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with Thomas R. Kramer

Does Peer Review Work?

Hearings held in July 1975 before a House Subcommittee found fundamental soundness in NSF peer review evaluation systems

Can peer review lead to the effective advance of science? From its examination of that procedure at the National Science Foundation (NSF), the House Subcommittee on Science, Research, and Technology is satisfied that applications are being evaluated in a basically sound manner; moreover, the NSF's peer review system has survived the test of time and appears to enjoy the support of the scientific community. The system should not, however, be regarded as an unchangeable structure: it can be improved immediately in several ways, and further study may indicate additional improvements (*1*).

Why peer review?

For six days of oversight hearings in July 1975, the Subcommittee, under my chairmanship, addressed itself to the question "Once monies have been appropriated to the NSF and the division of those monies among disciplines and purposes has been agreed upon, how does the NSF go about making individual awards?" Several factors led to the selection of peer review as the topic of the hearings, probably the strongest of which were the Bauman Amendment and the ridicule to which scientific grants have been subjected in Congress.

The Bauman Amendment to the NSF authorization bill for FY 1976 passed in the House but was later killed in the House and Senate conference agreement on the bill. The amendment would have required the NSF each month to send a list of proposed grants to Congress for a 30-day layover, during which time either the House or the Senate could stop any listed grant by a simple resolution disapproving of it. Making fun of grants by title has become almost a tradition in the House—one of its less laudable traditions, to be sure. Rep. H. R. Gross established it, and Rep. Robert Bauman of Maryland, author of the amendment, has cheerfully carried it on. In the Senate, scientific grants frequently receive Sen. Proxmire's Golden Fleece award—an award distinctly of negative significance.

Peer review as a hearings topic was also indicated by the trend of recent years toward openness in government. It was appropriate for the Subcommittee to determine how compatible openness might be with the effective evaluation of applications.

A final factor leading to the selection of peer review was the increase in competition for NSF funds. It was believed that an increase in the numbers of disappointed applicants might lead to an increase in complaints about the system. The NSF wanted Congress to understand its procedures before this happened.

Witnesses

The 23 witnesses I asked to testify at the hearings included two Congressmen who had requested to appear, four principal NSF witnesses, ten persons selected by the Subcommittee staff, and seven persons recommended by Rep. Conlan of Arizona (Table 1). Philip Handler, President of the National Academy of Sciences, submitted important written testimony.

The two Congressmen, Rep. Bauman and Rep. Conlan, both had been critical of the NSF before the hearings, and Rep. Conlan launched the hearings with the following characterization of the NSF's peer review system:

> It is an incestuous "buddy system" that frequently stifles new ideas and scientific breakthroughs, while carving up the multimillion dollar Federal research and education pie in a monopoly game of grantsmanship.

The four principal NSF witnesses, on the other hand, believed the NSF procedures to be fundamentally sound and devoted much of their testimony to describing how decisions are made and what the resulting distribution of funds and reviewers has been. The ten expert witnesses selected by the Subcommittee staff were also generally supportive of the NSF, but they went on to suggest improvements.

The Subcommittee staff and I wanted to be sure that responsible scientists with negative views on the NSF were fully heard, and Rep. Conlan's wit-

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Table 1. Witnesses, representing different points of view, who appeared at the hearings on peer review, before the House Subcommittee on Science, Research, and Technology

Congressmen	John Conlan, *Arizona* Robert Bauman, *Maryland*
National Science Foundation	H. Guyford Stever, *Director, NSF* Norman Hackerman, *Chairman, National Science Board* Richard Atkinson, *Deputy Director, NSF* Donald Rice, *member, National Science Board, and President, RAND Corporation*
Selected by Subcommittee staff	
Federal agencies	John Sherman, *former acting director, National Institutes of Health* William Raney, *Chief Scientist, Office of Naval Research*
Academic institutions	Charles Kidd, *Executive Secretary, Association of American Universities* James Powell, *Provost, Oberlin College*
Scientific societies	William Carey, *Executive Director, American Association for the Advancement of Science*
Engineering	* Donald Marlowe, *Executive Director, American Society for Engineering Education* * Daniel Drucker, *dean, University of Illinois* * Vincent Haneman, *dean, Auburn University*
Working scientists, NSF reviewers	Raymond Bowers, *Director, Program on Science, Technology, and Society, Cornell University* Philip Morrison, *professor, Massachusetts Institute of Technology*
Recommended by Representative Conlan	
Materials research	Doris Wilsdorf, *professor, University of Virginia, and member, NSF Advisory Committee on Metallurgy and Materials* Heinz Wilsdorf, *department chairman, University of Virginia* Rustum Roy, *department chairman, Pennsylvania State University, and member, NSF Advisory Committee on Metallurgy and Materials*
Biomedicine innovation	Gilbert Ling, *department director, Pennsylvania Hospital* Carlton Hazlewood, *associate professor, Baylor College of Medicine* Freeman Cope, *biophysicist, U.S. Naval Air Development Center Biochemical Laboratory*
Curriculum development project monitoring	Elmer Seevers, *science curriculum coordinator, Biomedical Interdisciplinary Curriculum Project*

*Drs. Marlowe, Drucker, and Haneman asked to testify.

nesses filled this need well: all seven were well-qualified scientists—several were leaders in their respective fields—and all were highly critical of one aspect or another of the NSF's operation.

As a result of the charges made by Congressman Conlan and his witnesses, the hearings were conducted in an atmosphere of perceptibly high tension. This was not without its beneficial effects. Issues were explored in more depth than they might otherwise have been, and the attention of those present rarely wandered. The hearings, which had been scheduled originally for a total of 12 hours, extended to nearly twice that.

Issues and Subcommittee views

The label "peer review system" describes a broad spectrum of processes for awarding grants. In particular, the label does not indicate who makes the final decision whether or not to fund a given proposal: it may be the group of peers, or it may be the person or organization controlling the money. The NSF, in fact, employs a wide variety of evaluation procedures, tailored to fit differing types of programs. The procedures normally include reliance on staff judgment and evaluation by an individual peer reviewer and/or an assembled panel, but they may also include site visits, consultation with other funding agencies, or action by the National Science Board (the NSF's policy-making body).

Four interrelated questions encompass the important issues of peer review at the NSF. Does the NSF support high-quality research? Are all the people involved in the decision-making processes performing the proper functions, and are they performing them well? How open and fair is the system of granting awards? Does a desirable distribution of monies result from the decision-making processes?

The full Subcommittee *Peer Review Report* (*1*) was released on March 8, 1976. It presents 22 findings and recommendations grouped according to those questions. The two principal findings and recommendations of the Report and a discussion of how open and fair (third of the four questions) follow in this article. Neither the Report nor this article deals in depth with two areas of controversy that arose at the hearings, namely, the Individualized Science Instructional System (ISIS) and materials research funding. These have been well publicized elsewhere. The Subcommittee's two principal findings and recommendations were:

1. *Finding:* Procedures relying on peer review for evaluating applications for scientific research awards can lead to the effective advance of scientific knowledge. The NSF's peer review evaluation systems appear basically sound. *Recommendation:* The NSF should continue to use some form of peer review. Congress should not require major changes at this time in the methods used by the Foundation for proposal evaluation.

2. *Finding:* Certain problems exist with the NSF's peer review evaluation processes and related operations. Substantial changes in the operation

of the NSF's peer review systems have been proposed which possibly could lead to improvements in the systems' effectiveness for consistently selecting the best proposals, and in the acceptability of the systems to potential applicants, the scientific community, and Congress. *Recommendation:* Some corrective actions should be taken immediately and certain proposals for substantial changes should be thoroughly investigated and instituted if judged worthy.

In the Subcommittee's judgment, the most important single consideration is whether the NSF's awards lead to the advancement of science in the most effective way possible. Using peer review procedures, the NSF has indeed fostered advances in basic science over the past 25 years. Beyond this empirical observation, the rationale for believing that peer review of proposed work tends to advance science is that experts in a scientific field are best able to judge several important factors, e.g. design and importance of proposed work, and past performance of the proposer.

It is widely agreed that the NSF staff could not perform as well without the benefit of peer review, and it appears that the potential for staff abuse is greater in systems lacking peer review. Additionally, peer review procedures are administrable, the concept of peer review is accepted by the scientific community, and the idea of evaluation by equals is considered fair.

The NSF evaluates over 20,000 proposals each year, and there are, undeniably, occasional failures and abuses of the system. The Subcommittee Report did not deal with isolated problems but did discuss broad areas in which improvement might be made (*1*). In the Report's summary, the Subcommittee recommended six areas for immediate NSF action and eight tasks for the National Science Board.

How open? How fair?

The most thoroughly discussed issue of the hearings was: How far can openness of the decision-making process coexist with the effective evaluation of award applications by the NSF? There was overwhelming agreement that openness per se is desirable and that applications ought to be evaluated effectively. The extent to which these two desiderata are in conflict and which should be favored in the conflict were hotly debated.

One set of arguments concerned the extent to which the comments and identity of reviewers should be known. No one supported the extreme position that applicants should not know anything about who the reviewers were and what they said, but until January 1, 1976, NSF policy was that applicants should not know the identity of reviewers and should receive, on request, only paraphrased reviewer comments. The National Science Board changed this policy in June 1975, and since January 1, 1976, NSF policy has been that applicants should still not know the identity of reviewers but should receive verbatim reviewer comments on request.

Witnesses who agreed with either the past or present NSF policy included Raymond Bowers, William Carey, Daniel Drucker, Vincent Haneman, and Donald Marlowe. Rep. John Conlan and Heinz Wilsdorf, however, believed that applicants should receive signed verbatim peer reviews on request, while Philip Morrison, James Powell, and Donald Rice held opinions intermediate between this position and present NSF policy. No one claimed that both applicants and the public at large should have access to signed verbatim peer reviews.

The National Science Board has also been deliberating the issue of confidentiality. The arguments it has considered encompass all the major arguments made at the peer review hearings and were elegantly summarized by Donald Rice (*3*).

With confidentiality, it is argued, reviewers will be more candid about all aspects of the proposal and about the qualifications of the proposer to accomplish the work. Without confidentiality, many potential reviewers would refuse to participate, and those that did participate would be reluctant to comment critically on proposals by others who could adversely affect their own careers. Personality clashes would arise, and program managers might have to take on the role of arbitrators between proposers and reviewers. Program managers would also find themselves spending more and more time defending their decisions, and the identification of reviewers would increase the opportunity for political pressures to intrude on the system.

Others argue that regardless of whether the system is open or closed, qualified reviewers will continue to participate in the interests of furthering the best quality science and can be relied upon to be candid and straightforward in their evaluation of proposals. They think openness would result in a more focused and effective evaluation; superficial or personality-based comments would diminish. Confidentiality makes the system unnecessarily difficult to defend from charges of internal bias, old-boy networks, favoritism, etc., and a new open system could better demonstrate its impartiality and effectiveness and therefore would better stand public scrutiny and attain a higher level of credibility.

Witnesses generally believed that the NSF's new policy will be an improvement over the old, but the kind of information presented in support of this belief or in support of applicants receiving verbatim peer reviews was largely anecdotal, personal opinion, or a small opinion survey. It is unfortunate that information concerning the important question of openness is so poorly developed. Better information might result from comprehensive surveys, experimentation—preferably using control groups—and analytical comparison of other, similar systems.

It is worth noting that in current practice the National Institutes of Health (NIH) study section system and the NSF ad hoc reviewing system share the principle that reviewers' names should be separated from their opinions in material provided to applicants. The NSF provides verbatim comments but withholds reviewers' names, whereas the NIH makes names available but provides only paraphrased comments unattached to any given name.

There is a degree of realism in current practice, which is the recognition that while it is a fairly simple matter to maintain the names of mail reviewers in confidence, it is impossible to keep secret the names of members of a standing committee who travel to Washington several times annually—

so to be equitable they should be published so that the entire community will be informed, not just a favored part of it.

The National Science Board has decided to make available the names of peer reviewers in an aggregated form. All witnesses who mentioned it felt that this was a step in the right direction, but several witnesses also felt that the reviewer list should be broken down to identify the reviewers in particular programs. The NSF has prepared a list of the reviewers drawn upon in 1974, and the list has been printed by the Subcommittee (*2*), but the preparation of future lists is under continuing debate. One undisputed contribution of the list, however, will be the public recognition of those scientists who have helped to advance science by reviewing applications submitted to the NSF.

Intertwined with the issue of confidentiality is the question of what other information should be provided to applicants. Excluding the matters of reviewers' names and verbatim comments, however, there was general agreement among witnesses who addressed the question that proposers should have the right to know the rationale behind the decisions taken on their applications and should be able to get it in writing. Moreover, proposers should be informed of their right to this feedback as a matter of course. It was not clear from the testimony whether the NSF in the past had adequately notified applicants of what information they could obtain on request.

Though one of the more important aspects of feedback, the question of what stage in the evaluation process applicants should be able to get verbatim reviewer comment has not yet been settled. Reviews might be provided upon request before a decision has been reached on an application, so that an applicant could provide rebuttal or alter the proposal. Alternatively, reviews might be withheld until a decision has been reached, so that grant evaluation does not become an adversary procedure. The Subcommittee had four findings and recommendations concerning openness and feedback:

1. *Finding:* Openness of NSF operations and the effective evaluation of proposals by the NSF are both desirable. *Recommendation:* The greatest degree of openness of the NSF's award decision-making process consonant with effective proposal evaluation and reasonable efficiency should be achieved.

2. *Finding:* In keeping with the policy of maximum feasible openness, the recent decision of the National Science Board to publish a list of reviewers used by the NSF is laudable. *Recommendation:* The National Science Board should study the effects of publication of the list and consider whether publication of the list in a less aggregated form might be desirable.

3. *Finding:* Information concerning the critical problem of effects on the NSF's peer review system of the level of confidentiality in which peer reviewers' names and verbatim comments are held is inadequate for making sound judgments on what that level of confidentiality should be. *Recommendation:* The National Science Board should collect further information concerning effects on the peer review system of the level of confidentiality in which peer reviewers' names and verbatim comments are held. The Board should report the information and any conclusions that may be drawn from it to Congress. Further changes in the level of confidentiality of the NSF's peer review system should be made slowly if at all.

4. *Finding:* Each applicant for an NSF award should have easy access to a description of the rationale for the decision taken on the application and a description of the decision-making process itself. *Recommendation:* The NSF should include in each letter announcing a funding decision to an applicant either a statement of the methods and rationale of the decision or a statement that such information will be provided on request.

Further surveys

The publication of the Report and of a full record of the hearings (*3*) has been followed up in several ways. With Norman Hackerman, Chairman of the National Science Board, I cosponsored a sample survey of NSF grant applicants and reviewers to gather facts and opinions about the peer review processes. I also asked the General Accounting Office—an arm of Congress—to perform two studies of NSF performance and to audit the peer review survey.

Preliminary data from the survey already make it clear that an applicant's satisfaction with the system depends strongly upon whether or not he or she has been successful. Reviewers and applicants—successful and unsuccessful alike—approved by a large margin the NSF's providing unsigned verbatim reviews to applicants but disapproved, also by a large margin, providing signed verbatim reviews.

Finally, I asked for a response from the NSF to the recommendations of the *Peer Review Report*. An ad hoc committee of the National Science Board was established to provide that response, and their report is expected by the time the Committee on Science and Technology acts on the NSF's authorization bill for fiscal year 1978.

References

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