

# Comment: Thinking about a Research Proposal?

Judith S. Sunley

It was my privilege to work with Bruce Trumbo during the most recent of his three appointments as Program Director for Statistics and Probability at the National Science Foundation. The advice found in his paper is based on a level of experience with NSF programs that is hard to match outside the permanent staff of the Foundation. Moreover, it is applicable to a much broader range of individuals than those looking for their first research award.

This discussion is developed in the form of questions that investigators may wish to ask themselves as they work through Trumbo's article and actually develop their first (or simply newest) proposal.

## WHAT DO I HOPE TO ACCOMPLISH IN MY PROPOSAL FOR RESEARCH SUPPORT?

Many investigators write a proposal for research support because it is the accepted thing to do, because they have done so annually for many years or perhaps because their institution requires them to do so. However, thinking carefully about what you hope to accomplish through the process allows much of the procedural detail to fall into place.

Virtually no one in our profession has sufficient time to investigate all the research ideas they are carrying around in their heads. Teaching schedules, consulting activity, committee work, editing or reviewing responsibilities and the like all tend to intervene. Thus, obtaining free time to put those ideas in a coherent framework and develop the concepts necessary to further the discipline is generally the most important consideration in a request for research support.

Although most frequently this translates to a request for support for 2 months of concentrated research work during the summer, you should pay some attention to whether or not that is most appropriate for your needs. It may be that teaching requirements are so onerous that relief during the academic year is more important or equally important. Alternatively, it might be possible to leverage a small amount of academic year support from a research grant into a full or partial sabbatical. In any case, your proposal

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should be structured to convey the importance of time devoted to the research in the fashion requested.

If carrying out your research requires a good deal of computational effort or could use an influx of ideas based on computation, support for equipment or access to computational resources may be of great importance. Again, your proposal should emphasize the computational requirements of the work proposed and the expected benefits from obtaining computational resources.

Colleagues working on the same or related classes of problems can also be resources in a research program. Consider a joint proposal if collaborative research seems an ideal way of meeting your research objectives. This can be particularly important for work that cuts across subdisciplines of the mathematical sciences or, more broadly, across science and engineering.

Perhaps there is a graduate student in your department who could work with you if there were funds to support that work, or you might like to bring a post-doctoral associate into the picture. The best way to assure support for these personnel resources is to make sure they are appropriately molded into the project you describe and that you provide available information on their abilities.

There are any number of other resources that may be important to carrying out your research as you envision it: travel, consulting with other investigators in your area, a research workshop, materials and supplies, publication costs to facilitate dissemination of your results. What you request should depend on what you need to perform the investigations described in your proposal.

Good research proposals, like good research work, require the investment of time and energy, imagination and care. Frequently, the development of a proposal may lead you into new lines of thought. At the very least, a well-written proposal helps you as a researcher to organize your thinking about your research and to codify your reasons for its pursuit. Even if the outcome of the search for funds is negative, the effort put into developing a good proposal is well worth it.

## WHAT DO THE REVIEWERS WANT TO SEE IN A PROPOSAL?

The reviewers play a very important role in determining the ultimate disposition of your proposal.

Thus, putting yourself in the place of the reviewer can be very useful in developing the proposal.

For example, suppose you were reviewing a proposal. What would you want to see there? Most likely, you would expect the proposer to have explained the research program clearly and concisely, describing its relationship to ongoing research in the field while outlining the directions of the research and the methods deemed most likely to lead to solutions. You would also expect a good description of how the proposer's earlier work fit the needs of the proposed program.

It is important for you to provide enough detail to convince the reviewer you know what you are proposing to do, understand its place in the landscape of the discipline and have the tools and imagination to carry it out. If the proposal is too short, you will not be able to do this. However, if it is too long, the detail provided may simply obscure your original ideas. Reviewers may find the going tedious and their response is less likely to be highly positive.

Sometimes it is appropriate to provide an appendix to the main proposal that contains one or two recent preprints or reprints so reviewers will have immediate access to some of your work. This will help them formulate an opinion on your ability to carry out the work proposed. However, your proposal should be independent of such appendices—you should not make it necessary for the reviewers to read the appendices carefully in order to understand the proposal.

In general, 10–15 typewritten, double-spaced pages should be sufficient for the body of the text. If your proposal is much longer or shorter, you might want to consider revision.

Another good method for getting into the mind of the reviewer is to have a colleague prescreen the proposal for you. This is particularly recommended for younger investigators. It is easy to become so involved in your own research work that it becomes difficult to see in it what others see.

In the long run, it is the mathematical ideas, their originality, their potential importance and your ability as an investigator to make them come to fruition that are the deciding factors in most reviewers' evaluations. But those evaluations can be affected (usually negatively) by the presentation of the material. You give yourself an advantage if that presentation is well developed.

#### **WHAT CAN GIVE ME AN EDGE WITH THE PROGRAM IN WHICH I'M COMPETING?**

Although program officers at NSF only recommend awards and declinations for the proposals in their programs, in general those recommendations control the outcome. When viewing proposals with an eye toward a recommendation, program officers react much like reviewers, so much of what is contained above is applicable at this level as well.

However, program officers see the full range of what is competing for funds in their programs and must, perforce, make comparisons that reviewers cannot make. They are never happy with the number and quality of the proposals they must recommend for declination. Therefore, it is important to give your proposal every possible advantage when it comes to the time for comparisons to be made.

In particular, there are special activities at NSF for proposals that fall into certain categories. By carefully considering your eligibility for one of these special activities and tailoring your proposal appropriately, you may be able to enhance your ability to compete. Examples include proposals from female or minority investigators and proposals received from faculty at predominately undergraduate institutions. There are also special activities to promote international collaborative research, programs in support of educational activities and programs in support of other disciplines in science and engineering that have components with significant mathematics orientation.

The Division of Mathematical Sciences has a number of special areas of emphasis as well, including computational mathematics, certain kinds of group-oriented activity and enhanced interactions between the mathematical and biological sciences. We particularly encourage researchers to take the broadest possible view of the mathematical sciences research enterprise, encompassing educational objectives at the precollege and undergraduate levels along with their research activity in a process we term "vertical integration."

Contacting the program officer before submission of a proposal is the best way to find out about the variety of opportunities. It will also let the program officer know a proposal is on its way, while providing you an opportunity to acquaint the program officer with your work. It is also possible to suggest the names of individuals familiar with your work as potential reviewers.

Young (Ph.D. age) investigators should also consider participating in the Mathematical Sciences Postdoctoral Research Fellowship competition or combining their research efforts with those of more senior colleagues in a joint proposal. Both of these mechanisms help to limit the competitive pool to individuals of comparable background, eliminating those with long-established research careers.

Another mechanism for enhancing your chances for success is to resist the temptation to limit yourself to just one potential source for funds. If the research you are interested in pursuing has many possible lines, you should consider which might be appropriate for submission to one or more of the mission agencies. Contacting the appropriate program officer at one of these agencies will help you decide how best to formulate a proposal to meet mission-oriented objectives.

Finally, program officers have the ability to be much more flexible in the nature of what they recommend than is generally recognized. If you believe you have an imaginative approach to supporting your research program, discuss it with the appropriate program officer.

### SOME FINAL THOUGHTS

Lastly, but perhaps most importantly, you should never invest too much of your self-esteem as a researcher in the outcome of the proposal process. For the funding agencies, it is not the individual that is being supported, it is the research activity proposed as it fits in the context of the overall program. If your sense of your worth as a researcher rises or falls on the basis of the success of your proposal, you are likely to be doing yourself a disservice.

Declinations can be devastating, particularly when they come for the first time. It may seem like more of a rejection of your research and your ability as a researcher than is the case. Frequently the reviews of your proposal will be very positive, and it is important to take the positive comments and build on them, rather than becoming discouraged. Negative comments should be carefully evaluated for the information they can provide to your future work. Take those

making valid points and address them as appropriate in planning the future directions of your research. It is important to remember that a broad range of what program officers would term fundable work is declined. Generally such work is roughly on a par with some of what is funded.

Receiving a declination does not mean that your work will never be supported, rather that it is not being supported at this time. Likewise, receiving an award does not guarantee that your work will always be supported. Independent of the outcome, it is a good idea to discuss with the program officer the positive and negative factors in the decision and how you can improve your position the next time you submit a proposal. Sometimes you will get good ideas for modifying your methods or adapting your line of research to broader questions.

By recognizing that you can and should participate in competition for research support funds in the future, regardless of the disposition of any individual proposal, you help ensure that the process of competing for funds has some positive feedback to your research program and that research in the mathematical sciences remains vital. By approaching the process with imagination and creativity, you help us in the funding agencies remain flexible and responsive to your requirements for research support.

## Comment

Edward J. Wegman

Bruce Trumbo's discussion gives an excellent overview of the grant process at the National Science Foundation and with it, some excellent advice on strategies for winning grants. Obviously the processes are different at the Department of Defense (DoD) agencies, so perhaps a few remarks in these directions would also be useful. My remarks, of course, no longer reflect any official view or policy and should not be interpreted to do so. My direct experience relates to the Office of Naval Research (ONR), but by extension also reflects frequent contact with the other DoD agencies, the Air Force Office of Scientific Research (AFOSR), the Army Research Office (ARO), the De-

fense Advanced Research Projects Agency (DARPA), the Strategic Defense Initiative Organization (SDIO) and, most recently, the National Security Agency (NSA). These agencies along with the Department of Energy (DoE) are sometimes referred to as the mission agencies. This is, I have often thought, a somewhat unfortunate label because it tends to color the attitude investigators, particularly young investigators, have of the agency. The tendency is to understand "mission" as a synonym for "applied," and, hence, to turn off theoretically minded young investigators. In fact, certainly during my tenure at ONR, the type of research funded was quite theoretical, but chosen with a view to its relevance to the mission of the United States Navy and the United States Marine Corps. Because antisubmarine warfare was a clear naval mission, for example, ONR tends to have a strong focus on topics related to sonar and nonacoustic signal processing. Thus, proposals related to time series analysis and stochastic processes tend to be more

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