7. ———, *Cost-Benefit Analysis of the U.S. Breeder Reactor Program*, Wash-1126 (Government Printing Office, Washington, D.C., April 1969), referred to herein as CB-68.
8. ———, *Updated (1970) Cost-Benefit Analysis of the U.S. Breeder Reactor Program*, Wash-1184 (Government Printing Office, Washington, D.C., January 1972), referred to herein as CB-70.
9. ———, *Draft Environmental Statement, Liquid Metal Fast Breeder Reactor Program*, Wash-1535 (Government Printing Office, Washington, D.C., March 1974), referred to herein as CB-74D.
10. ———, *Proposed Final Environmental Statement, Liquid Metal Fast Breeder Reactor Program*, Wash-1535 (Government Printing Office, Washington, D.C., December 1974), referred to herein as CB-74P.
11. U.S. Energy Research and Development Administration, *Final Environmental Statement, Liquid Metal Fast Breeder Reactor Program*, ERDA-1535 (Government Printing Office, Washington, D.C., December 1975), referred to herein as CB-74F.
12. D. B. Hertz, *Harv. Bus. Rev.* **42**, 95 (January/February 1964).
13. T. R. Stauffer, R. S. Palmer, H. L. Wyckoff, "An assessment of the economic incentive for the fast breeder reactor," draft (Harvard Univ., Cambridge, Mass., October 1974).
14. P. L. Auer, A. S. Manne, O. S. Yu, "Nuclear power, coal, and energy conservation," draft (Electric Power Research Institute, Palo Alto, Calif., 1976).
15. T. B. Cochran, *The Liquid Metal Fast Breeder Reactor, An Environmental and Economic Critique* (Resources for the Future, Washington, D.C., 1974); I. C. Bupp and J. C. Derian, *Technol. Rev.* (July/August 1974), p. 26.
16. B. G. Chow, *The Liquid Metal Fast Breeder Reactor, An Economic Analysis* (American Enterprise Institute for Public Policy Research, Washington, D.C., 1975).
17. W. J. Baumol, "On the discount rate for public projects," *The Analysis and Evaluation of Public Expenditure*, 91st Congress, 1st session (1969), vol. 1, p. 491.
18. U.S. Congress, Joint Economic Committee, *Interest Rate Guidelines for Federal Decision Making*, 90th Congress, 2nd session (January 1968), pp. 60–63.
19. Conversion factors are: 1 pound is 0.4536 kilogram; 1 foot is 0.3048 meter.
20. A. S. Manne and O. S. Yu, *Breeder Benefits and Uranium Ore Availability*, SR-3 (Electric Power Research Institute, Palo Alto, Calif., 1974).
21. U.S. Atomic Energy Commission, *Nuclear Fuel Resources*, Wash-1243 (Government Printing Office, Washington, D.C., 1973), p. 15.
22. The AEC did not describe the method of price determination. In CB-74F (*11*), the price is roughly twice the forward cost, but I do not necessarily agree with this.
23. *Nuclear Industry* (October 1975), pp. 7 and 74.
24. National Petroleum Council, *U.S. Energy Outlook—Nuclear Energy Availability* (National Petroleum Council, Washington, D.C., 1973), p. 6.
25. "U.S. growth rate set at 2 percent for 1975," *Nucl. News (Hillsdale, Ill.)* (February 1976), p. 33.
26. T. B. Cochran and A. R. Tamplin, "NRDC Comments on Wash-1535," in CB-74P (*10*, vol. 6, pp. 38–179).
27. *Nuclear Industry* (December 1975), p. 24.
28. "Breeder reactor: 'New sense of urgency,' " *Sci. News* (21 February 1976), p. 117.
29. P. W. MacAvoy, *Economic Strategy for Developing Nuclear Breeder Reactors* (MIT Press, Cambridge, Mass., 1969), p. 114.
30. U.S. Atomic Energy Commission, *Nuclear Industry*, Wash-1174(71) (Government Printing Office, Washington, D.C., 1971).
31. This work was supported by a research grant from the Saginaw Valley State College.
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NEWS AND COMMENT

Kennedy, GAO Criticize NSF; Grant Renewal Is Rejected

Senator Edward M. Kennedy (D–Mass.) has landed a haymaker on a George Washington University professor and bloodied the nose of the National Science Foundation (NSF) in an unusual case of senatorial second-guessing of the foundation's grant-awarding process.

Several months ago Kennedy challenged the propriety of two NSF grants that had supported energy policy studies by William A. Johnson, a research professor at George Washington who had previously served in senior posts with the RAND Corporation, the Council of Economic Advisers, the Treasury Department, and the Federal Energy Office (*Science*, 10 September 1976). He was particularly disturbed that Johnson's work was supported—in addition to the NSF grants—by funds from oil marketing groups with special-interest views on some energy issues.

Late last month the results of that challenge indicated that Kennedy had emerged a clear winner. In rapid succession, the General Accounting Office (GAO), which had investigated the situation at Kennedy's request, reported that there were indeed deficiencies in NSF's handling of the grants; Kennedy issued a strong statement criticizing the foundation for failing to require policy papers "to meet even the most basic test of independence, objectivity, and merit"; and NSF rejected Johnson's long-pending application for continued funding.

The rejection added to the accumulating woes of Johnson's policy analysis team. Johnson says that, as a result of the fracas with Kennedy, he has lost other potential sources of funding and has been forced to cut back drastically on his research.

NSF officials insist that they rejected Johnson's latest application on the merits, without paying heed to the political flap surrounding Johnson's work. "We tried to set aside political considerations in his case and look at his proposal," said Thomas Ubois, acting director of NSF's division of policy research and analysis, the unit responsible for monitoring Johnson's grant.

But the affair left Johnson grumbling that he had been the victim of a "book burning, American style." He complained that he had been singled out for attack by Kennedy's staff because he advocated energy policies that differed with Kennedy's. And he accused NSF of rejecting his proposal in an effort to appease Kennedy, who exerts tremendous power over NSF's fortunes because he chairs the Senate subcommittee that considers the NSF budget authorization. "It's very clear what happened," Johnson told *Science*. "The NSF has to live with Senator Kennedy as chairman of the subcommittee that reviews the budget. They don't have to live with Johnson. It's as simple as that."

Johnson had sought an additional $35,000 to support preparation of a book that would consolidate the work he had done under his first two grants and would include substantial amounts of new material as well. His proposal was rejected on the grounds that the old material was already available and that the proposal lacked "specificity" concerning the nature of the new material. Johnson acknowledges that the foundation might conceivably have rejected his application, even if Kennedy had never raised any questions. But he finds this hard to believe because supporters within the foundation have told him that the book project got "highly favorable" marks from six of seven reviewers and was strongly endorsed by NSF's own program manager for the project as well. Foundation officials declined to discuss the results of the review process other than to note that such reviews are purely advisory to those agency officials who make the granting decisions.

The struggle over Johnson's grants first reached public attention late last summer when Kennedy asked the GAO, the investigative arm of Congress, to review NSF's handling of two awards to Johnson, who was both a research professor at George Washington and head of the university's Energy Policy Research Project. The two grants—which totaled a hefty $130,000 for a 2-year period—were made by the Office of Energy R & D Policy, a unit of NSF that no longer exists. That office was created in 1973 to

assist the NSF director in the role he had then inherited (but no longer holds) as science adviser to the President.

The grants to Johnson supported preparation of a series of papers analyzing federal oil and gas policies. Johnson was also required to consult occasionally with federal officials. The work was at least potentially influential in that it was one of many sources of information which the science adviser was expected to consider in developing recommendations for oil and gas policy.

Kennedy's staff became concerned about the grants because Johnson's work was being touted by the oil industry as evidence that there is no need to break up the big oil companies—a move Kennedy supports. Upon inquiry, Anne Strauss, the professional staffer for Kennedy's subcommittee on NSF, was informed that, on top of the NSF grants, Johnson's work on the policy papers was also being supported by $125,000 from two groups of oil marketers, a source of funding that she feared might influence Johnson's findings. It also appeared to her that NSF had been rather cavalier in reviewing Johnson's proposal. Thus Kennedy called for the GAO investigation to lay bare the procedures used in awarding and monitoring the grants.

The GAO's investigative report, which was completed on 25 January, did not reveal much new information beyond what had previously been made public by NSF and Johnson as a result of Kennedy's earlier inquiries. The GAO did not attempt to evaluate the quality of Johnson's work or the extent to which it might be considered "biased." Nor did GAO pass final judgment as to whether NSF should make grants to individuals who are also receiving support from an industry that might be affected by the grantees' policy recommendations. But the GAO investigators did conclude that NSF should have—and failed to—address these issues. They also confirmed Kennedy's belief that the grant-award process had been handled in rather casual, incestuous fashion.

To begin with, the foundation's energy office made no effort to ascertain the nature and extent of Johnson's outside funding before making the grants. Johnson stated on his grant applications that he had outside support, but he did not identify the source or amount and NSF never asked him formally for details, though Johnson appears to have mentioned his funding sources informally on occasion. One reviewer did raise questions as to whether the outside support would affect the "independence" of the study, but an NSF program manager told GAO that such outside support was "not a principal concern" because foundation grantees commonly have other sources of support. Even NSF agrees that it flubbed in this case. Richard C. Atkinson, the agency's acting director, finds it "disturbing" and "discouraging" that the program officer disregarded Johnson's other funding, not only because of the conflict-of-interest potential, but also because the foundation must ascertain that investigators are not spreading themselves too thin or collecting too many grants. (Some NSF officials look askance at the scale of Johnson's support—a quarter of a million dollars from NSF and industry to pay for "a set of essays," as one official put it.)

Second, the GAO documented a disturbing buddy system at work in the evaluation of Johnson's grant application. Four of the nine reviews of Johnson's two grant proposals were submitted by individuals who had worked with or for Johnson at other government agencies, and the program manager responsible for reviewing Johnson's original proposal had also worked for him at the Treasury Department. Moreover, all but two of the reviewers were then working for NSF; only one was from the academic community, the traditional source for independent evaluations of proposals submitted to NSF. The rationale for skipping the traditional peer review process was that the energy policy office had to respond quickly to the needs of policy-makers and external peer review would be too slow and cumbersome. However, the GAO casts doubt on the need for great haste by noting that no one sought Johnson's advice (his proposal came in unsolicited) and he was given a full year to complete the work on each grant.

The GAO also found lapses in NSF's administration of the grant. There was no record of how NSF dealt with various questions raised by reviewers, no record of how Johnson's research might have been used, no clear indication whether the papers delivered by Johnson and his research team were those the foundation had sought under the grant, and no provisions for disposing of a small amount of income generated by the sale of one of Johnson's publications.

The GAO offered a number of recommendations for tidying things up, but it was ambivalent on the thorny issue of outside funding. It said that outside funding from organizations that could be affected by the research results [as in Johnson's funding by oil marketers] "should be avoided if possible because it could easily raise conflict-of-interest questions

Science out of Gas

The fuel shortage struck *Science* in a visible way this week. A cutoff of natural gas to the company that prints *Science* forced a change in the paper and ink used in two-thirds of this issue.

Ordinarily *Science* is printed on glossy-coated paper using a heat-set ink. As the paper, printed on both sides, streams off the high-speed web press in a long roll, it is fed through a gas oven that dries the ink before the pages are automatically folded. Without the drying process, the ink would smear during the folding operation and render the pages unsightly if not unintelligible.

Unfortunately, the drying ovens used by *Science*'s printer—Byrd Press, Inc., of Richmond, Va.—were rendered largely inoperable when the state of Virginia, reacting to a worsening energy crisis in late January, banned all nonessential uses of natural gas in the eastern and central portions of the state for 2 weeks. The ban affected customers supplied by the Commonwealth Natural Gas Corporation pipeline.

Two separate presses are ordinarily used to print each issue of *Science*. One can burn only gas; the other can burn gas or oil. As the hints of possible natural gas shortages became stronger, Byrd switched one press to oil; it has been used to print a 32-page segment of this issue, including all pages using colored inks. These pages look as they would in any issue of *Science*. The remaining pages in the issue have been printed on the other press whose oven is inoperable. As a result, uncoated paper and non-heat-set ink had to be used, giving those pages a duller finish and less sharply defined pictures.

The Virginia State Corporation Commission imposed the gas ban for 2 weeks initially, but there is no certainty when gas supplies will be restored.—P.M.B.

and reduce the credibility of the research." But GAO acknowledged that this was no panacea because a researcher might well receive payments from interested parties for services outside the scope of the NSF grant, or he might do work for those parties before or after the period of his NSF grant. The GAO's chief recommendation for ensuring the quality of policy research was that grant proposals be subjected to a broad selection of peer reviewers and that NSF require a formal evaluation of all policy papers after they have been completed.

Senator Kennedy hailed the GAO report as confirmation of his belief that there were "serious deficiencies" in NSF's handling of the grants. He charged that NSF had dispensed $9 million in policy research funds while "the peer review process was routinely short-circuited, and not even the most cursory efforts were made to guard against potentially serious conflicts of interest."

But NSF officials tended to roll with the punch. Atkinson noted that the GAO investigated how a now-defunct office, outside the mainstream of NSF activities, operated a year or two in the past. "I don't think we still do business the way we did then," he said. He found most of the GAO's recommendations "very sensible" and noted that many of them had already been implemented in one form or another. The remaining suggestions will be considered by foundation officials and by the agency's highest policy-making body, the National Science Board, which will review the foundation's handling of policy research on a priority basis.

Meanwhile, Johnson, an untenured research professor, is looking for a new job, a step he says he would have taken anyway, but which must now be performed "under the gun" because of the brouhaha with Kennedy.

—PHILIP M. BOFFEY

Gene-Splicing: At Grass-Roots Level a Hundred Flowers Bloom

For a research technique too new to have produced a single practical application, the recombinant DNA method of gene-splicing has evoked a perhaps unprecedented degree of public interest. Debate about the technique has raged through campuses, spilled over into city councils, and has now reached the attention of state legislatures.

Many of these bodies have made or are making their own reviews of the terms under which the research may proceed. So far all have accepted the guidelines issued by the National Institutes of Health last June, but usually with certain extra restrictions of their own.

With the exception of action being contemplated in New York State, these restrictions are of minor significance, so that in effect the NIH guidelines are being generally endorsed at the local level.

Yet public anxiety about the technique is so definite that even industry, in a change of position, is now, for reasons of self-protection, leaning toward having the government register and keep track of its gene-splicing activities.

Local involvement in the gene-splicing debate has included the following actions.

New York State. Having held public hearings on the gene-splice technique (*Science*, 12 November), the state attorney general's environmental health bureau has prepared a bill to control the research. The bill, which has not yet been introduced, would require everyone engaged in gene-splicing research or production to obtain a certificate from the state health commissioner, who would also specify training and health-monitoring programs. Deborah Feinberg, who drafted the bill, suggests in an accompanying report that all gene-splicing work should be done in P3 (moderate level) containment facilities.

An official of the New York State health department says his feeling is that all new laboratories should be equipped with P3 facilities, but that "we would not require everything to be done in P3 right away." But the department would probably upgrade some lower level experiments to P3 and P4 while endorsing the NIH guidelines in general, the official says.

California. Two committees of the state legislature are at present holding hearings, after which they will decide whether or not to introduce legislation. Marc Lappe, a special assistant in the health department who helped organize the hearings, says that the minimum likely requirement of such legislation would be to make the NIH guidelines applicable to everyone, particularly industry.

New Jersey. State attorney general William F. Hyland, whose interest in biomedical issues was manifested during his handling of the Karen Quinlan case, has been following the gene-splicing issue closely. His assistant on the subject, Dennis Helms, says his own feeling—Hyland has not yet come to a decision—is that state regulation is not a good idea for an issue that can be properly settled only on a national basis. There is no point in driving the research underground by excessive regulation, Helms believes, because "in the end we are going to depend on the responsibility of the individual scientist. But I can assure you the response will be electrifying if there is a bad accident. That will mean banning everything in the ridiculous fashion that always happens when you do things too fast."

Cambridge. The city council is in the throes of creating an ordinance on gene-splicing research. Though Mayor Vellucci would still like to ban all P3 and P4 research, the proposal of the citizens' review board—to endorse the NIH guidelines with added restrictions—will probably prevail in some form.

San Diego. Seeking to avoid a Cambridge-style confrontation, the University of California at San Diego informed city mayor Pete Wilson last year of its intention to build two P3 facilities. The mayor asked his quality of life board to set up a DNA study committee chaired by Albert Johnson, dean of sciences at UCSD. After hearing witnesses from both sides, the committee completed a report last week for submission to the mayor and council. The report endorses the NIH guidelines but in addition recommends that the council consider the desirability of confining all gene-splicing research to P3 facilities; that the university refrain from experiments requiring P4 facilities; that it notify the city of any P3 experiment requiring the highest degree of biological containment (EK3); and that an ordinance be passed to bring industry and others within the ambit of