able to talk with the program officer, scientists who have received grants from the sponsor, and a reviewer or two, then you should be prepared to finalize the focus of your proposal based on the priorities, interests, and even biases of the sponsoring organization. Of course, there is always the possibility that having gone through this "fact-finding" effort, that you will find that the probability of funding for your particular research interest is almost nil, and that it will be somewhat futile to pursue funding from this particular sponsor. It is probably best to cut your losses and investigate the next potential sponsor on your list. In some cases it will not be absolutely clear on the fit between your research and the sponsor – it will be your subjective decision if there is a high enough probability to warrant the effort of submitting a full proposal.

It is assumed you had a general concept in mind when you first approached the sponsor. Now having received further input from the sponsor, grantees, and reviewers, it is likely that you will need to modify your concept and redefine the objectives of your research to make it as **appealing** as possible to the sponsor and reviewers based on the new information you have received. MacKensie and Angle (1997) provide some key considerations in determining the focus within the context of the sponsor's priorities and interests, including some of the following:

- Show how the topic (focus) has appeal to a broad audience or end users, *i.e.,* stay away from minor problems.
- Emphasize an area that has good potential for publications or other tangible end products.
- Be careful that your topic is not perceived as an "old topic" that has little relevance today, or has already been researched.
- Consider any obvious cooperation and collaboration that the topic would encourage or justify.
- Demonstrate how the topic will extend into other areas.
- Stay away from the development of research methods *per se* or descriptive work unless these are explicitly defined as of high priority to the sponsor.

- Stay away from a topic that is not important to your geographic region.
- Relate your topic to "big picture" problems that are important to your particular region as well.
- Show how your topic contributes to science in general, or even better, to the general public.
- Insure your topic can be addressed with a realistic budget that doesn't appear overly large.
- Demonstrate a precise understanding of the topic and the need or problem you are attempting to solve.
- Make certain that you convey that the problem is feasible to solve through your research.
- Show the relevance of the topic to your own organization's goals.

Pre-proposal

If you received approval from the sponsor's program officer, prepare a concise and brief pre-proposal for the program officer to review. This document should be no more than two-three pages in length. It should clearly state the program of the sponsor for which you would like to be considered; it should clearly establish the relevance of your organization to address the topic; it should clearly state your research concept, preferably in a format that states the objective in the form of a problem or need in the context of the sponsor's interest; a statement of a logical solution to the problem or need; and, a brief description of a logical research approach to arrive at the solution. When considering the statement of objectives, Miner and Miner (1998) suggest you should be sure to convey in your pre-proposal that you have a ***s****pecific* problem in mind, there is an ***i****mmediate* time frame to be considered, there is a ***m****easurable* way to determine success of outcomes, there is a ***p****ractical* approach to reaching a solution, there is a ***l****ogical* way that the stated objectives systematically contribute to achieving goals, and there is a way to ***e****valuate* how much change can occur if the project is effective. You might remember this from the acronym: "Keep it **s-i-m-p-l-e**". The "simple" criteria represented are not mutually exclusive, but hopefully each of your stated objectives will touch on at least two or three of the criteria.

7.0 Writing the Proposal

Objectives

- To provide details on the writing of the major components of a research proposal
- To indicate for each major component of the proposal the
  - purpose
  - suggestions on content
- To provide a solid and appropriate model for the writing of most research proposals

This section will address, in considerable detail, the actual mechanics of writing the research proposal and provide tips and suggestions on each of the major components that most research proposals will contain. The discussion will follow a sequential order that relates to the typical organization of a research proposal. The organization and content are generic but together they should provide a good model for most research proposals. The recommendations are just that, and they shouldn't be rigidly adhered to if they stifle creativity or the particular sponsor guidelines suggest other modes or styles. There are several documents that provide general guidance for proposal writing and in many places I have liberally drawn from the excellent suggestions provided in Baldensperger *et al.* (1993), Geever and McNeill (1997), MacKensie and Angle (1997), and Miner and Miner (1998).

Organization of a Proposal

Most granting sponsors will offer guidelines that precisely indicate what information they expect in your research proposal (see Appendix II for one example). Follow them exactly. However, you will usually have the opportunity to add additional information, if not specifically disallowed, that can help strengthen your proposal. The content of the research proposal to be discussed here is organized into nine components that have been expanded from the six general components introduced in Chapter 5. This should give you plenty of opportunity to cover the basics of what can contribute to a solid and appealing research project. For each component, the purpose will be discussed along with

the necessary content and suggestions for writing the material of the section. These components are:

- Summary (or Abstract)
- Introduction
- Statement of Problem or Need
- Project Description
- Budget
- Budget Explanation
- Special Considerations
- Curriculum Vitae
- Appendices

The Proposal Summary

"This needs to be the best-worded, most concise and most appealing part of the entire proposal."

The Summary

If at all possible, it is important to get the most important part of your proposal up front, and the most important part is the summary (sometimes referred to as executive summary or abstract). This should be the first page of the proposal (sometimes a cover page in a particular format may be required by the sponsor) and be no more than one page in length. This needs to be the best-worded, most concise and most appealing part of the entire proposal. If reviewers and staff are limited in the amount of time that they can devote to each proposal, the summary will be the component they will most likely read carefully and in its entirety.

Purpose

The summary should provide the reader with an encapsulation of what is to be found in the rest of the proposal. It should summarize all of the key

information and convince the reader of the significance and potential contribution of the proposed research (**Example 7.1**). It is strongly recommended that you do not write the summary until you have completed writing the rest of your document.

Suggestions for Content

The length of the summary should be limited to no more than one page and will therefore be restricted to between about 300 and 500 words. The summary should include at least one sentence on (MacKensie and Angle, 1997):

- Your credibility (your ability and your organization's ability to carry out the research)
- The problem or need you wish to address
- The research objectives
- The procedures and methods that will be used
- The resource needs of the project
- The likely outcomes and benefits to be derived from the research

You can use the subheadings of the overall research proposal as a guide to writing the summary. Remember, this needs to be a "sales" statement to the reader – to excite, to interest and to convince.

The Introduction

Purpose

Miner and Miner (1998) stress that this section is to establish your credibility and the significance of your research ideas. The introduction will set the tone for the rest of the proposal. See, for example, how one researcher "set the stage" for a research project that was to evaluate native populations of *Cephaelis ipecacuanha* (**Example 7.2**). Here is where it is important to convey not only the importance of the research problem, but to show how it relates directly to the mission and priorities of the sponsoring organization as well as your own organization. The introduction should flow into the statement of problem so the two sections together make a clear and unambiguous statement about the significance of the research.

Example 7.1

The Summary - Capturing the Essence of the Proposal

Ipecac (*Cephaelis ipecacuanha*) is a small perennial shrub which in the past grew abundantly under shady areas of tropical rain forests of southeast Brazil and was employed by native Brazilians who taught the medicinal properties to European settlers. The ipecac drug has achieved worldwide usefulness as an amoebicide and as a vomitive agent because of its pharmacological active isoquinoline alkaloids. However, overharvesting of wild plants in Southeast Brazil and negligence in replanting ipecac plants after uprooting has led to a severe decline of native ipecac populations. Based on my previous investigations on biological diversity of a number of medicinal plants in Brazil (including work with a false ipecac), and the development of an effective genomic DNA extractive technique, I propose to evaluate the native populations of ipecac in Southeast Brazil as part of a concerted effort to preserve and maintain sustainable production of the ipecac drug. Specific objectives: 1) Locate endemic populations of ipecac in Southeast Brazil and characterize morphological traits, 2) Describe local environmental and climatic conditions of populations, 3) genetically evaluate existing variability within and among populations, using RAPD markers, 4) determine the levels of alkaloids and assess divergent biochemical patterns within and among each population, and 5) establish a core collection of *C. ipecacuanaha* characterized morphologically, biochemically, and genetically. Standard environmental parameters will be measured in the field including soil physical and chemical characteristics, vegetation density, and photosynthetic active radiation (PAR) at the ipecac canopy. Morphological measurements will include shoot height, number and length of nodes, flower color, shoot base diameter, and anatomical characteristics of leaves. Also root volume, root color and root weights will be collected. Leaf samples will be used in genomic DNA extraction and amplified by polymerization chain reaction (PCR) with random primers, according to random amplified polymorphic DNA (RAPD) methodology. Alkaloids will be analyzed by HPLC procedures currently in use. Establishment of plants in the greenhouse will be done by a combination of sexual and asexual propagation techniques. The anticipated outcomes of this research include: 1) Identification of environmental conditions associated with plant development at specific locales, 2) the amplitude of the gene pool within each ipecac population, 3) the establishment of a core collection of ipecac that is thoroughly characterized for a number of factors and that will provide material for improvement through breeding, and 4) the training of a professional cadre with appropriate laboratory resources that can continue to investigate novel ways for preservation and rational use of ipecac and other medicinal plants.

Example 7.2

Background for Proposed Research Project
- Setting the Stage

The Atlantic Rain Forest ("Mata Atlantica") was an extensive heterogenous forest that used to occupy an area larger than 1,000,000 km^2 (about 12% of Brazil's present-day territory). The settlement of European colonists within the forest domain was initially driven by its close proximity to the Atlantic Ocean (along the Brazilian coast). Soon however, the economy of local communities was bursting with trading goods gathered from the wealth of natural resources found in the forest. Today, around 70% of the Brazilian population (near 120 million inhabitants, both in urban and rural areas) live in the Atlantic Rain Forest domain. The natural habitat of many endemic animal and plant species are under encroachment, since the area of the original forest has been severely reduced. The remnant of the forest presently occupies only a fragmented area that is less than 9% of the original cover (*citation*). Many plant species from this tropical rain forest have achieved great importance in history as sources of phytotherapeuticals. At present, these plant species are especially in need of studies concerning conservation of their germplasm. A great number of them are still being collected in large quantities in Brazil, but no cultivation system has ever been established to support a continuous harvest in the future (*citation*). This event has already occurred to *Cephaelis ipecacuanha*, and is presently taking place with *Tabebuia aveliandedae, T. impetiginosa, Echinodorus macrophyllus, Cordia verbencea*, etc. I am interested in investigating the existing genetic resources for medicinal plant species in Southeast Brazil with the goal of preserving and utilizing their biological diversity.

Suggestions for Content

The introductory section should:

- Clearly establish who you are
- Describe your organizational goals
- Refer to the sponsor purpose and priorities as related to the research
- Establish your credibility in the project topic area
- Lead logically to the next section, the problem statement

Although your included curriculum vitae may provide the raw data about your qualifications and background, this section will allow you to specifically emphasize your particular expertise within the current research environment and as related to the proposed research (**Example 7.3**). Provide evidence of your accomplishments that are relevant to the research. Present the material in a brief and concise manner and avoid jargon.

Example 7.3

The Introductory Section -
Establishing Credibility of the Investigator

In my doctoral training I investigated the regulatory elements that control the expression of soybean glycinin genes (*citation*). I also engineered mutations into subunits of the soybean B-conglycinin protein and analyzed the assembly properties of the novel mutants (*citation*). Prior to this training, I spent considerable time as a MS student advised by a quantitative geneticist. These studies allowed me to learn techniques used in plant breeding and plant molecular biology research. A very short visit to Prof._____'s laboratory gave me the opportunity to have discussions and to carry out experiments on extraction and isolation methods for plant alkaloids. Currently my research focus is the basic understanding and preservation of the existing biological diversity of medicinal plants, combined with the economic utilization of their germplasm.

Regarding the proposed project, four sites containing a native population have already been located in southest Brazil (one has been sampled). Determining genetic diversity within this population is in progress at the moment. We have established an inexpensive and efficient method to extract genomic DNA from dried leaf tissue which renders it suitable for PCR (*citation*). Arrangements already established with EMBRAPA will allow the screening of ipecac accessions from the Amazonic Region (Northern Brazil). Contacts have been pursued in Mato Grosso (Western Brazil). In a related project, I have established a cell suspension culture of *Borreria verticillata* (known as the black ipecac, a false ipecac) that is now being characterized for growth and accumulation of secondary metabolites when cultivated under several conditions. The cell cultures are able to grow very well, although no alkaloid has yet been detected.

Statement of Problem or Need

Purpose

This section will represent the reasons behind your proposal and will specify what you wish to change through your research. This section should be a smooth transition from the introduction and logically continue the central theme. Hopefully you will have piqued the interest of the reader in both the summary and the introduction. This section should further increase their understanding of the significance of the proposed research and how the problem will be remedied.

Suggestions for Content

The statement of need will enable the reader to learn more about the issues (Geever and McNeill, 1997). It should present the facts and evidence that support the need for the research project. This evidence may come from your review of the literature, your own past research, preliminary experiments you have conducted, or other sources of an authoritative nature. Decide on the statistics or facts that best support your project but insure what you present is accurate and up to date. Information that is too general or generic will not be very helpful. You need to provide enough background information to show your familiarity with the prior research on the topic and to justify the need for the research (see **Example 7.4** for an example of the review of literature related to establishing importance of conducting research on ipecac). Do not try to justify a research project strictly on the basis of a "need for a method". And, do not assume that your reader will be familiar or understand the problem as well as you do. Even if the problem and research need is obvious, reviewers will want to know how clearly ***you*** can state it yourself .

- ☑ Establish the importance and significance of the problem.
- ☑ Justify why this problem is of particular interest to the sponsor.
- ☑ Demonstrate that it is feasible to solve the problem.
- ☑ Arouse the reader's interest and encourage him to read further.
- ☑ Show how the problem relates to your organization's goals.
- ☑ State the outcome of the research in terms of human needs and societal benefits.

Example 7.4

Reviewing the Literature -
Part of the Statement of Problem

Ipecac is a small perennial shrub that grows under shady areas. Its roots are reddish-brown, annulated, with distinctive rounded ridges (*citation*). Native Brazilians recognized Ipecac roots as having medicinal properties and employed them as an expectorant and as a pain reliever. Settlers soon sent it to their home countries to treat dysentery, a devastating disease in Europe (*citation*). Ipecac became accepted wordwide and appeared in Pharmacopoeias of several countries (*citations*). Commercial harvesting occurred in southeast Brazil since the 18th century when ipecacs became a valuable trading good (*citation*).

Careless harvesting was a destructive procedure in view of the negligence in replanting after uprooting. Remaining populations are restricted to three discrete regions: Central America, the southern Brazilian Amazonia, and the Atlantic forest of southeast Brazil (*citation*). Closer species may co-exist (*citation*). Currently, this plant species and its utility is almost unknown to people living in southeast Brazil. Emetine, the major alkaloid, has proven activity against amoebiasis (*citation*). Dehydroemetine, a synthetic and less toxic derivative (*citation*) can replace emetine commercially. Cephaeline and psychotrine, minor alkaloids, have strong emetic activity (*citations*).

Although emetine occurs in other species (*citation*), ipecac has been the only plant system in which its biosynthesis has been investigated (*citation*). The drug is administered either in low dosages (as an amoebicide in case of acute amoebic dysentery (*citation*)), or in high dosages (as vomitive in case of poisoning by toxic, noncorrosive substances (*citations*)). It is also useful to treat whooping cough, bronchitis, and asthma (*citations*). The world demand for the drug is about 100 tonnes (T). Only 7-10 T are provided by cultivation in India (*citation*) where domestication has been achieved with clones introduced from Brazil (*citations*). "Rio Ipecac" (harvested in southeast Brazil) has a better quality, but the drug is more scarce due to difficulties of wild gathering (*citations*). Micropropagation through tissue culture is proposed as an alternative manner for mass propagation (*citation*).

The statement of need should avoid presentation of the problem in grand or general terms. Avoid such terms as "little is known about...", "there is a general lack of information about...", or "no research has dealt with...". The problem with these type of statements is that you appear to be arguing for something that isn't certain, which makes for a weak statement of need. Instead, explain the consequences of this lack of information in terms of potential impacts (Miner and Miner, 1998) (**Example 7.5**).

Example 7.5

Statement of Consequences
Rather than stating "no research has dealt with the role of insect A on foliar damage of tree species B...", state that "over 10,000 hectares of defoliation of tree species B in province X has resulted in Y economic loss to the region. Although suspected as a primary defoliator in the area, insect A ....." This could then be followed up with the possible benefits that would result from studying some defined aspect of insect A's role.

It is also important to provide a smooth transition between the problem statement and the importance of your proposed methodology. This will assist the reader in actually anticipating the possible solution, based on your methodology and analysis of the problem.

Project Description

The description of your research will have subsections that basically provide the focus of the research (**objectives**), how you plan to do the research (**experimental plan**), what you plan to do with the results (**dissemination**), what specific facilities and equipment will be required to conduct the research (**facilities and equipment**), and the documentation for the research and approach (**literature cited**). All of these subsections together should provide a total picture of the research project.

Objectives

Purpose

The objectives section should specify the measurable outcomes of your research project, *i.e.*, the end products. The objectives will also define your research methodology and the way you will evaluate what will be achieved. This section should precisely indicate what you intend to change through your research and what you accept as proof of project success. Note: Do not confuse objectives with goals. The latter are conceptual, ultimate and more abstract. Objectives are specific and immediate.

Types of Objectives

There are at least four different types of objectives (Geever and McNeill, 1997), and, depending on the nature of the research, a research proposal might have a mixture of these. The first type of objective is one that is **behavioral**, where you anticipate that some particular human action will occur (**Example 7.6**).

Example 7.6

Behavioral Objective

The behavior of small non-industrial land-owners in timber production will be primarily influenced by profit maximization and only secondarily by aesthetic values, as determined by the empirical profit function X model.

Another type is one that is **performance,** where a particular behavior will occur at an expected proficiency level over a specified time frame (**Example 7.7**).

Example 7.7

Performance Objective

The new isolation technique for pathogen A will allow 75% of the evaluated nursery managers to identify pathogen A within a 2-day period after initial detection.

An objective can also be a **process,** where the manner in which something occurs is an end in itself (**Example 7.8**).

Example 7.8

Process Objective
Determining the range of temperature and humidity that allows the successful penetration of the leaf palisade layer by pathogen A, allows defining the environmental conditions conducive to further spread of the disease on tree species B.

And finally, an objective can be a **product**, where the end product is a tangible item (**Example 7.9**).

Example 7.9

Product Objective
Defining the susceptibility of pathogen A to the specific chemical group X of Y class of organics will allow the synthesis of an organic pesticide to control the pathogen within environmentally acceptable limits.

Need for Specificity, Conciseness, and Focus

The objectives section should be kept as brief and concise as possible, yet convey exactly what you plan to do in your research. In writing objectives try to keep them limited to one or two sentences. Don't get carried away with unnecessary text, and make sure the objectives stand out on the page. Regardless of the kind of research, theoretical or very applied, clear objectives must be stated for the reviewers. Don't get your objectives (the outcomes) confused with methods (the means). A good objective emphasizes what will be done and when, whereas a method will explain how it will be done. Consider using bullets, numbers, or indentations to call attention to your objectives in the text.

Suggestions for Content

The actual statements of objectives should have the following characteristics (Miner and Miner, 1998):

- Clearly describe your project's objectives, hypotheses, or research questions.
- Signal the project's objectives without being buried in unnecessary narrative.
- Show that the objectives are important, significant and timely.
- Comprehensively describe the intended outcomes of the project.
- State the objectives, hypotheses, or questions in a way that they can be evaluated or tested later.
- Show why your project's outcome is appropriate and important to the sponsor.

It is appropriate to make a few comments about hypotheses. In some areas of science, a research hypothesis would logically be part of the objective. However, it is recommended that one avoid the statement of a statistical "null" hypothesis (MacKensie and Angle, 1997). As stated earlier, null hypotheses are better left to mathematics and logic where all logical parameters and constraints can be defined. Part of the problem with stating problems in a null hypothesis form is that it presents an unrealistic picture of the real situation. For example, if you were interested in studying the effect of a specific chemical on a metabolic pathway of a specific organism, a hypothesis stated in the null form would be *"the application of chemical X to organism Y will have no effect on ..."*. This, in a sense, is unrealistic, because you probably have a good idea that chemical X ***will*** affect organism Y and that the effect will even be significant statistically. This is with the assumption that you had good reasons and supporting documentation to suggest such a cause and effect relationship in the first place. By using null hypotheses, you lose the opportunity to state research objectives in a much more realistic, interesting and precise way. If you use hypotheses, they should capitalize on key words and relationships. Some examples are given in **Example 7.10**.

The use of such terms as "to increase", "to decrease", "to reduce" are more convincing and indicative of anticipated outcomes than such terms as "to provide", "to establish", or "to create".

Example 7.10

Hypothesis statements

"It is hypothesized that the application of chemical X to organism Y will cause an interruption of the life cycle at the ..."

"It is proposed that the relationship between X and Y is explained by ..."

"I expect that the cause of this mortality can be linked to ..."

"Our preliminary data support the hypothesis that this change can be attributed to ..."

"The spread of pathogen A in region Y has been shown related to factor X, and therefore, the modification of factor X by enhancing factor Z will result in a substantial reduction in the occurrence of pathogen A during ..."

Experimental Plan

Purpose

The experimental plan should describe your research project activities in detail, indicating how your objectives will be accomplished. The description should include the sequence, flow and interrelationships of activities as well as planned staffing.

Experimental Design, Statistical Analysis, and Evaluation

The scientific method involves testing a hypothesis by conducting an experiment or making observations (Chapter 2). In either approach, it is important to specify an experimental design or approach that will allow you to corroborate or validate your hypothesis. The experimental design will often be dictated by the necessary and appropriate statistical

tests or other evaluation tools that can validate the hypothesis. The description of this section might include specific data collection methods, tests, surveys, statistical tools, all within the framework of a specific design. Evaluation may include measurement of the end product, or analyses of the process. The nature of the research and its objectives will determine which of these evaluations is appropriate. Evaluation of the process might be quite important to large and complex research projects where it is important to monitor the activities and allocation of resources to insure adequate project performance and efficiency (see Chapter 10 for more details).

Methods and Materials

This section describes in detail the specific methods and the materials needed to accomplish the research within the context of the experimental design. Geever and McNeill (1997) point out that it is useful to consider the three questions of **"how?"**, **"when?"**, and **"why?"** when describing your methods. To answer "how?", you will provide a detailed description of what will occur from the time the project starts until it ends, *i.e.*, how you will do the research. To answer "when?" , you will present the methods in a logical sequence of activities in a time frame. To answer "why?", you will justify (perhaps defend) your chosen methods, especially if they are new or unique. Also you should explain why the planned activities are expected to produce certain outcomes. If you anticipate particular pitfalls or problems with certain methods, so indicate, with possible alternatives, if such problems occur. In some research circumstances it may also be important to consider **"where"** in describing your methods. Where the activity will explicitly take place may partially dictate particular methods.

Suggestions for Content

The experimental design section should flow from the statement of need and objectives. This section should allow the reviewers to visualize the implementation of the project. A reasonable and logical way to organize this section is to address each objective in the order presented. Begin by describing what precise steps you will follow to carry out each objective, including what will be done, who will do it, and when it will be done. It may be necessary to indicate steps you will take to add additional research personnel, acquire equipment, rent vehicles, or meet other logistic needs. Considering that you will undoubtedly be limited as to the total number of pages you can include in your proposal, it is

important to use just enough detail so reviewers will believe you can do the research. Too much detail can become boring and may even detract from the truly exciting and significant approaches.

Once you have determined the sequence of events to be followed for each objective, you must also show how they are interrelated, especially if the activities related to one objective are significant in addressing another objective. A word of caution: Avoid the trap of setting hypotheses or objectives in sequence such that one objective is dependent on a particular outcome of another objective. This can be very dangerous indeed, and reviewers usually look for this. For example, assume you anticipate that the outcome of hypothesis 1 will be conclusion A, and you have therefore constructed hypothesis 2 in such a way that it addresses the relationship between conclusion A and factor B. It should be obvious that hypothesis 2 becomes irrelevant if conclusion A cannot be validated in hypothesis 1. "Sequential" hypotheses or objectives can be used as long as there is a decision tree that allows the next objective in sequence to address alternative outcomes resulting from the previous hypothesis.

It is often very useful to construct a time-and-task chart (Miner and Miner, 1998) that outlines the major milestones that are to be reached at a specific time. This not only helps the reviewer in understanding the methodology (and gives the impression that you know what you are doing) but it will help you better manage your project by having thought through time-task relationships. This visual summary of the entire methodology section should be kept to one page.

Dissemination of Results

Purpose

This section will make it clear to the sponsor and reviewer that you consider it highly important to let others know about the project: its purpose, methods, and accomplishments. This not only explicitly acknowledges the support by the sponsor but provides recognition for your efforts.

Suggestions for Content

In the environment of stiff competition for limited research funds, it is not sufficient to simply mention that results will be published in an appropriate scientific journal. You should be specific as to anticipated

titles of journal articles, monographs, or presentations at conferences or workshops, with indicated target dates. In this section indicate why dissemination of the results is important as part of the project. Miner and Miner (1998) emphasize the need to succinctly describe what you believe the products of the research will be and how you will disseminate the products. This would be an appropriate place to justify an item in the project budget if needed to cover the costs of specific modes of dissemination. Possible modes of dissemination include: journal articles, conference papers, lectures, seminars, workshops, poster presentations, newsletters, site visits, interim working papers, books or manuals, audio/visual materials, Internet web pages or other types of computer network postings.

Some funding organizations will require a report on the findings of the research upon completion of the project. This report may also need to contain information on how the results will be used. For example, the International Foundation for Science (IFS) asks that scientists give serious consideration as to how the results of their research will be used, and how the research can receive even more attention for application (Baldensperger *et al.*, 1993).

Facilities and Equipment

Purpose

It is almost certain that you will require the use of specific facilities and equipment to carry out your research. This section should clearly state what specific facilities and equipment will be needed. If your budget requests funding for part of these needs, this should be clearly delineated from what is currently available to you. Later on, as part of your budget, you will have to provide a justification for funding equipment or facilities. This section is to establish that you have the capabilities to accomplish the proposed research.

Suggestions for Content

This is an opportunity to spell out the generosity of your organization in supporting the research (MacKensie and Angle, 1997). List the specific laboratories, field sites, service facilities, equipment, computer facilities, library facilities, etc. that will be available for your use. Don't require the reviewers to guess as to what might be available. Your goal in this section is to convince the reviewers that you will have the capability to

accomplish the research and that the facilities and equipment are suitable. If your research is in collaboration with other scientists or organizations, include the expertise and in-kind resources that they provide as well.

Literature Cited

Purpose

This section should demonstrate that you have reviewed the literature and are aware of the relevant and pertinent information that is currently available.

Suggestions for Content

Be current and complete, but don't overdo the citations so they become redundant and boring. The completeness of the review should consider the "political" aspects as well as the scientific. That is, make sure you don't fail to include citations of possible reviewers or panel members if at all relevant to your research. This is one area where it may be best to add too much rather than too little. Remember, this is the section that is going to document your understanding of the body of literature that applies to the statement of problem, the significance of the proposed research, and the appropriate methodology to accomplish the research. This is also the place to cite your own relevant publications. ***Regardless of your experience or your "track record" in the proposed area of research, do not assume that the reviewers will consider you knowledgeable about the literature without documentation***. This type of assumption would be considered arrogant, or at best foolish, by many reviewers.

When you discuss specific citations in the body of your proposal, be as objective as possible and not overly critical of existing literature (Geever and McNeill, 1997; MacKensie and Angle, 1997). Be prudent and cautious in your criticism of specific work since it might be the work of one of your reviewers! In fact, you should anticipate possible peer reviewers and perhaps offer some justified praise of their work.

> *"… **How prone to doubt, how cautious are the wise**!"*
> – Alexander Pope 1688-1744.

In terms of mechanics, be accurate and consistent in the way you list literature citations (**Example 7.11** for an example of a list of references cited). Use complete citations and spell out authors' names. Incorrect spelling of an author's name, especially if it happens to be a reviewer of your proposal, may create a negative attitude by the reviewer. Also be certain of your source. Citing a source without having seen the original can lead to embarrassment and loss of credibility if the secondary source from which you gained the information is in error.

Budget

Purpose

The budget section is a statement of proposed support and expenditures, and, if written creatively, can present an alternative way of expressing your project activities. But, if a sponsor provides a specific budget format, make sure to follow it closely. The budget should closely mirror your proposed research plan and in itself be credible and realistic. If the project has been well thought out, the preparation of the budget should be fairly easy to draft. A poorly presented budget probably reflects a poorly developed research project (Baldensperger *et al.*, 1993).

Categories

Most sponsor guidelines will specify the allowable budget categories to be included, and will usually include as "direct costs": personnel, materials and supplies, equipment, travel, support services, computer use, and publications. Usually there will be an "indirect costs" category that is calculated as a percentage of the direct costs. Your research organization may also have specific guidelines how budgets are to be prepared. More details on how to handle these categories will be discussed below.

Cost-sharing

As discussed in Chapter 4, some sponsors require the research organization to explicitly indicate how it will contribute to covering part of the costs of the research. If so required, a part of the budget section will need to specify in-kind contributions or "hard" cash sources. The institution's contribution should be discussed with the research director or another

Example 7.11

Consistency and Accuracy in the Listing of the References Used - The Literature Cited

LITERATURE CITED

APHA, AWWA and **WEF** (1992) Standards methods for examination of water and wastewater. 18th ed.

Binkley, D. (1986) Forest nutrition management. John Wiley & Sons, N.Y.

Eaton, J. S., G.E. Likens and F.H. Bormann (1973) Throughfall and stemflow chemistry in a northern hardwood forest. J. of Ecology 61: 495-508

Edmonds, R.L., T.B. Thomas and J.J. Rhodes (1991) Canopy and soil modification of precipitation chemistry in a temperate rain forest. Soil Sci. Soc. Am. J. 55: 1685-1693

Fahey, T.J., J.B. Yavit, D.H. Knight and J.A. Pearson (1985) The nitrogen cycle in lodgepole pine ecosystems. Biochemistry 1:257-275

Fahey, T.J., J.B. Yavit and G. Joyce (1988) Precipitation and throughfall chemistry in *Pinus contorta ssp.latifolia* ecosystems, southeasternWyoming. Can. J. For. Res. 18: 337-345

Foster, N.W. (1985) Acid precipitation and soil solution chemistry within a maple-birch forest in Canada. For. Ecol. Manage. 12: 215-231

Haibara, K., Y. Aiba and K. Suetsugu (1984) Nutrient content of throughfall in a Sugi (*Cryptomeria japonica*) and (*Charnaecyparis obtusa* unestablished young plantation. In: Bulletin of the Experimental Forest No. 20, Tokyo Uni. of Agric. and Technology, pp. 17-21 (in Japanese)

Klemmedson, J.O., C.E. Meier, R.E. Campbell and D.B. Marx (1983) Effect of stand composition and season on chemistry of throughfall and stemflow of ponderosa pine forests. For. Science 29 (4): 871-887

Leininger, T.D. and W.E. Winner (1988) Throughfall chemistry beneath *Quercus rubra:* atmospheric, foliar and soil chemistry consideration. Can. J. For. Res.18: 478-482

Lindberg, S.E., G.M. Lovett, D.D. Richter and D.W. Johnson (1986) Atmospheric deposition and canopy interactions of major ions in a forest. Science 231: 141-145

Lovett, G.M. and S.E. Lindberg (1984) Dry deposition and canopy exchange in a mixed oak forest as determined by analysis of throughfall. J. Appl. Ecology 21:1013-1027

Velthorst, E.J. and N. Van Breemen (1989) Changes in the composition of rainwater upon passage through the canopies of trees and of ground vegetation in a Dutch oak-birch forest. Plant Soil 119: 81-85

research officer of the organization well in advance of finalizing the proposal. Depending on the extent of the sponsor's requirement for cost-sharing, severe constraints could be placed on the research organization and significantly impact your proposed budget.

Special Collaboration/Cooperation

If your research project involves other organizations or researchers from other organizations, there may be a need to have a special section of the budget that relates to this in terms of resources. Types of collaboration can vary widely, and therefore this section will only provide some general thoughts and concerns of which you should be aware. Some types of formal collaboration may actually require a subcontract between your organization and the other organization. In this case, your budget will usually have an one-line entry indicating the costs of the subcontract. The cooperating organization will then provide a separate research proposal that will document the subcontractor's statement of work, detailed budget, period of performance and identification of key personnel. Details of the subcontract budget should be itemized on a separate page and attached to the main proposal budget.

Another type of formal arrangement is the employment of a consultant to assist with the research. Consultants are usually considered independent contractors and are not otherwise employees of the same organization. The budget will need to reflect this cost as a separate item and will undoubtedly require a justification in the budget narrative.

In other cases, you may have an arrangement where a cooperator or an institution (or other departments or laboratories within your own institution) has agreed to assist in the research project by providing certain resources (personnel, facilities, or equipment) that will assist you to accomplish your research. If this requires special costs in your budget, but does not fall within the definition of a subcontract or consultant, then this needs to be identified in the budget. For example, you may need to increase the amount of travel expenses to allow adequate contact with the cooperator. Facilities and equipment that are provided by an outside collaborator or cooperator should be included in your Facilities and Equipment section of the proposal. Again, there may be a need to include justification within the budget narrative section. Some research sponsors may actually require a statement to describe areas of research or resources at your institution that are related to your proposed research

(See **Example 7.12** for an illustration of how a researcher has related his research to other resources within his institution).

Suggestions for Content of the Budget

Introduction

Before addressing specific parts of the budget, let's consider some key questions, suggested by Miner and Miner (1998), that you should consider about the content of the budget. Will your budget –

- provide sufficient resources to carry out the project?
- include a budget narrative that justifies the major items of the budget?
- be in the format required by the sponsor and your organization?
- provide enough detail that the reviewer can easily see the way the items were calculated?
- show a clear relationship between the budget items and the research activities?
- include any attachments or appendices to justify unusual requests?
- identify evaluation and dissemination costs?

As you prepare your budget, go through your proposal document beginning with the introduction, and make a list of personnel, equipment, materials, facilities, *etc*. that you will need to carry out the research. Don't overlook the expenses that will be incurred by the project even if they are not part of the budget request. After you have compiled an estimate of the needed resources, *e.g.* number of people, types of equipment, specific supplies, *etc*., you will need to establish the appropriate costs for each item. You may need to confer with others in your organization who are knowledgeable about such costs, especially if you need to include salaries and wages, fringe benefit costs and other such items. Do this estimation of resources as early on in the proposal planning as possible, because undoubtedly the costs of doing the research will be greater than you anticipated and there may be a need to adjust your research plan to keep it within a reasonable budget.

The initial list of needed resources will provide you with the basis for organizing the various cost items into the appropriate categories. These

Example 7.12

Collaboration and Cooperation - Identifying Additional Resources Within Your Institution

The below research groups at our institution are carrying out research related to this proposed research and provide an additional source of expertise and resources. Each of these research groups has been contacted and made aware of this proposed research. The Laboratory for Plant Breeding and Genetics is a research group that brings together 5 scientists under the direction of Prof._____. These scientists provide leadership for 15 graduate and 10 undergraduate students for their training in the following research areas: Classical plant breeding, plant cytogenetics, molecular markers applied to plant breeding, and plant molecular genetics. Graduate Research Assistants on our research project will have access to the facilities of the laboratory and the training opportunities. The Laboratory for Germplasm and Genetic Resources has as its main goal the establishment and the characterization of an active germplasm collection of crop and medicinal plants, and fruit, palm, and forest trees. The medicinal plant collection has more than 100 accessions. The germplasm collection will be used in support of our proposed plant breeding research objectives. A phytochemistry group has also been put together to pursue research studies on natural product chemistry. The Crop Science Laboratory is carrying out research focused on the establishment of novel production systems that could be applied specifically to medicinal plants (one of the projects is related to the production of essential oils by *Cymbopogom citratus* when the plants are cultivated under different environmental conditions). The advances they are making on crop production systems will be especially useful to us in our experimental cultivation of *Cephaelis ipecacuanha.*

lists are likely to have considerable more detail than what will finally be included in the budget, so it will be useful to keep them for later reference (Geever and McNeill, 1997). They may be useful for monitoring the costs of the project once it is underway. See **Table 7.1** for an example of what such a worksheet might look like for personnel needs.

Table 7.1 - Worksheet for Determining Personnel Expenses for Research

Item	Description	Expense (Annual basis)
Principal Investigator	Primary responsibility for research and supervision	2 months of salary = $10,000 Benefits (20%) = $2,000 1 month cost-share by institute (this will be time commitment of 25%)
Co-Principal Investigator	Secondary responsibility for research and supervisor of GRA	1 month of salary = $4000 Benefits (20%) = $800 1 month cost-share by institute (this will be time commitment of 16%)
Graduate Research Assistant	Half-time graduate student for field research	graduate research assistantship stipend = $8,000
Parttime Field Assistants	Hourly wages for 2 months in summer for two technicians to collect plant and soil samples	2 asst X 60 days X $40/day = $4800
Secretarial Support	To assist in correspondence, manuscript preparation, ordering supplies, travel arrangements	2 months of salary = $3500 Benefits (15%) = $525
Office Space	Two scientist offices, secretary, GRA; estimated to be 10% of department space	Provided by department
Indirect Costs (overhead)	Institute has set a rate of 40% of direct costs	Salary + benefits = $33,625 IDC = X0.4 = $13,450 --- Cost-share contribution of IDC = 2 months salary + benefits ($5000 + $1000 + $4000 +$ 800) X 0.4 = $4320

This type of worksheet should be considered for all of the major categories of anticipated expenses. For example, a travel worksheet

might include the number of trips to visit field research sites, vehicle rental costs, airfare to specific conferences or workshops, per diem costs, *etc*.

Personnel Category

This category will primarily consist of salaries, wages, and any benefits of the personnel who are involved in the project. It is often useful to distinguish between the senior research staff and the other support staff. A typical hierarchy is to list these costs as in **Table 7.2**.

Table 7.2 - Salaries and Wages

	Months / %time	Amount
Senior Personnel		
Principal Investigator	xx	$$$$
Co-Principal Investigator(s)	xx	$$$$
Senior Associates	xx	$$$$
Other Personnel		
Research Associates/Post-doctorates	xx	$$$$
Other Professionals	xx	$$$$
Graduate Students	xx	$$$$
Pre-baccalaureate students	xx	$$$$
Secretarial-clerical	xx	$$$$
Technical, Shop, Field and Other	xx	$$$$
Total of Salaries and Wages		$$$$
Fringe Benefits of above Personnel		**$$$$**
(may need to be itemized for each person)		
Total Salaries, Wages and Fringe Benefits		**$$$$**

The senior personnel should be identified by name. You may have to hire some of the other personnel once you receive the funding. Sometimes the secretarial-clerical staff will be provided as a cost-share item and, therefore, may not appear in the budget as a direct cost item.

As you work out the budget for support personnel, it is important that you discuss this with your research director or department head to insure that the salaries and wages are within the range of pay set by the institution's policy. Determination of the time to be shown for senior

personnel should take into consideration that reviewers will make a judgement as to whether there is enough commitment of time by the researchers to get the job done (MacKensie and Angle, 1997). A 5% to 10% commitment may send the negative signal to the reviewers that you don't consider this project of high enough priority to devote any more time than this. However, be certain to indicate "cost-share" time if you are planning to commit time but not ask for support of salary from the sponsor. The setting of salaries for the senior personnel is not an easy matter. Salaries are often a large portion of the total budget, and the request for support of too much salary may limit the budget in other categories of your project or make your budget too high for realistic consideration by the funding agency. Also, it is a good practice to keep track of your commitments of time to various research activities, since many sponsors will ask for a statement of your time commitment to other research projects, teaching, extension, or administration.

Operations Category

This category will primarily consist of expendable items, some services, and travel costs required to carry out the research. Generally such items as laboratory and field supplies, materials for fabrication of equipment, and office supplies will be called "materials and supplies".

Another subcategory might be "communications" such as telephone, fax, and postage. Other items to consider for inclusion under operations are photocopying, computer-related costs (not capital equipment) and publication or other dissemination charges. Travel is sometimes itemized in its own separate category and should stipulate whether the travel is domestic or foreign. Depending on your institution's policy on the value that constitutes major equipment, small instruments and equipment may be included in materials and supplies. You probably will not need to itemize these items in the budget, but it may be necessary to justify the subcategories of expenses in the budget narrative (see **Table 7.3** for a possible breakdown of these expenses for a budget).

Permanent Equipment Category

Requests for major items of equipment will require a separate budget entry. Small items of equipment may be included in the Materials and Supplies section (but determine what your organization's or sponsor's guidelines are on this). If the equipment request is a substantial amount

Table 7.3 - Operations

Material and Supplies (incl. office supplies used for projects)	$$$$
Communications (telephone tolls, fax, postage)	$$$$
Publications and Dissemination Charges	$$$$
Photocopying and Other Reproduction	$$$$
Computer Services (x hrs. @ $/hr)	$$$$
Travel	
Domestic	
Field site visits (x no.)	$$$$
Meeting with sponsor	$$$$
Conference (specify)	$$$$
International (specify)	$$$$

of money, it will increase your chances of approval if your organization will cover part of the cost (cost-share). If your proposal is approved for funding by the sponsor but subject to a needed reduction in budget, deleting major equipment would probably appear suspect, or suggest that the equipment was never really necessary to conduct the research. Therefore, make sure the equipment is truly necessary and critical to your research work. Justification will be needed in the budget narrative.

Budget Explanation and Justification

Purpose

The itemized budget needs to be explained in a detailed narrative and unusual items justified. If your budget is fairly straight forward, a narrative may not be needed, but it is usually a good practice to provide some explanation of the budget.

Suggestions for Content of the Narrative

This section should provide the reasoning for your budget items, even though some items will seem self-explanatory. Explain the basis for calculating the fringe benefits used for personnel, and the basis for indirect costs rates. For materials and supplies, actually give some examples of the major kinds of items you will need to purchase, but don't

provide detail on every item. For travel, explain what kind of transportation will be used and why it is necessary. If there are costs for rental or leasing of equipment or vehicles, indicate here. Explain the basis for the publication and dissemination expenses. If you have requested that the cost of major equipment be funded, it is mandatory to provide an explanation and justification for the equipment with details on any cost-sharing. The basis for any other cost-sharing in the budget should also be explained.

Special Considerations

Purpose

This section is to call attention to any special circumstances or special regulatory approvals that are related to your proposed research.

Suggestions for Content

Many institutions have special provisions that must be addressed if research involves hazardous substances, recombinant DNA, use of experimental animals, use of human subjects, pathogens or insects that may pose special hazards to areas adjacent to the research location, or the use of radioactive substances. If you have reason to believe your research may need special consideration, insure that you review your proposed research with the appropriate officials at your organization as well as examining the sponsor's guidelines for reference to special conditions. Some sponsors may require that you submit completed special forms to insure that you have conducted a review of your research with appropriate committees and officials at your organization and are in compliance with relevant requirements.

Curriculum Vitae

Purpose

Almost all sponsors will require some evidence of your qualifications and expertise. This is usually summarized in a "curriculum vitae" or "resume." Your curriculum vitae (CV) is the story of your

educational and professional life reduced to outline form in an attractive, easy-to-read layout. It must quickly present your strongest assets to the proposal reviewer. It should highlight your unique background and qualifications that are relevant to the proposed research.

Suggestions for Content

The term "curriculum vitae" [which derives from the Latin meaning "the course of (one's) life"] is often used interchangeably with the term "resume." However, the CV is a more formally structured listing of education, publications, projects, awards and work history, and is usually preferred for use by scientists and educators. Prepared CV's can be used for a number of purposes, including seeking employment. But remember, the purpose of the CV in the research proposal is not to seek employment but rather to convince the reviewers that you have the appropriate qualifications to do the research. Therefore, don't simply "pull off the shelf" a CV you might have prepared for seeking your last position. Make sure the material in the CV is focused on your research capabilities, including your publications!

Briefly list or state your educational and work background and focus on evidence of your research productivity (MacKensie and Angle, 1997). Your publications for the past 5 years will be especially important, and some peer reviewers may use this as an indication of your potential to publish in the future. You may wish to append your most recent and relevant publications to the proposal. This could be especially useful if your most recent publications have not yet received wide distribution, or are "In Press." Avoid listing extraneous information that is not directly relevant to your research capabilities. It is not necessary to list your home address, marital status or other such personal information. Information on membership in organizations that don't directly relate to research or scholarly contributions is unnecessary. And certainly do not list previous work experience that has little relevance to your current research or professional responsibilities. Do list your teaching experience, graduate advising activities and travel experience that is relevant to your research. A suggested CV format is given in **Example 7.13**. Basically it provides information on current position and location, educational history, professional employment history, honors and awards, professional activities, and publications.

Example 7.13

A Sample Curriculum Vitae for Research Proposals

Curriculum Vitae

Comments:

Name: Dr. José C. Lopez

self explanatory

Title: Associate Research Scientist

Address: Department of Silviculture
Forest Research Institute
(Street address or PO Box)
(City, Province, Country)
(Postal Code)
(Telephone number)
(FAX number)
(Email address)

Include identity of who you work for with complete address.
Include appropriate contacts by phone, email or other means.

Education:

University X, D. For., 1988 - Forest Ecology
University X, M.S., 1984 - Forest Ecology
University Y, B.S., 1978 - Forest Management

List your most recent degrees first and then list in reverse chronological order. Make it clear from which institutions your degrees were conferred. Show year degree received and area of speciality

Employment:

Forest Technican, Level 7, Provincial Forest Service, (1978 - 1981)
Graduate Research Assistant, Department of Forestry, University X, (1984 - 1988)
Post-doctorate Associate, Institute of Forest Management, Federal Forest Service (1988 - 1990)
Assistant Research Scientist, Department of Silviculture, Forest Research Institute (1990 - 1998)
Associate Research Scientist, Department of Silviculture, Forest Research Institute (1998 - present)

List chronologically.
Only show work experience that contributes to your research capabilities or understanding of the issues.

Example 7.13 cont'd.

Honors and Awards:

Outstanding Graduate Dissertation, Department of Forestry, University X, 1988
Certificate of Merit for Research Performance, Forest Research Institute, 1992
Outstanding Research Paper, National Association of Forest Management, Annual Conference, 1994
Elected Regional President, National Association of Forest Management, 1994 - 1996

Show any awards, distinctions or honors that give evidence of your professional abilities and achievements.

Professional Activities:

Silviculture Certification Standards Committee, National Association of Forest Management, 1990 - 1992
Workshop Co-Chair, Silvicultural Systems for Sustainability, International Forestry Congress, 12-13 August, 1995
On-site Research Review Team, Institute of Genetics, Federal Research Council, 20-25 January, 1997.

List those professional activities that relate to your proposed topic of research. In this case, if your research proposal is in the area of forest ecology and silviculture, it would be of little value to list a professional activity that related to securing new members for the National Assoc. of Forest Mgn.

Publications: (Last 5 years; 12 of career total of 2 book chapters and 19 refereed articles):

Lopez, J.C. 1998. Silvicultural systems of subtropical plantations. Agroforestry (In Press).

Lopez, J.C. 1997. Light quality impacts on seedling establishment under XXX canopies. J. Silviculture 20: 143-150

Lopez, J.C. and D.L. Jones. 1997. Changes in LAI of species XXX in plantations over the rotation length. Ecology 35:12-17.

(Continue with listing of publications)

This is a very critical part of the CV. Some sponsors may only allow you to list recent publications and not total career publications. If restricted to number of publications, select carefully to highlight those most relevant to your proposed research. Be accurate and consistent in your format.
Do not list papers in preparation or submitted unless accepted for publication (i.e. In Press).

Appendices

Purpose

Appendices can be used to attach additional information that is relevant to the proposal but is peripheral and not absolutely required. Although this material can be valuable to the reviewer, it may not be read in its entirety.

Suggestions for Content

> ***"....reviewers may not read beyond the main proposal, and....if the appendices appear lengthy....reviewers will avoid reading through them, especially if they are limited in time."***

This is the place to add supplemental information that was not required or allowed in the main proposal. Recognize that most sponsors' guidelines impose a limit on the total number of pages that are allowed in the proposal. Before considering adding appendices, clarify if appendices pages will be counted toward the total number of allowed pages. Even if no restrictions are placed on the number of pages that can be included in appendices, try to keep the number to a minimum. Some reviewers may not read beyond the end of the main proposal, and certainly if the appendices appear lengthy, you can be assured that reviewers will avoid reading through them, especially if they are limited in time.

With the caveat that you are not assured that appended materials will be read, examples of the types of material that can be placed in appendices are reprints of your articles (published, In Press, submitted), definition of terms, subcontract data, cooperative agreements, letters of support from collaborators/cooperators, brochures about your research organization, organizational charts, department research reports, membership of research advisory boards, or other information that may add value to your proposal. Avoid photographs if possible, but concise tables and graphs can be useful (Miner and Miner, 1998).

Check with the program officer of the sponsoring organization about the use of appendices. Sometimes, even though acceptable, appendices are not forwarded to reviewers by the sponsor. Try to keep the appendices to a minimum. You don't want to overload the reviewers with too much paper. Long appendices can actually detract from the main proposal.

8.0 Tips on Writing Techniques and Appearance of Proposal

Objective

- Provide suggestions and tips on writing style and mechanics

Assume you have carefully followed the suggestions that have been presented in Chapters 1 through 7. You have now identified and articulated a hard-hitting research need, crafted a concise set of objectives, provided the critical methodology for achieving the objectives, provided the necessary budget and other required information, and cleverly summarized it all in a well-worded, exciting abstract. What else is there left to do?

You still have one last and important task — to place the proposal in a style and layout that is "reader-friendly". With the extensive use of word processing today, it is usually fairly easy to modify style, fonts, margins, and other format factors once the basic text has been written. Even if word processors are not available to you, the following suggestions should be considered in preparing your typewritten text.

The appearance of your proposal will not improve your ideas or your approaches, but a pleasing appearance can assist the reviewer to absorb and understand the information in your proposal more easily. On the other hand, cosmetic improvements in appearance and style will probably do little to enhance a poorly conceived research project. There are several aspects about the type of reviewer and the tools you can use that should be given some thought as suggested below by Miner and Miner (1998).

Types of Readers

The amount of time that a reviewer has to review your proposal will depend on the process used by the sponsor and may vary considerably. As pointed out earlier, if proposals are sent to reviewers for them to review at their leisure, the type of reading that the proposal will receive is likely to be quite different than in a process where time for review is

much more limited, *i.e.*, a panel review. Reviewers always try to critically review proposals, but use different approaches depending on time available.

If reviewers are required to cover a large number of proposals in a short period of time, they may be forced to use a reading style of **skimming,** where they look for points and factors that readily stand out in the body of the proposal. They may also heavily depend on the abstract to arrive at an evaluation of the proposal. When reviewers evaluate your proposal on the basis of an evaluation sheet provided by the sponsor, they are more likely to **search read,** *i.e.*, search for specific points or factors that correspond specifically to the items on the evaluation sheet. If reviewers have a greater amount of time to review each proposal, as often in a mail review, then they may spend more time in **critically reading** the proposal in its entirety. If you have some idea before hand of what kind of process the sponsor uses, then you can use a writing technique that is more appropriate for a particular reading style. Writing techniques for each of these types of readers are summarized below (Miner and Miner, 1998):

Reading Style	Writing Technique
Skimming	White space Headings Ragged right margins
Search Reading	Bold type Lists Examples
Critical Reading	Transitions Type style Line spacing

Writing Techniques

White Space: Blank space can be used to break up long text. It makes a proposal appear more inviting and user-friendly. White space can be

used to indicate the end and beginning of sections, or the emphasis of a particular idea by setting it off by itself. White space is used in making lists and denoting paragraphs. Indentation can be an effective way to emphasize a section or indicate a transition. Contrast the use and non-use of white space (**Examples 8.1** and **8.2**.)

Example 8.1

Lack of "white space"

Following the prescribed fire treatment, plots will be forced into a visibly eroded state using a rainfall simulator. All erosion sub-plots will be treated with the same amount and intensity of simulated rainfall as determined by trial runs and other simulation experiments in the region. If a rainfall event occurs following the burn treatment, and it is significant enough to initiate an erosional event, then the rainfall simulation will not be applied. Since the study site is relatively small, it is reasonable to assume that the effects of a given rainfall event would be uniformly distributed. Plots will be surveyed for sediment loss throughout the life of the study. A collection catchment will be established on all plots to monitor both runoff and sediment loss. Changes in infiltration rates will be evaluated using a disk permeameter (infiltrometer) where disturbance effects on the sorptivity (S) and unsaturated hydraulic conductivity (K), a function of water content, are evaluated (Bouwer 1986, Green et al. 1986, Sullivan et al. 1996). Thorough discussions on the design, operation and applicability of the disk permeameter to measure infiltration rates can be found in Perroux and White (1988), White and Sully (1987), and Sullivan et al. (1996). It is suggested that the applied treatments will significantly effect these hydraulic properties because of their impact on soil structure. Therefore, it is hypothesized that there will be differences in infiltration rates among the treatments. The measurement of these rates will be taken annually during the same period as the late summer and fall vegetation sampling. The results of these measurements will then be compared with the values collected the previous year.

Example 8.2

Use of added "white space"

Following the prescribed fire treatment, plots will be forced into a visibly eroded state using a rainfall simulator. All erosion sub-plots will be treated with the same amount and intensity of simulated rainfall as determined by trial runs and other simulation experiments in the region. If a rainfall event occurs following the burn treatment, and it is significant enough to initiate an erosional event, then the rainfall simulation will not be applied. Since the study site is relatively small, it is reasonable to assume that the effects of a given rainfall event would be uniformly distributed.

Plots will be surveyed for sediment loss throughout the life of the study. A collection catchment will be established on all plots to monitor both runoff and sediment loss.

Changes in infiltration rates will be evaluated using a disk permeameter (infiltrometer) where disturbance effects on the sorptivity (S) and unsaturated hydraulic conductivity (K), a function of water content, are evaluated (Bouwer 1986, Green et al. 1986, Sullivan et al. 1996). Thorough discussions on the design, operation and applicability of the disk permeameter to measure infiltration rates can be found in Perroux and White (1988), White and Sully (1987), and Sullivan et al. (1996).

It is suggested that the applied treatments will significantly effect these hydraulic properties because of their impact on soil structure. Therefore, it is hypothesized that there will be differences in infiltration rates among the treatments. The measurement of these rates will be taken annually during the same period as the late summer and fall vegetation sampling. The results of these measurements will then be compared with the values collected the previous year.

Headings: The use of headings and subheadings is a way to indicate main ideas and the organization of your proposal. The use is like a table of contents within the body of the proposal. It provides the reader with

an easy way to quickly understand the major components of your proposal. If you know a specific reviewer evaluation form will be used, then build your headings to coincide as much as possible with the evaluation items. Notice how much easier it is to discern the major ideas in **Example 8.3** when headings are used.

Example 8.3

Use of headings

Erosion Treatment

Following the prescribed fire treatment, plots will be forced into a visibly eroded state using a rainfall simulator. All erosion sub-plots will be treated with the same amount and intensity of simulated rainfall as determined by trial runs and other simulation experiments in the region. If a rainfall event occurs following the burn treatment, and it is significant enough to initiate an erosional event, then the rainfall simulation will not be applied. Since the study site is relatively small, it is reasonable to assume that the effects of a given rainfall event would be uniformly distributed.

Plots will be surveyed for sediment loss throughout the life of the study. A collection catchment will be established on all plots to monitor both runoff and sediment loss.

Surface Infiltration Measurement

Changes in infiltration rates will be evaluated using a disk permeameter (infiltrometer) where disturbance effects on the sorptivity (S) and unsaturated hydraulic conductivity (K), a function of water content, are evaluated (Bouwer 1986, Green et al. 1986, Sullivan et al. 1996). Thorough discussions on the design, operation and applicability of the disk permeameter to measure infiltration rates can be found in Perroux and White (1988), White and Sully (1987), and Sullivan et al. (1996).

It is suggested that the applied treatments will significantly effect these hydraulic properties because of their impact on soil structure. Therefore, it is hypothesized that there will be differences in infiltration rates among the treatments. The measurement of these rates will be taken annually during the same period as the late summer and fall vegetation sampling. The results of these measurements will then be compared with the values collected the previous year.

Ragged Right Margins: Interestingly enough, a ragged right margin is much easier to read than one that is right justified. The reader's eye tracks easier from the end of one line to the beginning of the next line when the right margins are uneven. Contrast the readability of **Examples 8.4** and **8.5**.

Example 8.4

Use of Left and Right Justified Text

Following the prescribed fire treatment, plots will be forced into a visibly eroded state using a rainfall simulator. All erosion subplots will be treated with the same amount and intensity of simulated rainfall as determined by trial runs and other simulation experiments in the region. If a rainfall event occurs following the burn treatment, and it is significant enough to initiate an erosional event, then the rainfall simulation will not be applied. Since the study site is relatively small, it is reasonable to assume that the effects of a given rainfall event would be uniformly distributed. Plots will be surveyed for sediment loss throughout the life of the study. A collection catchment will be established on all plots to monitor both runoff and sediment loss.

Changes in infiltration rates will be evaluated using a disk permeameter (infiltrometer) where disturbance effects on the sorptivity (S) and unsaturated hydraulic conductivity (K), a function of water content, are evaluated (Bouwer 1986, Green et al. 1986, Sullivan et al. 1996). Thorough discussions on the design, operation and applicability of the disk permeameter to measure infiltration rates can be found in Perroux and White (1988), White and Sully (1987), and Sullivan et al. (1996). It is suggested that the applied treatments will significantly effect these hydraulic properties because of their impact on soil structure. Therefore, it is hypothesized that there will be differences in infiltration rates among the treatments. The measurement of these rates will be taken annually during the same period as the late summer and fall vegetation sampling. The results of these measurements will then be compared with the values collected the previous year.

Example 8.5

Left Justified and Right Ragged Text

Following the prescribed fire treatment, plots will be forced into a visibly eroded state using a rainfall simulator. All erosion sub-plots will be treated with the same amount and intensity of simulated rainfall as determined by trial runs and other simulation experiments in the region. If a rainfall event occurs following the burn treatment, and it is significant enough to initiate an erosional event, then the rainfall simulation will not be applied. Since the study site is relatively small, it is reasonable to assume that the effects of a given rainfall event would be uniformly distributed. Plots will be surveyed for sediment loss throughout the life of the study. A collection catchment will be established on all plots to monitor both runoff and sediment loss.

Changes in infiltration rates will be evaluated using a disk permeameter (infiltrometer) where disturbance effects on the sorptivity (S) and unsaturated hydraulic conductivity (K), a function of water content, are evaluated (Bouwer 1986, Green et al. 1986, Sullivan et al. 1996). Thorough discussions on the design, operation and applicability of the disk permeameter to measure infiltration rates can be found in Perroux and White (1988), White and Sully (1987), and Sullivan et al. (1996). It is suggested that the applied treatments will significantly effect these hydraulic properties because of their impact on soil structure. Therefore, it is hypothesized that there will be differences in infiltration rates among the treatments. The measurement of these rates will be taken annually during the same period as the late summer and fall vegetation sampling. The results of these measurements will then be compared with the values collected the previous year.

Bold Type: The use of bold type is much easier to read and thus preferable to underlining, italics, or all capital letters as a way to provide emphasis. Be careful to use bold type sparingly and avoid overemphasis. Which of the following means of emphasis is more striking, **Example 8.6** or **Example 8.7**?

Example 8.6

Use of Underlined Headings

Erosion Treatment

Following the prescribed fire treatment, plots will be forced into a visibly eroded state using a rainfall simulator. All erosion sub-plots will be treated with the same amount and intensity of simulated rainfall as determined by trial runs and other simulation experiments in the region. If a rainfall event occurs following the burn treatment, and it is significant ...

Surface Infiltration Measurement

Changes in infiltration rates will be evaluated using a disk permeameter (infiltrometer) where disturbance effects on the *sorptivity (S)* and unsaturated *hydraulic conductivity (K),* a function of water content, are evaluated (Bouwer 1986, Green et al. 1986, Sullivan et al. 1996). Thorough discussions on the design, operation and applicability of the disk permeameter ...

Example 8.7

Use of Bold Headings

Erosion Treatment

Following the prescribed fire treatment, plots will be forced into a visibly eroded state using a rainfall simulator. All erosion sub-plots will be treated with the same amount and intensity of simulated rainfall as determined by trial runs and other simulation experiments in the region. If a rainfall event occurs following the burn treatment, and it is significant ...

Surface Infiltration Measurement

Changes is infiltration rates will be evaluated using a disk permeameter (infiltrometer) where disturbance effects on the **sorptivity (S)** and unsaturated **hydraulic conductivity (K),** a function of water content, are evaluated (Bouwer 1986, Green et al. 1986, Sullivan et al. 1996). Thorough discussions on the design, operation and applicability of the disk permeameter ...

Lists: A list is an easy way to convey a message with a minimum of text, yet with a sense of immediacy. A list is easy to skim by a reader and can convey a lot of information quickly. If the list is information to be read in sequence, then use a numbered list. If all the items in the list are of equal importance, use a bulleted list.

Examples: Sometimes an example can quickly clarify a complex point or idea by drawing an analogy to a similar situation that is of greater familiarity to the reader.

Transitions: To show the connection between one idea or theme and another, make use of transitional words and phrases to achieve coherence in your writing. Common transitional words and phrases can show –

- **Addition**: also, again, and, and then, in addition, moreover, besides, next, further, furthermore, equally important, finally, likewise, first, second, third, last
- **Example**: for example, for instance, thus, as an illustration, namely, specifically, in particular, that is, incidentally
- **Result**: therefore, thus, consequently, so, accordingly, as a result, hence, otherwise, then, that caused, that produced
- **Summary**: as a result, hence, in short, in conclusion, as a consequence, finally, to sum up, therefore, in summary, at last

Type Style: Word processing systems provide considerable latitude in selecting type style (font) and size, ***but if your sponsor's guidelines specify a particular style and size, make sure you follow them!*** If not specified, consider using **serif typefaces** for the text of your proposal and **sans serif typefaces** for titles and headings. Serif typefaces have small strokes that finish off the main stroke of a letter and make it easier to read (for example the text here is *New Times Roman*). Sans serif typefaces do not have the small finishing strokes and are better used for headings because they stand off from the body of the text.

An example of sans serif is *Arial*, which is used in the major headings in this document. Do not be too creative with typefaces, especially with ones that are unfamiliar. A familiar-looking document is a friendly document. Do not use a size of type that makes it difficult to easily read the text. Attempts to include more information within a page-limited document by using a smaller size font, or by decreasing the margins, often leads to an unfriendly appearing document and can lead to a negative attitude of the reviewer. The following examples of typefaces illustrate differences:

Serif Typefaces	Sans serif Typefaces
(12 point size)	(12 point size)
Times New Roman	Arial
Courier New	Univers
(10 point size)	(10 point size)
Times New Roman	Arial
Courier New	Univers

Line Spacing: Line spacing is one of the ways to achieve white space in your document. Most proposal guidelines will allow you to use single-spaced text to conserve the number of final pages. You may wish to double space between paragraphs and between major sections.

Page Numbering: Place page numbers in the top right or bottom center of each page of your proposal. Do not number the first page. Do not forget to number the pages. There are few situations that can be more frustrating than dropping a document, mixing the pages, and then finding that the pages are not numbered!

Proofreading: It cannot be emphasized too strongly that you need to proofread your document, and then proofread it again. As you proofread, be on the lookout for:

" **Content** " Does the proposal have substance? Are your ideas complete?

“ **Form** “ Is your organization logical? Are all facts and figures accurate?
“ **Mechanics** “ Is spelling correct, especially of proper names? Are all numbers and calculations accurate? Are sentences grammatically correct, including subject-verb agreement? Is punctuation proper?

9.0 Post-Proposal Writing

Objectives

- To indicate the need for internal review prior to final submission of a proposal
- To suggest follow up procedures if the proposal is rejected

Internal Proposal Review

After completion of the "final" proposal, it is advisable, if time permits, to have an internal review of the proposal document before it is finally submitted to the sponsor. This should ordinarily be done by scientific colleagues who are not directly involved with the project, but ones who would have some knowledge about the subject area. Sometimes, a review by someone who is not extremely knowledgeable about the area may be more useful than someone intimately familiar with the topic and who may unknowingly "read-in" missing information. It may be a better test of the logic, reasoning, and organization used in your proposal if you can convey a sense of significance and excitement to the less knowledgeable peer.

Depending on the receptiveness of your internal reviewer, you may want to have a review of an early draft and not wait until the penultimate document. However, a word of caution! Do not ask for a review of a proposal draft that is too fragmented and not fully developed, especially in the concept and approach. Your colleague's time is valuable, as is yours. Don't waste his or her time with a sketchy or poorly conceptualized project.

Don't be reluctant to ask a colleague for his or her review and comments of your proposal. There will probably be a time when they will ask the same of you.

Proposal Rejection

If your proposal is rejected, and there is a good chance statistically that this will happen, there are important follow up measures that you need to carry out to realize the maximum benefit from the proposal preparation and submission process.

First of all, ask for reviewers' or review panel comments or evaluations of your proposal. Many funding organizations will provide anonymous review comments, specifically for assisting the applicant in improving their proposal for a possible re-submission. If you are unsure what type of comments you can expect back from the sponsor, contact the program officer and ask. If you receive comments verbally from the program officer, certainly do not be argumentative. Try to be gracious and fair in assessing the review comments. This is an opportunity to utilize critical assessments by your peers in improving your research project in the future. Don't be discouraged. If you believe you have written a good proposal based on solid concepts and methodology, rewrite your proposal based on review comments and re-submit. Seek assistance on the rewrite if necessary. Make sure you re-address the areas that were identified to be weak. Perhaps more preliminary data needs to be collected, or better methodology sought out.

Remember, some funding agencies have a low rate of projects funded relative to the number of applications received. With some sponsors, it is not unusual for an applicant not to be successful until the 3rd or 4th submission. Very often the projects that receive funding are those that are re-submissions!

Common Reasons for Rejection

If you have conscientiously followed the recommendations presented in the earlier chapters on how to write a research proposal then hopefully your proposal will not fall into the following common reasons given by program officers for rejection of research proposals (Baldensperger *et al.*, 1993; MacKensie and Angle, 1997).

- The science presented was not completely sound.
- The methodology or approaches in the experimental section were unclear or vague.
- The investigators were inexperienced in the experimental design or the methodology, *i.e.*, the investigators did not convince the reviewers that they were capable of accomplishing the defined objectives.
- The proposed research did not fit the mission or purpose of the grant program of the funding sponsor.

- The research plan was not focused.
- The literature review was incomplete and failed to establish that the proposed research was new and significant and not repetitive, *i.e.*, the work being proposed had already been carried out in similar ecological and socio-economic conditions. (It is extremely important that you convince the reviewers that you are completely familiar with all the relevant literature for your proposed project. Do not take for granted that the reviewer will assume you are familiar with the literature because of your current position or publication record).
- The objectives do not give heed to the socio-economic situation of the country or region and thus may not be applicable.
- The proposed budget does not match the proposal work plan.

10.0 Group Research

Objectives

- To provide suggestions to develop group research project proposals
- To indicate difficulties of group research
- To stress importance of planning and organizing research
- To suggest some characteristics of group research
- To stress need for working with the sponsor

Multidisciplinary and Interdisciplinary Research Approaches

There are numerous needs in forested areas of the world which present to the researcher such complexity that individual efforts are doomed to failure, or at best are able only to address minor aspects of major problems. In many cases, reductionist approaches are simply not adequate to bring about a realistic understanding of the whole. There is an increasing need for researchers to band together and design research projects that address major complex forest problems, whether they are related to the biological and physical environment, new wood products, or to sociological and economic systems.

There are past examples where groups of scientists have attempted to understand complex systems through multi- and interdisciplinary approaches. The International Biology Program in the 1960's and 70's provided impetus to "ecosystem" research, where scientists from many disciplines worked together to better understand the ecological workings of different major biomes in the world. Ecosystem research efforts continue, especially in forested systems, and attempts are being made to address even larger scale processes and functions of our natural environment such as "global climate change" programs in different parts of the world. "Ecosystem management" approaches in natural resource and forest management require quite a different understanding of how biological, physical and social systems interact, and suggest that perhaps new research paradigms are needed.

However, "group" research is a very difficult approach to solving problems and faces many impediments not usually evident in individually-driven research projects. The research culture in many of our research institutions, especially universities, is still structured to recognize and reward individual research accomplishments. Even if one accepts that group research approaches are difficult, the opportunity for substantial gains in our understanding of both natural and man-made systems suggests that such research should be encouraged and supported.

The following material provides some observations and suggestions to consider when planning a group research proposal. The term "group research" is used here to encompass both multi- and inter-disciplinary efforts, and implies that three or more scientists from either different disciplines or from different institutions collaborate to address the same overall research problem or need, and further, that the research will be done under a single combined administrative structure. It is also assumed, in fact obligatory, that the proposed group research project is more than "the sum of the parts" and that synergy is expected from the collaboration. Research sponsors will not favorably consider a research proposal that is purported to be an integrated group research effort but rather is simply a collection of researchers doing their own work without any real plan or process for integrating the research at every step along the way throughout the life of the research project.

Planning and Organizing a Group Research Proposal

The concepts and principles presented earlier about writing research proposals still apply when writing a group research proposal. However, one can expect that the time required to plan and organize a successful group research project will be greatly increased and the effort demanding. Considerable discussion will have to occur among the scientists involved once a potential research need is identified and considered feasible for a group approach. If investigators are from several different institutions, then the differences in research administration will have to be compared early on, and support from appropriate research administrators at each institution will need to be sought. Even if several investigators are from the same institution, but from different administrative units, differences in administration of research will need to be thoroughly discussed.

Some Fundamental Characteristics of Group Research

Almost all sponsors who are likely to fund group research are going to require at least the following:

- The identification of a single individual who will take responsibility as the Principal Investigator (PI), regardless of the responsibilities or percentage of effort by other collaborating investigators. Other investigators might be identified as Co-Principal Investigators, but it is the PI who is ultimately responsible to the sponsor.

- Evidence that the proposed research project can be effectively managed administratively.

- A clear rationale of the need for a group research effort.

- A clear delineation of the research responsibilities of each collaborating scientist, and how it contributes to the whole.

This latter requirement is absolutely mandatory if the project is to successfully address a multi-faceted and complex problem. The approach to group research must show an integration of all the research parts and show how this integration of research from a number of investigators will be truly conducive to a better understanding or the provision of a solution to the stated problems or needs. It is suggested that substantial attention be given to the development of a time-and-task diagram (as suggested for the preparation of the experimental plan for individual research projects in Chapter 7) that clearly relates the various research objectives, the time they will be completed, and the identification of intermediate milestones that are to be attained. This diagram can be very useful in showing how each of the delineated research tasks of the various collaborators are interlinked to meet the overall group research goals.

From the above, it is clear that the PI must have considerable respect among his research collaborators and have the leadership ability to manage a complex research project. It is for this reason that it is unlikely that a scientist at the beginning of his research career and without substantial research experience should consider putting together a collaborative research effort.

There are a number of models by which a group research project might be administratively managed, but the simpler the better. In most cases, it will be expected that a single research institution, that of the PI, be responsible for the administration of the research grant. The handling of funding of the collaborating scientists at other institutions might be facilitated through a sub-contract arrangement from the primary administering institution. In some circumstances, sponsors may allow the submission of a budget from each collaborating institution directly to the sponsor. Although the PI's institution may not have budget control over the other institutions under this arrangement, the PI may still be ultimately responsible for the outcome of the group research. Even if the sponsor allows funding directly to each collaborating institution, it will be incumbent on the PI and Co-PI's to show how the funds at each institution will meet the overall goals of the proposed research and how the funds will be effectively administered. Pragmatically, it would be preferable for the PI, who has the ultimate responsibility, to have considerable budgetary control in case reallocation of resources is needed because of poor performance by a collaborator.

Because the PI will have ultimate responsibility for the productivity and outcome of the research project, a clear understanding of each investigator's responsibility should be spelled out in writing before hand. Not only should specific assignments on research activities be spelled out, but a plan for authorship and dissemination of results should also be articulated. As in any other research proposal, alternatives should be thought out before hand in case particular objectives or milestones cannot be attained by specific investigators as anticipated. As mentioned in Chapter 7 under "Experimental Design", for complex research projects it may be extremely valuable to have a way to monitor the process toward accomplishment of specified research objectives and the allocation of resources. This would be useful if reallocation of resources is necessary to insure adequate research productivity.

Good communication within the research group is essential. In the planning phase, consideration should be given to how the researchers will communicate with one another on a regular basis. A regularly scheduled meeting of all participants in the research, including graduate students and technicians would be advisable. The frequency may depend very much on the stage of the project, but at least monthly meetings might be considered. Early on, attention should focus on

coordination, methodology and logistics of the research program. Later, after the experimental phase is well under way, periodic reports on results, difficulties and other outcomes could be discussed. Perhaps a seminar series or workshop could be built around the project so the progress could be shared with other colleagues for comment and input.

As part of the design of the project, and if financial resources will allow it, a regularly scheduled forum for discussion of the research project by the participants and selected outside scientific colleagues and stakeholders could be very useful.

Working with the Research Sponsor

The process of planning a group research proposal also requires a close working relationship with the potential sponsor, even more so than for individual research proposals. Because of the substantial amount of effort that will have to be expended by a number of people to plan a group research proposal, you want to be assured that you fully understand the guidelines of the sponsor and any unique requirements that the sponsor may have in regard to multi-investigator, multi-institutional projects. The sponsor may require a pre-proposal or synopsis of the proposed research prior to encouraging the submission of a full proposal. The suggestions made in Chapter 6 on contacting the sponsor's representative may be doubly important when proposing group research.

Since it is likely that most research sponsors are more accustomed to providing research support to individual research projects, you should pursue possibilities of waiving certain restrictions that the sponsor might have on proposal preparation. For example, if a page length maximum is imposed for individual research proposals, will the sponsor provide more latitude to group projects that may require more pages to describe the responsibilities of each researcher or institution in contributing to the whole? The way in which the sponsor wants budget and budget justification handled, when several institutions are involved, must also be sorted out.

References Cited

Baldensperger, J., Dubernard J., R. Oliver, and M. Roesch. 1993. How to draft a grant application for a research programme. International Foundation for Science, Stockholm, Sweden.

Bauer, H. H. 1995. Ethics in science.
[Online] Available *http://www.chem.vt.edu/ethics/hbauer/*;
21 July, 1998

Commission of the European Communities, Evaluation Unit Methods and Instruments for Project Cycle Management. 1993. Manual, Project cycle management, Integrated approach and logical framework. Nº. 1. Office for Official Publications of the European Communities, L-2985 Luxemburg.

Community of Science, Inc.
[Online] Available *http://www.cos.com./collateral/international.htm*;
4 August, 1998

Geever, J. C. and McNeill, P. 1997. A proposal writing short course. The Foundation Center's guide to proposal writing, revised ed. The Foundation Center, New York.
[Online] Available *http://fndcenter.org/onlib/prop.htm*; 10 August, 1998

Goldenberg, J. 1998. What is the role of science in developing countries? Science 279:1140-1141.

Information Training and Agricultural Development (ITAD) Ltd. 1999. Project cycle management training handbook. The European Commission; [Online] Available *http://europa.eu.int/search/s97.vts;*
31 March, 2000

Job, D. A. 1995. A guide to grants, fellowships, and scholarships in international forestry and natural resources. USDA Forest Service, International Forestry Staff, Washington, D.C. Publ. No. FS-584, 114 pp.

Lundgren, A. L., Scott J. J., Gregersen H. M., and David N. Bengston. 1994. Module 2. Initial steps in strategic planning. In: Planning and managing forestry research: A Self-learning course. IUFRO-SPDC, Vienna, Austria.

MacKensie, D. R., and J. S. Angle. Principles of grantsmanship: A manual on organizing a competitive grant proposal. University of Maryland, College of Agriculture and Natural Resources. Released 1997.

Miner, J.T., and Miner, L.E. 1998. A guide to proposal planning and writing. [Online] Available *http://www.oryxpress.com/miner.htm*; 10 July, 1998

National Academy of Sciences (NAS). 1995a. On being a scientist: Responsible conduct in research. Committee on Science, Engineering, and Public Policy. National Academy Press, 2nd ed. [Online] Available *http://www.nap.edu/readingroom/books/obas/*; 21 July, 1998

National Academy of Sciences (NAS). 1995b. Reshaping the graduate education of scientists and engineers. Committee on Science, Engineering, and Public Policy. National Academy Press, 2nd ed. [Online] Available *http://www.nap.edu/readingroom/books/obas/*; 21 July, 1998

National Science Foundation Guidelines (NSF) [Online] Available *http://www.nsf.gov/bfa/cpo/gpg/cont.htm*; 9 July, 1998

Office of Research and Sponsored Programs, Northwestern University, Cost-sharing/matching policy. [Online] Available *http://www.nwu.edu/vp-research-gradstudies/rig/rig-policies/*; 5 August, 1998

Schafersman, Steven D. 1997. An introduction to science: Scientific thinking and the scientific method. [Online] Available *http://www.muohio.edu/~schafesd/documents/*; 21 July, 1998

Texas Tech University, Department of English, The problem statement, PhD program in technical communication and rhetoric. [Online] Available *http://www.as.ttu.edu/department/techcomm/phdguide/problem.htm*; 29 July, 1998

The Foundation Center. Your gateway to philanthropy on the world wide web. [Online] Available *http://fdncenter.org/*; 10 August, 1998

University of Hong Kong, The English Center, Communication reference manual. Investigative reports. [Online] Available *http://www.hku.hk/crm/invrep/invrep.html;* 29 July, 1998

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Appendix I

Activities for Study Units

Study Unit 2.0 - The Need for Scientific Research

Answer the following questions that relate to the scientific research process.

1. What are the three guiding principles of scientific investigation that also apply to critical thinking?

2. Why is emotional evidence not considered as a valid basis for reliable knowledge?

3. Why is primary literature not necessarily considered reliable knowledge?

4. List the 6 Basic Steps in putting the scientific method in practice.

5. What is the difference between “technology” and “science”?

6. If your organization permits the employment of advanced study students to assist in research, answer the two following statements:

a. Provide examples of several benefits that might be derived from employing graduate students as research assistants on sponsored research projects.

b. Provide examples of possible disadvantages.

Study Unit 3.0 - Identifying and Prioritizing Research Needs

A. Answer the following questions that pertain to some of the steps required in preparing a research proposal.

1. a. Define an important problem or need relative to your own experience and interests.

b. Restate the above problem, illustrating the use of the "A BUT B" technique.

c. Justify researching the problem (How will outcomes of research be valuable and to whom? Perhaps list specific anticipated impacts).

2. Identify the resources you will require to carry out the research project.

3. What are the resources (human, facilities, equipment, supplies, funding, institutional support) you currently have directly available to you to carry out your preferred research?

4. What additional resources might be provided by your department or research unit if requested?

5. List what you believe to be the key support functions that your unit/ organization can provide you in your research program. (*e.g.* personnel, fiscal management, clerical support, major equipment, field sites, *etc*.)

6. Identify what you believe to be the main obstacle to performing your preferred research program (be specific – trained personnel, specialized techniques, special equipment, travel budget, *etc.*)

B. Consider the following hypothetical situations and comment.

1. A research project proposes to determine the impact of several different silvicultural improvement harvesting techniques, in moist, mixed species tropical forest stands, on improving future timber yields. List, based on your own experience, who might be important stakeholders in such research.

2. Contrast the above project with one that proposes to examine the measurable nitrogen fixation capacity of potted seedlings of tropical legume tree species under controlled greenhouse conditions. Who might be the important stakeholders in this research?

3. In general, contrast what are likely to be the anticipated and desired outcomes of research when viewed by a ministry of natural resources versus a national research council?

4. For the hypothetical problem, *There is a need to prevent defoliation of large areas of tree species A by insect Z.z in region Y, BUT, we don't have effective and economical control measures for this insect,* put together a list of probable stakeholders who you think would be concerned with this problem. Use Table 3.2 in Chapter 3 as a format for listing stakeholders, what they want, and their possible criteria. Do not try to fill in the column on your performance.

Study Unit 4.0 - Identifying Sources of Research Funding

Please respond to the following questions or statements that refer to sponsor funding of research.

1. Identify a sponsor that might be interested in a particular research problem of interest to you. (See examples of several sponsor guidelines)

2. Examine the goals of the sponsor and comment on your eligibility (assume university or research institute).

3. What specific requirements of the selected sponsor are of special importance?

4. What are the specific guidelines provided by the sponsor for proposal preparation?

5. List by name, the organizations, groups, or agencies that could potentially be a collaborator or cooperator on your research project and indicate what expertise they bring which will complement yours.

6. List by name, the individuals or research groups within your own organization that could potentially be a collaborator or cooperator, and indicate their complementary expertise.

7. List all sponsors that you believe would be potentially interested in supporting your kind of research. Categorize these as to government, foundation, or corporate sponsors.

8. What sources of information have you used to identify these potential sponsors?

9. The principles and guidelines for preparing a research proposal consisting of basic research and a proposal consisting of applied research are essentially identical. However, the way in which the outcomes are evaluated from the completed research may differ significantly. Why?

10. If you were to submit a research proposal to a private corporation, what should be the primary approach you must use with the corporation to maximize chances of success?

Study Unit 6.0 - Pre-Planning

Please respond to the following questions or statements that consider pre-planning of a research proposal.

1. In the pre-planning phase of writing a research proposal, it is necessary to secure the guidelines for submitting research proposals to a specific funding sponsor. After receiving written guidelines and reviewing them, what would be the next logical step to take in your proposal pre-planning?

2. List a number of logical questions that a potential research proposal applicant might ask the program officer of a funding sponsor prior to submitting a proposal.

What kinds of questions would be inappropriate to ask?

3. List some reasonable questions that a research proposal applicant might address to a fellow scientist who had previously been funded by the research sponsor you are considering.

4. List some key questions that you might ask a reviewer of proposal applications that has been previously used by a specific funding sponsor.

Study Unit 7.0 - Writing the Proposal

Please respond to the following questions or statements that pertain to writing research proposals.

1. Write an ***Introduction*** to your research proposal (follow suggested guidelines for content).

2. Develop at least two to three ***Objectives*** for your proposal (again, following suggested guidelines for content).

3. Give an overview of the major components of an ***Experimental Plan*** for your research (You may not be able to provide specific details but please provide general comments on the experimental design, evaluation, and possible methods).

4. What would be your plans for disseminating the research results and outcomes from your proposed research proposal, and by what means ?

What means do you have readily available to you?

Which means are most likely to be the best for the primary stake-holders of your research outcomes?

5. Develop a draft budget with all major components. Include a budget narrative of justification.

6. Identify your current job responsibilities and provide an estimate of the percentage of time that you are required to devote to each separate activity (e.g. research investigation, research administration, teaching, general administration, service on committees, program reviews, etc.).

7. Consider the amount of time (as percentage of total) you currently devote to current research projects.

a. How much time would be available for a new research project?

b. How would you reallocate your time to different responsibilities, if necessary?

8. a. What is your organization's policy on ***Indirect Cost*** (overhead)?

b. What is the usual rate?

c. Does it differ depending on type of funding sponsor?

9. a. Does your organization provide assistance in the preparation of research proposals?

b. Does it provide help with budget preparation?

c. If assistance is provided, what is the office/unit that does so?

10. a. Review your organization's mission and goals and please summarize.

b. If your organization does not have a stated mission or set of goals, what do you believe to be the primary purpose and goals of the organization?

c. How does your proposed research specifically relate to these purposes and goals?

Study Unit 8.0 - Tips on Writing Techniques and Appearance of Proposal

Respond to the following questions and situations that emphasize tips on writing proposals.

1. If you were able to determine that a particular sponsor requires reviewers to review research proposal applications on-site at the location of the sponsor, and that each reviewer is likely to have many proposals to review over a short period of time, what would be some key writing techniques you might use to present your proposal in the best format for a reviewer under these conditions?

2. Take the following assemblage of statements and rewrite them to illustrate the use of ***transitions*** in writing style. Feel free to "add" necessary wording to make a convincing "problem statement" out of the material presented below.

Defoliation of spruce is a critical problem.
Rural communities depend on the tourism and primary milling of spruce timber in about 70% of the province.
Spruce is a major component of the forests in our province.
Defoliation is caused by the spruce leaf midge, an introduced exotic insect.
No chemical control or natural predator of the spruce leaf midge is known to be effective.
A new systemic insecticide developed by Acme Chemical Co. shows promise of controlling the insect in preliminary studies under controlled greenhouse conditions.
Our proposed research ...

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Appendix II

Application and Review Criteria by Different Sponsors

Example of Application Form Required by the International Foundation for Science

[IFS Grant Application Form (1998)]

This illustrates that many research sponsors have specific forms and formats that must be used and filled in by the applicant. IFS provides four pages of narrative on guidelines to potential applicants. The total number of pages included in the Application Form is nine. No attachments or appendices are accepted. It is apparent in this example that applicants must be prepared to be brief and concise in many sections of the proposal because of space and page limitations.

Item on Form		Length on Form
1.	*Applicant Information*	1/3 page
2.	*Research Project Title (120 character max.) and Short Summary (150 word max.)*	1/3 page
3.	*Signatures*	1/4 page
4.	*Education*	
4.1	Formal education	1/4 page
4.2	Other studies	1/6 page
5.	*Present Position*	1/4 page
6.	*Previous Positions*	1/3 page
7.	*Publications and Research Expertise*	
7.1	List publications	1/2 page
7.2	Describe results and relevant experiences to proposed research	1/4 page
7.3	Ongoing scientific work at your institution related to proposed research	1/4 page
8.	*Proposed Research Project*	
8.1	Background	1/3 page
8.2	Present status of scientific knowledge	1/3 page
8.3	Objectives; scientific hypothesis; expected outcome	1/3 page

9.	*Experimental Design and Data Analysis*	
9.1	Contacted biometrician?	1/12 page
9.2	Relevant literature for experimental design and statistical methods	1/12 page
9.3	Statistical methods to be used	1/12 page
9.4	Computer software to be used	1/12 page
9.5	References if using own programme	1/12 page
9.6	Site plan or layout of project with treatments and replications	1/2 page
10.	*Research Plan*	2 pages
11.	*Scientific Contacts*	
11.1	Relevant contacts already established	1/6 page
11.2	Additional contacts to be made	1/6 page
12.	*Facilities and Funding*	
12.1	Facilities	1/12 page
12.2	Other funding	1/12 page
13.	*Justification for Requested Budget Items*	1/2 page
14.	*Estimated Budget*	
14.1	Equipment	1/3 page
14.2	Expendable supplies	1/4 page
14.3	Literature, documentation, information	1/5 page
14.4	Local travel	1/8 page
14.5	Extra manpower	1/8 page
14.6	Other costs	1/8 page

Total of 9 pages

Examples of Review Criteria Used by Different Sponsors

I. The International Foundation for Science (Stockholm) stresses three major areas in evaluating research applications (personal communication):

Applicant Qualifications and Feasibility of Project

- Applicant's training and experience
- Available and requested resources
- Realistic goals and time plan

Scientific Quality

- A well-formulated hypothesis based on up-to-date knowledge of the problem and science
- A statistically and/or logically sound design of experiments or plans for trials and observations
- Relevant and up-to-date methods for sampling, laboratory work, measurements, etc.

Relevance of Results to:

- Development applicability
- Scientific knowledge
- National priorities

II. National Science Foundation (USA) stipulates two general review criteria that are designed to be useful and relevant across NSF's many different programs (NSF Grant Proposal Guide, 1998):

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 and original 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?

III. US Department of Agriculture National Research Initiative Competitive Grants Program (USA) uses three major evaluation factors in reviewing applications for Standard Research Grants (USDA NRICGP 1999 Program Description):

Scientific merit of the proposal, consisting of:

- Novelty, uniqueness, and originality;
- Conceptual adequacy of the hypothesis or research question;
- Clarity and delineation of objectives;
- Adequacy of the description of the undertaking and suitability and feasibility of methodology;
- Demonstration of feasibility through preliminary data, and
- Probability of success of project.

Qualifications of proposed personnel and adequacy of facilities.

- Training and demonstrated awareness of previous and alternative approaches to the problem identified in the proposal, and performance record and/or potential for future accomplishments;
- Time allocated for systematic attainment of objectives;
- Institutional experience and competence in subject area; and
- Adequacy of available or obtainable support personnel, facilities, and instrumentation.

Relevance of the project to long-range improvements in and sustainability of U.S. agriculture or to one or more of the research purposes outlined in Applicable Regulations of this Program Description.

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Appendix III

Preparation and Submission Checklist

PREPARATION AND SUBMISSION CHECKLIST
(Adapted from McKensie and Angle, 1997)

The following is a list of questions, prepared by MacKensie and Angle (1997), that represent common oversights and errors committed by principal investigators when preparing to submit a grant proposal. As they point out, rarely does one error cause a proposal to be rejected. Often it's a combination of things that convince reviewers that a given proposal is not worthy of funding. This list is not all inclusive, but merely an attempt to assist you in preparing your grant proposal.

CATEGORY A

PROPOSAL FORMAT AND SPONSOR INSTRUCTIONS	YES	NO
Do you have the most recent set of instructions (application kit) for your proposal?	☐	☐
Have you read the grant proposal instructions thoroughly?	☐	☐
Is your proposal renewal or resubmission adequately updated?	☐	☐
Have you contacted the grants program office to get an update on any changes?	☐	☐

CATEGORY B

PROPOSAL CLARITY	YES	NO
Is your proposal's title clear and informative?	☐	☐
Are your methods clear, complete and acceptable to others?	☐	☐
Have you had a colleague or two "review" your proposal before submission?	☐	☐
Is your research plan clear to someone of a related scientific discipline?	☐	☐
Have you avoided reference to an earlier grant application that may otherwise confuse or frustrate a new reader?	☐	☐

Are all portions of your proposal completely honest?	☐	☐
Is your proposal strengthened with good scientific writing?	☐	☐
Have you been careful with your words, terms or jargon?	☐	☐

CATEGORY C

PROJECT PLANNING	**YES**	**NO**
Is your project suitable to the funding sponsor?	☐	☐
Is the project acceptable to your host institution?	☐	☐
Have you clearly defined the project?	☐	☐
Have you stated your plans for any leaves-of-absence or other interruptions?	☐	☐
Have you specified an accurate portion of time and effort to be devoted to the proposed project?	☐	☐
Have you honestly considered, and described if required, all of your current and future obligations?	☐	☐
Have you left nothing of the research plan to the imagination of the reviewers?	☐	☐
Do you have sufficient space for all of your planned activities?	☐	☐
Are the facilities and services at your institution adequate?	☐	☐
Have you clearly developed the sequence of investigations?	☐	☐
Have you given a logical sequence of steps for your investigation?	☐	☐
Have you sufficiently focused on an appropriate project?	☐	☐
Does the amount of work proposed seem reasonable?	☐	☐
Have you stated your plans for the recruitment of staff, should the grant be awarded?	☐	☐

CATEGORY D

RESEARCH METHODS AND PROCEDURES	YES	NO
Have you thoroughly described all of the new and novel methods, protocols and procedures you plan to use?	☐	☐
Have you discussed all potential difficulties?	☐	☐
Do you specify alternatives, should procedural problems be encountered?	☐	☐
Have you pointed out all hazardous procedures, situations and materials?	☐	☐
Have you specified the precautions to be taken for lessening any hazards?	☐	☐
Have you explained why you have chosen a more difficult procedure over a simpler, preferred choice?	☐	☐

CATEGORY E

YOUR COMPETENCE	YES	NO
Are all of the articles in your *curriculum vitae* actually published (not just "in preparation")?	☐	☐
Have you incorporated new data of your own into the proposal?	☐	☐
Have you listed your (and other collaborators') post-doctoral experiences?	☐	☐
Have you been honest, straight-forward and fair in representing your unique interest, competence and abilities?	☐	☐
Does your proposal omit all misconceptions, misinterpretations or misrepresentations?	☐	☐
Is your CV complete and in sufficient detail to convince reviewers that you can undertake the proposed research?	☐	☐

Have you been forthright to the extent that reviewers will not question your competence?	☐	☐
Are all of the data you have included absolutely reliable?	☐	☐
Are all of the conclusions you have presented warranted?	☐	☐
Have you demonstrated your productivity and dependability as a research scientist?	☐	☐

CATEGORY F

IMPORTANCE OF ANY FINDINGS	YES	NO
Have you established that "gap" exists in scientific knowledge that needs to be researched?	☐	☐
Does your recent research progress justify a resubmission?	☐	☐
Have you stated the importance of your expected discoveries?	☐	☐
Have you expressed with certainty your future directions for this research?	☐	☐

CATEGORY G

COMPLETENESS OF THE PROPOSAL	YES	NO
Have you presented all pertinent literature?	☐	☐
Have you used unquestionable reasoning in your approach to the problem?	☐	☐
Have you developed an acceptable scientific rationale?	☐	☐
Does your institution plan to support and reward externally funded research projects?	☐	☐
Have you specified in the proposal the degree of institutional support you have been promised?	☐	☐

CATEGORY H

BUDGET	YES	NO
Did you list yourself as an investigator in the budget and budget explanation?	☐	☐
Does the amount of effort reflected in the budget correspond to the effort described in the research narrative?	☐	☐
Has your institution offered your time and effort at no cost (or reasonable cost) to the project?	☐	☐
Is your institution willing to allow you to specify "cost sharing"?	☐	☐
Have you adequately justified all equipment requests?	☐	☐
Have you addressed the disposition of all purchased equipment at the end of the project?	☐	☐
Have you explained any increased funding that you requested for future years?	☐	☐
Is your budget reasonable?	☐	☐
If required, have you honestly described all of your current and pending sources of funding?	☐	☐
Have you resolved all questions on patents and copyrights?	☐	☐
Are all questions resolved on indirect cost charges?	☐	☐

CATEGORY I

CONCERNS FOR REVIEW	YES	NO
Have you read the relevant information from the sponsor's program office about the proposal review process?	☐	☐
Have you included your full address, phone and fax numbers, and E-mail addresses correctly on the proposal?	☐	☐
Are you aware that your renewal or resubmission will very likely be reviewed by different reviewers?	☐	☐

Are you presenting any original ideas?	☐	☐
Have you been critical but fair of what is known and what needs to be known?	☐	☐

If you checked NO on any of the above questions, you should justify that decision in your own mind.
We expect that this list will be useful throughout the period of your proposal development leading up to your decision to submit the final version to the sponsor's competitive grants office.

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Appendix IV

Logical Framework

(contributed by Dr. Peter Wood)

Guidelines for Preparation of a Logical Framework for a Research Project[1]

INTRODUCTION - WHAT IS A LOGICAL FRAMEWORK?

The logical framework is a management tool that aims to promote good design by clearly stating the logic of the proposed project and the components that contribute to it. Essentially it is used to help research planners to structure and formulate their ideas in a clear standardised form. The logical structure linking the components takes the following form:

IF [the activities carried out] AND [the assumptions are met] THEN [the results or outputs will be delivered],

IF [the results or outputs are delivered] AND [the assumptions are met] THEN [the purpose will be achieved], and so on. The logical framework must define the project in terms of

goal - purpose- outputs - activities
and
quantity - quality - time

APPLYING LOGICAL FRAMEWORKS TO RESEARCH

Why should such a structure be applied to a research project? Some researchers have argued that they cannot possibly know in advance what they will find out and that therefore they should not be asked in advance what they propose to do.

This is obviously totally unacceptable if a researcher is asking for a grant to carry out research. Of course, the results of research cannot be known in advance, but the work programme to obtain those results can and should be carefully worked out by the researcher. This is the only way that an honest estimate of the costs to produce a realistic budget can be obtained. This is also the reason that "QQT " should be given - quantity, quality and timing.

[1] This Guideline has drawn heavily on the Natural Resources Guide to Logical Frameworks, an internal document of the Department for International Development, London, UK and permission to use it is gratefully acknowledged.

Before we go on to consider the logical framework itself let us be clear about the importance and relevance of QQT. The *Quantity* can include such things as area of land occupied by trials, numbers of laboratory experiments, number of visits to and kilometres travelled to reach experimental sites. The *Quality* refers to such things as the type of land occupied, the experimental designs used, the kinds of analysis used, the kinds of publication expected. The *Timing* refers to when planned work will be completed, when results (positive or negative) will be written up, when, in other words, the donor can expect to see what has been done with the money.

Logical frameworks are not carved in stone at the start of a research programme. They are living documents, which may change over the life of the project according to changes in the external environment and to any alterations that need to be made to the results/outputs or deliverables. The information in a logical framework is generated during the design of the research project and is used to manage its implementation. Extra information with more detail about work plans and procedures, etc., can be inserted into separate documents and referred to in the logical framework. The modification of a logical framework should ideally be done by and with the agreement of all the people who are concerned with it, but with this proviso it can be done at any agreed time during the life of the research project. One of the major reasons for using the framework is that it spells out how to judge progress towards achieving the project purpose.

THE STRUCTURE

The logical framework consists of a 4 x 4 matrix. As we have seen above, it has a vertical hierarchy of objectives at the (i) goal, (ii) purpose, (iii) result, and (iv) activity levels.

It also has a horizontal hierarchy and these horizontal components are (i) summaries of the information and objectives at each level, (ii) performance indicators for achievement of those objectives, (iii) the sources needed to verify the indicators, and (iv) the important assumptions for moving from one level of objectives to the next. Slightly different wording is used by different agencies but the meaning is the same.

The form is thus:

	Narrative Summary/ Intervention Logic	Measurable Indicators/Objectively Verifyable Indicators	Means/ Sources of Verification	Important Assumptions
Goal/Overall Objectives/ Shared Vision				
Project Purpose:				
Outputs/ Results/ Deliverables ...				
Activities		Means	Budget/ Costs	Preconditions

The addition of Preconditions by some organisations in the lower right hand box indicates that there may be certain things that the researcher - or the donor - may have to provide or achieve before any research can start at all.

The components of the matrix are defined as follows:

a. the goal is the higher level objective or longer-term impact of the research project on national or development agency objectives;

b. the purpose is the measurable near-term impact of the project which is the final accomplishment of the project;

c. the outputs are the results or deliverables of the project that the project leader can guarantee;

d. the activities are the key activities undertaken by the research team that summarise the action strategy to produce the outputs;

e. the indicators are measurements to verify to what extent the objectives at each level are achieved, targeted in terms of quantity, quality and time;

f. the means of verification are the specific sources of data necessary to verify the indicators at each objective level;

g. the assumptions are important events, conditions and decisions outside the control of the project that are necessary for meeting the objectives.

RECOMMENDED PROCEDURE FOR CONSTRUCTING A FRAMEWORK

The procedure for constructing the logical frameworks is:

Define the overall goal

This is the rationale for the project. It is also a vision of the future that the researcher is helping to reach. This vision should be agreed and shared by the funding agency, but it cannot be totally achieved by the research project. A portfolio of projects may share the same goal and its accomplishment is reached through the efforts of many projects.

Define the purpose

Why is the research project being done, in terms of the desired impact? The project purpose describes the impact which it is hoped to generate by producing project outputs. The project should only have one clearly stated purpose (which is not merely a reformulation of the outputs). Although the project is aiming at it, it is not directly produced by it. At project level, it may be defined as the PROGRAMME OUTPUT to which the project contributes.

Define the outputs

What is the project to accomplish? These are the research results or outputs appropriate to the project purpose and are what the researcher promises to deliver as a result of the activities planned. The outputs should be clearly stated as results and all of them should be necessary for accomplishing the purpose of the project. Outputs can be written to show their sequence over time. In the case of research, it may only be possible to specify outputs for the first year or so, in which case the final output would indicate that, by a certain date, the logical framework

would be re-written with a new set of outputs approved by the appropriate stakeholders or collaborators.

Define the activities

How will the project be accomplished? Activities are the action components needed to accomplish the outputs, and are the responsibility of the researcher. Each objective at the output level should have an activity or group of activities associated with it; the activities defining the action strategy for accomplishing each output.

Verify the vertical logic

Use the IF [ ] AND [ ] THEN…logic path to check links between the objective levels. Another way of doing this is to ask the question "how" in moving down the hierarchy, and the question "why" in moving upwards. The if/then relationship between the purpose and goal should be logical and not omit important steps. The vertical logic among activity, output, purpose, and goal should be realistic as a whole.

Define the important assumptions

Do this:

(i) at the purpose level,
(ii) at the output level,
(iii) at the activity level, and
(iv) at the goal level.

Important assumptions are external conditions or factors over which the project chooses not to exert control or does not have control, but on which the accomplishment of objectives depends. An assumption that does not hold true can derail a research programme as often as poorly executed outputs, e.g. good co-operation with another institution needed, rains do not fail, access to suitable field sites.

The purpose plus assumptions at that level should describe the critical conditions for achieving the goal. The outputs plus the assumptions at that level should produce the conditions needed for achieving the purpose. The assumptions at the activity level should not include any

preconditions; these may be placed below the activity level assumptions, as separate items.

Define the measurable indicators:

(i) at the purpose level,
(ii) at the output level,
(iii) at the goal level, and
(iv) at the activities level and show a Budget Summary.

Indicators should define in quantifiable detail the performance levels required by the objectives and they should thus state what will be a sufficient performance to assume that the next level of objective can be reached. The assessment of quantity, quality and timing involves putting numbers and dates on the indicators, and this is important for effective monitoring (at the results/output level) and evaluation (at the purpose level). The purpose indicators should measure what is important; also have quantity, quality and time measures; and be independent from the outputs. The output and goal level indicators should be objectively verifiable in terms of quantity, quality and time.

Define the means of verification:

(i) at the purpose level,
(ii) at the output level,
(iii) at the activity level, and
(iv) at the goal level.

Identify sources of information for verifying the indicators, and thus for demonstrating what has been accomplished. At the activity level these would follow the reporting requirements of the donor. At the output level these will often be the publication details for papers, articles, talks, lectures, extension activities etc. The activities should identify any actions required for gathering means of verification.

Review the logical framework

To arrange a system for monitoring and evaluation, complete the logframe, paying particular attention to the INDICATORS and VERIFICATION columns. The completed logframe then forms the basis for the project evaluation plan.

Key questions:

Goal

- What is the overall problem which the research project is trying to solve ?
- How will the project contribute to its solution ?
- How will the contribution be measured ?
- What other key conditions need to be met and what are the risks ?

Purpose

- What will be the project's direct effects and impacts ?
- How will these help to solve the problem ?
- How will the effects and impacts be measured ?
- What other key conditions need to be met if the project is to contribute to the goal and what are the risks ?
- How will the results of the research be applied in practice?

Outputs

- What will the project deliver ?
- How will the outputs be measured ?
- What other key conditions need to be met if the outputs are to achieve the purpose and what are the risks ?

Activities

- What is going to be done ?
- What know-how, facilities and equipment are required ?
- What finance is required ?
- What other key conditions need to be met if the activities are to produce the outputs and what are the risks ?

ACKNOWLEDGEMENTS AND REFERENCES

Permission from the Department for International Development, London, UK, to use their Natural Resources Guide to Logical Frameworks is gratefully acknowledged.

For further reading the following may be consulted:

Anon. 1993. Manual Project Cycle Management. Integrated Approach and Logical Framework. Brussels, Commission of the European Communities.

Information Training and Agricultural Development (ITAD) Ltd. 1999. Project cycle management training handbook, Brussels, The European Commission.

Schubert, B. Nagel, U.J., Denning G.L., & Pingali, P.L. 1991. A Logical Framework for Planning Agricultural Research Programmes. Manila, International Rice Research Institute.

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Appendix V

Glossary

Glossary

Biohazard. A hazardous material usually including carcinogens, mutagens, teratogens, all microbiological agents and sometimes radiological hazards and GMOs.

Contract. An agreement between a research organization and a sponsor in which an offer is made and accepted, and each party benefits.
See **cost-reimbursement contract**; *see* **fixed-price contract.**

Cost-Reimbursement Contract. The sponsor agrees to pay for all allowable costs incurred by the research organization in the process of doing the research up to an agreed maximum. If the project cost less than the original amount budgeted, the sponsor is obligated to reimburse the organization only up to the allowable costs of the project.

Cost Sharing. The participation by the research organization in funding the costs of a project. This is sometime termed as "matching" when shown as a ratio of the sponsor and research organization contributions.

Curriculum Vitae. A formally structured listing of education, publications, projects, awards and work history. A type of resume preferred for use by scientists and educators.

Deduction (reasoning)**.** Reasoning from theories to account for specific experimental results.
See **induction**.

Empirical Evidence. Evidence that can be experienced by observation through sight, touch, taste, sound or smell. The experience is repeatable and can be experienced by others.

Fixed-Price Contract. The sponsor pays a fixed sum to the research organization to complete a specific project regardless of the actual costs.

Font. A font is a set of printable or displayable text characters in a specific style and size. The type design for a set of fonts is the **typeface** and variations of this design form the typeface family. Times New Roman is

a typeface family, Times New Roman italic is a typeface, and Times New Roman italic 10-point is a font. In practice, font and typeface are often used without much precision, sometimes interchangeably.

Fringe Benefits. These are employee-related expenses that cover the costs of such employee benefits as health insurance, retirement, and unemployment insurance.

Gift. A donation given to an organization that does not require that a benefit be returned to the donor. Usually would not include those criteria listed for a "Sponsored Project".
See also **Restricted Gift** *and* **Unrestricted Gift**.

GMO. Genetically modified organism produced by genetic engineering techniques.

Goal, proposal. The final purpose or aim; the ultimate end to which a design tends, or which a series of objectives tend toward.
See **objective**.

Grant. A mechanism for supporting a specific activity, or project under the direction of a principal investigator. Grants are usually used when the principal objective is to accomplish a public purpose.

Hazardous Materials. Any chemical or biological agent that may cause a physical or health hazard to persons exposed to them.

Hypothesis, scientific. An informed, testable, and predictive solution to a problem that explains a natural phenomenon, process, or event.

Indirect Costs (IDC). Additional costs of a project that are part of the total budget. Expressed as a rate (percentage) of the direct costs of a project (salaries and wages, fringe benefits, materials and supplies, services, travel and subgrants or subcontracts). Indirect costs are usually at a predetermined negotiated rate. IDC are costs of supporting the infrastructure of the research organization.

Induction (reasoning)**.** Reasoning from specific observations and experiments to more general hypotheses and theories.
See **deduction**.

Objective, proposal. That which one wants to achieve. Something toward which effort is directed. A specified, measurable outcome over a defined period of time (*i.e.*, "immediate" rather than "ultimate"). Outcomes can be in the form of behavioral, performance, process or product. *See* **goal.**

Pre-Proposal. A short description of a proposed project that does not involve a commitment from the researcher's organization.

Primary Literature. That body of science that exists primarily as articles in research journals and has generally been reviewed by peers in the particular discipline.
See **secondary literature**.

Principal Investigator. The individual who bears primary responsibility for technical compliance, completion of programmatic work, fiscal stewardship of sponsor funds, and compliance with the administrative requirements of the project.

Reliable Knowledge. Knowledge that has a high probability of being true because its veracity has been justified by a reliable method.

Request for Proposal (RFP). A type of solicited proposal. Usually a one-time solicitation for specific needs by a sponsor.

Restricted Gift. A donation of money or property that must be used for a specific purpose.

Scientific Method. A process that seeks to establish scientific fact and reliable knowledge by the use of empirical evidence and logical reasoning while maintaining a skeptical attitude.

Secondary Literature. Primary literature that has received further scrutiny by the scientific community and becomes cited in other articles and review papers.
See **primary literature**.

Solicited Proposal. A proposal prepared by a researcher in response to a specific written program announcement by a sponsoring organization.

Sponsored Project. A project that meets any one of the following criteria:

- A proposed project that binds the organization to a specific scope or area of work.
- A requirement for progress, technical, final reports or other deliverables.
- A requirement for billing, separate accounting procedures, or report of expenditures.
- Unexpended funds must be returned to the sponsor at the end of the project
- The project involves disposition of property, tangible or intangible, that may result from the project (equipment, inventions, copyrights, rights of data).
- The project has a specified performance period or completion date.
- The project has budgeted indirect costs.
- The contract contains intellectual property terms.

Stakeholder. Individuals, groups, or organizations that have a claim on the research organization's and individual researcher's attention, resources, or output, or are affected by that output.

Technology. The systematic application (a process) of scientific knowledge to practical tasks.

Typeface. *See* **font**.

Unrestricted Gift. A donation of money or property for which the donor does not specifically restrict the use of the principal or any interest derived from the principal, or otherwise suggest or require a specific use of the funds.

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Dr. C. P. Patrick Reid

Professor and Director
School of Renewable Natural Resources

Biographical Sketch

Dr. C.P. Patrick Reid (PhD, Duke University) is Professor and Director of the School of Renewable Natural Resources at the University of Arizona. He has been an educator and researcher in forestry and natural resources for over 30 years. He was Head of the Department of Forestry at the University of Florida and a faculty member at Colorado State University. His research in ecological physiology has focused on mycorrhizae and the relationships between soil microorganisms, plant roots and soil. He has lived and conducted research in England, Austria and Australia, and is best known for his work on the effects of mycorrhizae on photosynthesis of woody plants and the role of microbial siderophores in the iron nutrition of plants. He was a Senior Fulbright Scholar at the University of Innsbruck, Austria, and has served as chair of the IUFRO Working Party on Root Physiology and Symbioses. He is currently President-Elect of the National Association of Professional Forestry Schools and Colleges, an association of 67 universities in the United States.

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