BOOKS: SCIENCE POLICY

# Formative Effects of Federal Funding

**James E. Strick**

In 1994, E. O. Wilson's confessional autobiography *Naturalist* described the tensions of "the molecular wars" when, from 1955 to 1975 or so, molecular and cellular biology grew exponentially and gobbled up resources proportionately. The past decade has witnessed the dramatic expansion of exobiology into astrobiology, prompting some to speculate that funding for such studies might eventually reach $100 million per year. Amid all the tumult and competition for resources in the biological sciences over the last 50 years, one thing has become true and, today, remains truer than ever: survival in biology without grant money, especially large sums of federal money, has become very difficult indeed. A good deal has been written on the history of Rockefeller Foundation support for life sciences from the 1920s through the 1960s, and a small amount of work has been done on support for research by the National Institutes of Health (NIH). Until now, however, there has been no serious history of the impact the National Science Foundation (NSF) has had on biology since its founding in 1950.

**Shaping Biology**
**The National Science Foundation and American Biological Research, 1945–1975**
*by Toby Appel*
Johns Hopkins University Press, Baltimore, 2000. 408 pp. $42.50. ISBN 0-8018-6321-X.

Toby Appel's *Shaping Biology* tells a critical part of the story of how some fields in the biological sciences managed to compete for funding, even if they could promise no medical breakthroughs or bioengineering bonanzas. It also tells working biologists about the processes by which the NSF grants landscape was formed during the Foundation's first 25 years. Because navigating that landscape has become a make-or-break matter in biological careers, few can afford not to know the history of how that terrain was shaped and of what forces still further shape it today.

Appel, a seasoned historian whose previous works include *The Cuvier-Geoffroy Debate* and a history of the American Physiological Society, has done a very thorough job of evaluating the influence of NSF's Division of Biological and Medical Sciences on shaping biology in the United States from 1950 through 1975, when a reorganization dissolved the division. As the book's title implies, NSF program officers from the very beginning shared a particular vision about what kind of biology required their support. Above all, they favored basic research freed of any need to justify itself through its potential applications. Furthermore, Alan T. Waterman and the other founders of NSF shared the belief that the organization could and should play a role in unifying biology. Neither of these objectives was a noncontentious matter.

It is worth remembering that biology has never been a single, unified science. Rather, for more than 200 years there have existed a wide array of life sciences, many with domains that overlap or intertwine in complex ways (from botany and *materia medica* in the 18th century to embryology, genetics, and medical sciences more recently). Naturalist, laboratory, and (at least since 1953) molecular approaches have often competed for limited resources and defended their individual fiefdoms against one another. Appel shows that, despite an admirable founding vision of the purity of intellectual research, these deeply rooted antagonisms frustrated NSF's goal of a unified biology at many levels, from lofty theory to mundane bureaucracy.

**Form followed funding.** In the mid-1960s, NSF support helped the University of Florida consolidate its collections in this new museum and become the largest center for systematic biology in the Southeast.

CREDIT: ALAN CHEUVRONT/COURTESY FLORIDA MUSEUM OF NATURAL HISTORY

Nonetheless, Appel also demonstrates that NSF can rightly claim credit for supporting systematics, ecology, evolutionary studies, and population biology in the wake of the redirection of grant dollars to molecular approaches, especially at NIH. Although some of its funds went to molecular and biochemical heavyweights such as Max Delbrück, Jacques Monod, Edward Tatum, James Watson, and Melvin Calvin, NSF was at the same time a sheriff riding in with a white hat in E. O. Wilson's story. From 1957 to 1968, NSF provided $9.3 million in support of systematic biology collections. These dollars helped construct major new facilities, including projects at the University of Michigan, University of Florida, Harvard's Museum of Comparative Zoology (Wilson's academic home), and the American Type Culture Collection. At the same time, NSF attempted to create "big biology," following the leads of big physics and big astronomy projects. These efforts, including phytotrons, biotrons, a fleet of research ships, and a National Biological Laboratory, experienced equivocal success at best. Biologists did not want to be unified by any central authority, if at all.

One of NSF's most noble moments came during the McCarthy era's intimidation campaign against left-leaning intellectuals. In the spring of 1954, the Department of Health, Education, and Welfare (which included NIH) adopted the official policy of terminating grants to scientists even only suspected of disloyalty to the U.S. government. NSF program officer William Consolazio immediately insisted that NSF take a strong stand against such an incursion into intellectual freedom. After 21 May 1954, NSF policy was to deny funding only to avowed Communists or to those proven disloyal through judicial process. Furthermore, NSF deliberately provided funding for numerous prominent researchers who had been cut off by NIH, including Linus Pauling, Elvin Kabat, and Martin Kamen. By 1956, NIH had quietly shifted to the same policy NSF used, but this change did not remove the legacy of bad feeling among many former NIH grantees.

The story of how, as the "new kid on the block," NSF vied to establish its role among the other federal agencies funding life sciences, initially in much larger amounts, is a fascinating study of pluralism in federal support of biology. Interactions with such agencies as NIH, the Office of Naval Research, and the Atomic Energy Commission resulted in both constructive and destructive interference. In this competition to define niches, individual personalities played no small part. Consolazio's role during the 1950s loyalty crisis is mentioned above; also instructive are the efforts of Paul Weiss, the University of Chicago embryologist, to shape biology through the National Research Council (NRC) in the mid-1950s. A rather high-handed and domineering Central European in personal style, Weiss attempted to place

The author is at the Department of History of Science, Technology, and Medicine, Johns Hopkins University, Ames Hall, 3400 North Charles Street, Baltimore, MD 21218–2690, USA, and the Center for the History of Recent Science, George Washington University. E-mail: jamesstrick@earthlink.net

NSF and the American Institute of Biological Sciences in subordinate roles to his NRC Biology Council. Both NSF and Weiss's former patron Warren Weaver of the Rockefeller Foundation saw this arrangement as conflicting with the mission Congress had assigned to NSF, and they opposed the plan unless Weiss's Biology Council would work in conjunction with NSF to set priorities in the biological sciences. In the end, the competition was at least somewhat destructive: Weiss's Council could have covered some functions and areas not covered by NSF, but as Appel notes "biologists, fragmented as ever, provided it little moral support." Though NSF took a key role in undermining Weiss's plans, the other federal agencies also feared formation of any central authority over biology, especially one having the aura of the National Academy. "In the end, no one had the resources to take a broad view of biology." Indeed, unlike astronomers, no group of biologists or any of the various biological societies attempted any kind of organized promotion of biology for NSF support.

Although NSF had a lofty initial vision and showed noteworthy independence for a federal agency during the McCarthy witch hunts, it was not, of course, immune to political pressures. The area in which politics most decisively came to affect the organization was in regard to its support of "pure" research. During its first 15 years, NSF defended a sharp distinction between pure and applied research; it favored basic research that it deemed much less likely to be funded by other agencies. By the mid-1960s, however, Congress was pushing NSF toward more applied research. A 1969 Act of Congress explicitly directed NSF to support applied research, and the trend towards greater funding of such proposals continued into the 1970s. The ups and downs of NSF support for interdisciplinary and multidisciplinary research—a topic revisited in the last decade with a new wave of enthusiasm for these approaches—also make a fascinating, if complex and winding, tale.

All in all, Appel has done a remarkable job. No subsequent historical work on NSF and the biological sciences can begin without building on the solid foundation she provides in *Shaping Biology*.

**NOTA BENE: SCIENCE AND TECHNOLOGY**

## For the Curious

At the heart of science is the attempt to answer questions of why. Clifford Stoll includes a description of his final oral exam in *The Cuckoo's Egg* (Doubleday, New York, 1989). His answer to "why is the sky blue?" began with the properties of light and passed through discussions of oscillator theory, electricity and magnetism, thermodynamics, and even quantum mechanics as he was asked for ever more detail. Engineers favor questions of how: "how does this work?" or when all goes wrong, "how do we make this work?"

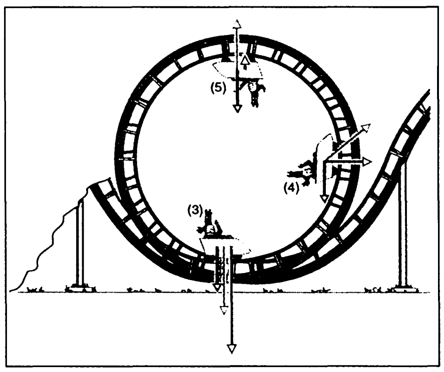
**How Things Work**
**The Physics of Everyday Life. 2nd ed.**
*Louis A. Bloomfield*
Wiley, New York, 2001. 536 pp. Paper, $74.95. ISBN 0-471-38151-9.

***Scientific American* How Things Work Today**
*Michael Wright and Mukul Patel, Eds.*
Crown, New York, 2000. 288 pp. $29.95, C$49.95. ISBN 0-375-41023-6.

Two recent books address such questions by examining aspects of everyday life. Louis Bloomfield developed *How Things Work: The Physics of Everyday Life* out of his popular physics course for nonscientists at the University of Virginia. Bloomfield's textbook draws on numerous examples of ordinary objects, including roller coasters (see image), baseballs, automobiles, microwave ovens, and sunlight. The comparison of a bicycle to a tricycle illustrates unstable and stable equilibria, and readers learn that physicist David Jones deliberately designed and tested unridable bicycles to learn which factors affected their dynamic stability.

The book is supported by a Web site (www.wiley.com/college/howthingswork), which provides supplemental material on subjects discussed in the text and covers topics offloaded from the first edition. In some cases, entire chapters have simply been shifted to the Web; other sections have been moved to new positions within the book. Unfortunately, the index no longer includes some of the scientific principles covered in the online sections. The Web site helps students make connections between different topics and place phrases into context, key elements of the learning process. Bloomfield provides answers to inquiries, evidently from individuals of all ages and backgrounds, prompted by his explanations of everyday objects. He answers these expressions of scientific curiosity in detail and impressively tailors his responses to the questioner's level of understanding.

In a quite different vein, *How Things Work Today* is not limited to physics. Based on the "Working Knowledge" column in *Scientific American*, it samples a wide range of subjects from "The Urban and Domestic Environment," through "Transportation," to "Space."




Individual topics are generally presented in two-page layouts built around photographs and explanatory diagrams. Many of the images are three-dimensional, cut-away illustrations, which often provide more detail than can be absorbed in a single sitting. Readers will encounter objects as ordinary as vacuum cleaners and as specialized as particle accelerators. There are accounts of how locks work (for those locked out with nothing more than toothpicks and a credit card) and of how police put together composite images (for fans of murder mysteries).

The book has two weaknesses. In some instances, the placement of topics within subjects seems haphazard. Ceramics, for example, are featured in "Medicine and Research" instead of "Power and Industry" despite the fact that two of the applications cited for these materials are superconductivity and insulators for electricity transformers. There is also the lack of cross-referencing among topics. As a result, the compartmentalization of individual topics obscure the links between related subjects, and so readers are not encouraged to make logical connections and comparisons.

Despite their individual shortcomings, both books are useful references, and in many ways they complement one another. Leafing through *How Things Work Today* is an easy way to learn a little about any number of curiosities in a visual and self-contained fashion. Bloomfield's *How Things Work* is first and foremost a textbook, complete with questions to test one's understanding, problems, and case studies. Bloomfield, however, also makes it easy to delve into a specific topic without needing to read entire chapters. For those curious about the whys and hows of our world, both books offer a lot of answers.

—MARC LAVINE

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