Essays of an Information Scientist, Vol:10, p.21, 1987 Current Contents, #4, p.3, January 26, 1987

Current Comments®

EUGENE GARFIELD
INSTITUTE FOR SCIENTIFIC INFORMATION®
3501 MARKET ST., PHILADELPHIA, PA 19104

Refereeing and Peer Review. Part 3. How the Peer Review of Research-Grant Proposals Works and What Scientists Say About It

Number 4 January 26, 1987

This essay is the third in a series on refereeing and peer review in science. The first part examined the anecdotal evidence and other literature and opinions about refereeing, the evaluation of scholarly articles before publication.[1] The second discussed research on refereeing and suggestions for improving the system.[2] This part focuses on the workings of the peer-review system of evaluating research-grant proposals, as employed by major US federal funding agencies such as the National Science Foundation (NSF) and the National Institutes of Health (NIH); the fourth section will cover the research on the grant-review system and proposed alternatives to it.

The emphasis in Parts 3 and 4 is on peer review in the physical, chemical, and biological sciences, since those are the fields examined by the major studies sponsored by the NSF and the NIH. However, it should be noted that the social sciences and the arts and humanities also have funding mechanisms that incorporate peer review and that funding for science, the arts, and the humanities also comes from numerous private sources that have their own methods of determining the level of support they wish to provide.

The Science-Government Connection

The principle, if not the full-fledged system, of peer review developed along with the scholarly societies and learned journals that were founded in the seventeenth and eighteenth centuries.[3,4] But until this century, it remained a matter of interest and concern only within the scientific community. In the US, however, during the 1940s, science and government began to establish a close working relationship that went beyond the advisory role scientists had previously played in affairs of state. For instance, according to Jay A. Levy,[5] University of California School of Medicine, San Francisco, with the passage of the Public Health Service Act in 1944,[6] the US Surgeon General was authorized to "make grants-in-aid to universities, hospitals, laboratories, and other public or private institutions and to individuals for...research."[5,7] And in the late 1940s, according to Rustum Roy, director, Science, Technology and Society Program, Pennsylvania State University, University Park, the Office of Naval Research (ONR) was "the first systematically organized government source of research funds for universities."[8] At that time, "peer review began as an informal 'seeking of a second opinion' by the grants manager, who mailed a copy of a proposal on the periphery of his competence to a colleague and followed up with a phone call."[8]

The close ties that evolved during World War II between the government and the scientific community were formalized in 1950 by the creation of the NSF.[9] According to former NSF director, psychologist Richard C. Atkinson, chancellor, University of California, San Diego, and physicist William A. Blanpied, currently international studies specialist at the NSF, the "science-government contract [was an attempt] to bring science into the political system while at the same time preserving its autonomy."[9] But Roy claims that in the process, each agency using some form of informal peer review "enshrined" its version, "without any thought, examination, or analysis,...[as] 'THE peer review' system."[8]

As Atkinson and Blanpied note, however, it was primarily through peer review that scientists convinced the government that the public interest would best be served "if scientists...retained decisive influence over how public funds were spent to support scientific activities."[9] The assumption was—and is—that since few in public office have the expertise to determine, from a technical standpoint, which projects are most deserving, the task of evaluating research proposals should fall to scientists. The Public Health Service Act allowed for the provision of funds only to projects approved by the National Advisory Health Council or the National Advisory Cancer Council—the precursors of the current NIH system of National Advisory Committees.[10] This method, with peer review as its cornerstone, served as a model for other government agencies, such as the NSF.

Atkinson and Blanpied point out, as have many others, that in recent years, despite increases in levels of NSF funding, the total funding of science, in terms of real dollars, has declined.[9] There has not been a similar decline in funds or in buying power at the NIH, according to William F. Raub,[10] deputy director, but Raub does not dispute Levy's observation that 95 percent of competing applications recommended for funding received support in the mid-1960s, while only 30 to 40 percent receive funds today.[5] "Funding has gone up, but the number of those asking for funds has gone up even faster," Raub explains.[10] And of those whose applications are okayed, most receive support at levels reduced from the amounts originally recommended.[5] Incidentally, an interview[11] with Raub on the subject of misconduct in science was recently published in *The Scientist*.[12,13]

Still, until the early 1980s, scholars and the institutions with which they were affiliated abided by the consensus that peer review was the best method to ensure the fair distribution of the ever-smaller federal pie.[9] But in 1983 and 1984, 15 universities bypassed the peer-review system and obtained more than $100 million in special authorizations and appropriations for new facilities directly from the US Congress; some even hired professional lobbyists to assist them.[9,14]

Peer Review: Love It or Leave It?

John Silber, president, Boston University, in a comment reported in *Science News*, justified his institution's abandonment of accepted channels by charging that the peer-review system is an old-boy network that preferentially funds some 20 institutions.[14] In calling for reforms to the peer-review system, Robert L. Sinsheimer, chancellor, University of California, Santa Cruz, said that peer review perpetuates the status quo.[15] And according to a recent report in *Chemical & Engineering News*, Senator Dennis DeConcini from Arizona claimed that "50 percent of all federal R&D [research and development] funding was put into the hands of 16 eastern and West Coast universities" in the 1984 fiscal year.[16] (DeConcini represents an area that includes the University of Arizona, which secured $25 million from the Senate Appropriations Committee.) Whether or not there is research to support the claims of Silber, Sinsheimer, and others is a question that will be discussed in Part 4, but it is interesting to note that Columbia University—which can by no means be labeled a "have-not" institution—was among those that took shortcuts with the system. Atkinson and Blanpied note that Columbia officials secured $8 million in US Department of Energy (DOE) funds for the construction of a chemical research laboratory.[9]

The tactics of those who have bypassed the peer-review system have predictably elicited a strong, negative response from those who have remained within the system. Roland W. Schmitt, chairman, National Science Board (the policy-making arm of the NSF), claims that, without peer review, US science is on "the fast track to mediocrity."[14] Senator Jeff Bingaman of New Mexico worries that bypassing peer review may weaken the morale of scientists who have worked hard to develop meritorious proposals, only to find themselves politically outmaneuvered.[16] The practice may also divert scarce resources from research projects that the scientific community considers to be of higher priority. As Atkinson and Blanpied write, "At issue is not whether meritorious research will be carried out in facilities obtained through pork-barrel tactics. Rather, [such] tactics violate the understanding that available resources are to be allocated in the best overall interests of science—and the public—rather than in the interests of individual claimants."[9] Roy, however, pointedly wonders who will define what the "best overall interests of science" are.[17]

How Peer Review Works

The principal agencies that support basic scientific research in the US are the NSF, the NIH, the Veterans Administration (VA), the Department of Defense, the DOE, the Department of Agriculture, and the National Aeronautics and Space Administration (NASA),[9] although funds are also provided through such organizations as the American Chemical Society, which administers the Petroleum Research Fund.[18] Various congressional committees and the US Office of Management and Budget determine the amount of money each government agency has available to disburse.[9] In general, how that money is spent depends largely on peer review: area experts judge proposals on their scientific and technical merit and make recommendations accordingly. But each agency or organization charged with dispensing funds for scholarship operates with a somewhat different set of procedures.

The NIH, which accounts for most US basic research-grant funding in terms of total dollars per year, makes use of a two-tiered system called "dual review."[19] (p. 41) At the first level, a panel of experts in a given field, called the Initial Review Group (IRG), evaluates a research application for its scientific merit. The IRG also comments on the applicant's performance on any previous grants and recommends a funding priority for the application, as well as the amount and duration of the grant.[18] At the second level, the respective National Advisory Council/Board of each bureau, institute, or division of the NIH reviews the recommendations made by the IRG and makes its own, final judgment concerning the application's relevance to the NIH's various programs and priorities.[19] (p. 42-3)

At the NSF, applications in chemistry, physics, and mathematics are mailed to 3 to 10 independent experts selected by a program officer.[18,20] (p. 7) These experts, referred to as mail reviewers, individually evaluate applications for their scientific quality through written comments and boxes checked off on a multiple-choice form.[20] (p. 7) Applications in the earth, biological, and social and behavioral sciences are usually reviewed by a combination of mail reviewers and panel reviewers.[18,20] (p. 7) Panels consist of scientists selected by program directors; the size of panels varies from section to section, but each meets in Washington, DC, three times a year to evaluate proposals.[20] (p. 8) Like the NIH's IRG, NSF reviewers report on the applicant's track record, as well as on the relevance of the work and on the capability of the applicant's institution to provide technical support. Based on these comments, the program officer makes a recommendation to higher-ranking officials, who in turn make the final decision.[18,19] (p. 22-4) [20] (p. 3-11) One significant difference between the NIH and the NSF procedures is that NSF officers have considerable discretion to modify or even disregard peer-review recommendations, whereas at the NIH, all recommendations by the IRGs are followed very closely.[10]

The procedures of other agencies and organizations are, for the most part, variations on either the NSF or the NIH models. For instance, the VA, like the NIH, conducts an initial review of a grant application through a discipline-based review board that makes a recommendation to VA administrators; they constitute a second level of review.[19] (p. 25-6) Unlike the NSF or the NIH, however, the VA attempts to provide some funding for all approved proposals. When NASA receives unsolicited research proposals, it operates in much the same fashion as the NSF, with *ad hoc* reviewers who make recommendations based on scientific merit. Review procedures at the ONR are also similar to the NSF's, in that Navy scientists may evaluate proposals themselves or have them reviewed through the mail or by a panel of experts convened for the purpose.[18] Naval officers have much more to say in the decision-making process, however, than do their counterparts at the NSF or the NIH.

Peer Review Outside the US

The peer-review systems of the UK, France, and the Federal Republic of Germany (FRG) provide a perspective on complaints about the US system and point the way toward possible improvements. In the UK, according to a two-volume compendium of source materials researched and published by the NSF, general support for all university programs and operations is provided through a dual system.[21] The first element, the University Grants Committee (UGC), provides general support for all functions of British universities in the form of annual block grants; about a quarter of this money goes to the direct support of research. Although there is general agreement between the universities and the UGC on how this money should be spent, the universities have wide latitude in the use of these grants. On rare occasions, however, the UGC makes a grant for a specific purpose and suggests the most effective use for the funds.

The second element of the UK system is provided in the form of research grants for specific university activities. These monies are administered by the five publicly funded research councils—the Science and Engineering Research Council, the Medical Research Council, the Natural Environment Research Council, the Agricultural Research Council, and the Economic and Social Sciences Research Council.[21] The role played by the UK's scientific community in the disbursement of funds from the UGC and the research councils is similar to the peer-review process in the US, but much of UK scientists' advice is provided through informal channels.

The US and the UK carry out more than half of their key basic research in universities, whereas national laboratories and independent institutions produce most of the work in other countries. In France, for instance, the single most important funding agency is the National Center for Scientific Research (CNRS) in Paris, which in 1979 directly employed about 8,500 scientists and 14,000 support personnel.[21] R&D priorities are developed at the level of national policy by the Secretary of State for Research, and the size of each CNRS laboratory, its budget, and the number of new positions in the system are all determined by the government. All university faculty are civil servants, paid directly by the Ministry of the Universities. The most prominent scientific advisory group is the Advisory Committee for Research in Science and Technology (CCRST), also known as the Committee of Sages. Made up of 16 members, the CCRST advises the Secretary of State for Research on a wide range of scientific issues.

Several large French government R&D agencies, however, pursue courses that are essentially independent of CNRS.[21] The Ministry of Defense, for example, which accounts for one-third of all government financing of research, relies heavily on its own facilities and establishes its own priorities, although it does have extensive contact with industry and academia. Other largely independent agencies include the National Institute for Health and Medical Research, the National Institute for Agricultural Research, the National Center for Space Studies, the National Center for Telecommunications Studies, and the National Center for Exploitation of the Oceans. The CCRST has no influence with the technical ministries, which have their own advisory groups of scientists.

Research funds in the FRG are provided by state and federal governments, private foundations, and industry.[21] For basic research, most of the funding is supplied by the federal government's Ministry of Research and Technology (BMFT) and the Ministry for Education and Science. However, state governments also contribute significantly—especially to the privately operated Max Planck Institutes, a system of research institutions set up outside the university system to support outstanding scientists in key fields. The BMFT also provides the principal support for applied research. The money from these agencies is funneled into grants by the German Research Society (DFG), a scholarly society that operates beyond the boundaries of formal government. For scientists affiliated with German universities, which are state-owned, DFG grants supplement a certain minimum level of funding. DFG support goes out mainly in the form of small, individual project grants that run from one to three years. Grant applications are evaluated by peers who are elected to their positions by the entire scientific community.[21]

In summary, the three countries briefly discussed here, as well as others, provide a relatively stable level of operating support to their universities, as well as to a parallel basic-research system separate from the university system.[21] And although many governments provide some funds on a competitive, peer-reviewed basis to scientists working both within and outside of the university systems, such support is relatively small compared with the baseline funding. Since research support in other countries is not limited to individual projects for short periods of time, foreign scientists, unlike their US counterparts, do not have to cope with the distractions of securing grant money and the disruptions suffered when grants are reduced or discontinued.[21] Atkinson and Blanpied claim that systems outside the US are less effective in encouraging competition among the most innovative ideas, and that other nations' faculty members, who are virtually or even literally employees of their respective governments, "cannot claim the same degree of autonomy they can in the United States."[9] Roy says that "not one study has ever been supported to test this" claim[17] or to compare the review systems of various government agencies with other methods of allocating funds.[22]

Criticisms of Peer Review

With research projects, jobs, and even careers at stake each time the review process renders a verdict, it is not surprising that the effectiveness and fairness of the system are matters of great concern—especially since the mid-1970s, when government support began declining.[18] Making matters worse, the NIH and the NSF, the major grant-giving agencies, do not have the money to fund every application they approve. In a remark reported in *Science*, NIH director James B. Wyngaarden said that the issue of distinguishing between "shades of excellence" was among those that most concerned scientists. The distinctions between one excellent proposal and another are often so fine that judgments concerning relative quality cannot be rendered on an objective basis, leaving those whose top-rated proposals are rejected "angry and frustrated."[23] Many scientists also feel it is inappropriate to rank disparate proposals that have little in common with one another.[5] And Roy goes even further, charging that "there is no theoretical or empirical justification to support the contention that 'good' research can be predicted on the basis of the 'evaluation of' proposed ideas contained in an essay."[8]

Another, almost universal, concern about peer review—found even among reviewers and agency administrators—is the time, effort, and money it takes to complete the paperwork involved in applying for and evaluating proposals. To ensure approval of a grant application, physiologist Daniel H. Osmond, University of Toronto, Canada, writes, "many have sacrificed 1-3 months of productive research.... The entire year is dominated by thoughts of preparation, and of the tragic consequences of refusal.... We must do quick experiments, write them up fast, and publish, publish, publish.... Innovative, time-consuming work must be done on the side with unbudgeted dollars to diminish the risk of rejection by an overcautious grants committee when the work eventually surfaces."[24]

Rosalyn S. Yalow, VA, New York, and the 1977 Nobel laureate in physiology or medicine, adds that grant proposals are "inherently dishonest," since "few established investigators whose contributions are highly original and imaginative can spell out... detailed plans for a three- or a five-year period."[25] If the investigator can do so, she continues, then "he does not expect to make a discovery; in fact, that mind-set can keep him from recognizing a discovery."[26] And Osmond adds that the constant pressure of applying for grant renewals can cause scientists, both consciously and unconsciously, to groom research results to fit the expectations of the funding agency, rather than allowing the work its own head.[24]

Other complaints about peer review closely resemble those made concerning the refereeing of manuscripts prior to publication, which were discussed in detail in Part 2 of this essay.[2] Just as authors complain of referee bias and old-boy networks that conspire to keep new, challenging ideas out of print, so too do applicants for research grants charge that young or new scientists with little or no track record don't get a fair shake in competition with older, more established scientists and that grant-review committees are hesitant to risk funds on innovative or speculative proposals.[18,27] And, like authors, grant applicants also fear that those who review their work may end up stealing from it as well.[24]

Summarizing the workings of the complex peer-review systems in the US and some parts of Europe is not a simple task. Equally difficult is the job of condensing the dissatisfactions with peer review, which are mainly reflected in anecdotal complaints about the current US system. The final part of this series will focus on research findings concerning grant-review systems and suggestions for improvements.

* * * * *

My thanks to Stephen A. Bonaduce and Terri Freedman for their help in the preparation of this essay.

REFERENCES

1. **Garfield E.** Refereeing and peer review. Part 1. Opinion and conjecture on the effectiveness of refereeing. *Current Contents* (31):3-11, 4 August 1986.
2. ———. Refereeing and peer review. Part 2. The research on refereeing and alternatives to the present system. *Current Contents* (32):3-12, 11 August 1986.
3. **Zuckerman H & Merton R K.** Patterns of evaluation in science: institutionalisation, structure and functions of the referee system. *Minerva* 9:66-100, 1971. [Reprinted as: Institutionalized patterns of evaluation in science. (Merton R K.) *The sociology of science.* Chicago, IL: University of Chicago Press, 1973. p. 460-96.]
4. **Kronick D A.** Authorship and authority in the scientific periodicals of the seventeenth and eighteenth centuries. *Libr. Quart.* 48:255-75, 1978.
5. **Levy J A.** Peer review: the continual need for reassessment. *Cancer Invest.* 2:311-20, 1984.
6. Public Health Service Act. (PL 410, 1 July 1944), *United States Statutes at Large*, 58, p. 682-711.
7. **National Institutes of Health.** *1983 NIH almanac.* Bethesda, MD: NIH, 1983. p. 5. NIH Publ. No. 83-5.
8. **Roy R.** Funding science: the *real* defects of peer review and an alternative to it. *Sci. Technol. Hum. Val.* 10(3):73-81, 1985.
9. **Atkinson R C & Blanpied W A.** Peer review and the public interest. *Issues Sci. Technol.* 1(4):101-14, 1985.
10. **Raub W F.** Personal communication. 12 December 1986.
11. **Powledge T M.** NIH's Raub on misconduct. *The Scientist* 15 December 1986. p. 18-9.
12. **Garfield E.** Introducing *The Scientist*: at last, a newspaper for the science professional. *Current Contents* (29):3-6, 21 July 1986.
13. ———. *The Scientist*: how it all began. *Current Contents* (33):3-6, 18 August 1986.
14. **Mathewson J.** More controversy over peer review. *Sci. News* 128:71, 1985.
15. **Sinsheimer R L.** Letter to editor. (Peer review and the public interest.) *Issues Sci. Technol.* 2(1):9-10, 1985.
16. **Long J.** Funding bill stirs academic research issue. *Chem. Eng. News* 64(24):12, 1986.
17. **Roy R.** Personal communication. 29 November 1986.
18. **Sanders H J.** Peer review. How well is it working? *Chem. Eng. News* 60(11):32-43, 1982.
19. **Kirschstein R L, Akers R P, Brooks G T, Fretts C A, Gary N D, Goldwater W H, Green J G, Solowey M, Kaufman A A, Raub W F, Russell G F, Riseberg R J, Schiaffino S S & Wilson K S.** *Grants peer review: report to the director, NIH. Phase I.* Washington, DC: NIH, 1976. 226 p.
20. **Cole S, Rubin L & Cole J R.** *Peer review in the National Science Foundation: phase one of a study.* Washington, DC: National Academy of Sciences, 1978. 193 p.
21. **Committee on Science and Public Policy of the National Academy of Sciences.** Research in Europe and the United States. (National Science Foundation) *The 5-year outlook on science and technology, 1981.* Washington, DC: NSF, 1981. Vol. 1. p. 255-84.
22. **Roy R.** Alternatives to review by peers: a contribution to the theory of scientific choice. *Minerva* 22:316-26, 1984.
23. **Culliton B J.** Fine-tuning peer review. *Science* 226:1401, 1984.
24. **Osmond D H.** Malice's Wonderland: research funding and peer review. *J. Neurobiol.* 14:95-112, 1983.
25. **Yalow R S.** Peer review: some suggestions. *Chem. Eng. News* 57(40):5, 1979.
26. ———. Peer review and scientific revolutions. *Biol. Psychiat.* 21:1-2, 1986.
27. **Horrobin D F.** Referees and research administrators: barriers to scientific research? *Brit. Med. J.* 2:216-8, 1974.