Scientific Fraud Probed at AAAS Meeting

Pressure to publish frequently is cited as a factor in several cases; NIH may require notification when fraud is suspected

Los Angeles. Intense competitive pressures are contributing to an apparent upswing in the incidence of scientific fraud, according to a panel of academic officials and scientific journal editors appearing at the annual meeting of the AAAS here on 29 May. In particular, the recent growth of professional incentives for frequent scientific publishing has created a climate that rewards unethical behavior and sometimes allows it to remain undetected, the panelists said.

"It is true that science in 1985 is too competitive, too big, too entrepreneurial, and bent too much on winning," said Robert G. Petersdorf, dean of the school of medicine at the University of California at San Diego. The problem begins in college, he said, where the intensely competitive "premedical culture is an eroding factor in the moral fiber of our future physicians." The enormous financial resources at stake in successful research also often serve as an inducement to unethical conduct, he said. More important, however, is the attention paid to prolific publishing as a measure of significant achievement in promotion and funding decisions.

Petersdorf's words were given additional currency by recent reports of problems at Columbia University, where nine papers by two members of the medical school faculty have been retracted. An external investigating committee said it "could not find overt evidence for deliberate fabrication of data, although this could not be excluded." Henrik Bendixen, dean of the College of Physicians and Surgeons, told the *New York Times* that "the high pressure environment" at major universities today was a contributing factor.

In the past, Petersdorf said, fraudulent reports were weeded out partly by department chairmen, who read and approved what members of their department wrote. With the growth of large departments and increasing academic specialization, this "is clearly no longer possible," Petersdorf said. Now, "academic promotions committees count and weigh papers, they do not read them."

As an illustration, Petersdorf described a recent discovery of apparent fraud at an unnamed medical school in California. A 33-year-old junior faculty member, who had been first in his class in college and in medical school, was recommended for a tenured faculty position partly because of his extremely frequent scientific publishing. Upon close inspection, however, some of the data in his articles appeared questionable and supporting documentation was suspiciously absent. Although the investigation is continuing and none of the papers have yet been withdrawn, the faculty member has resigned to enter private medical practice.

Lax laboratory supervision allows such episodes to remain undetected, Petersdorf said. He urged that laboratory directors carefully screen job applicants and avoid expansion solely to absorb federal funds. "I have from time to time seen the size of a laboratory equated with the quality of work emanating from it," he added, explaining that in his experience this was frequently not the case.

> Science is "too competitive, too big, too entrepreneurial," says Petersdorf.

Patricia Woolf, a sociologist and co-director of an ethics and sciences program at Princeton University, agreed that although "pathologically prolific publishing is still rare in American science," there is considerable evidence that fraud is its by-product. "First of all, fraud has been detected at our best universities, where research excellence is emphasized and where many professors do publish considerably more papers than the norm. Second, young people on the tenure track have been more frequently caught at fraud than older, established scholars. Third, many of the perpetrators of publicly disclosed scientific fraud had published many papers, especially in the time period immediately surrounding the fraud."

Several highly publicized cases of scientific fraud have taken place "in laboratories where there was a great deal of publishing, far above the norm," Woolf added. William Summerlin, who resigned from Memorial Sloan-Kettering after falsifying the results of an experiment with mice in 1974, worked in a laboratory directed by Robert Good, for example. In the 5 years preceding Summerlin's resignation, Good had published 341 papers, an average of 68 each year, Woolf said. John Darsee, who resigned from Harvard Medical School after falsifying data for a heart study in 1981, worked in a laboratory directed by Eugene Braunwald. From 1975 to 1980, Braunwald had apparently published 171 papers, or an average of 28.5 each year. Similarly, Vijay Soman, who resigned from the Yale School of Medicine after fabricating data in 1980, worked in a laboratory directed by Philip Felig, who from 1975 to 1980, had published 201 papers, or an average of 31.8 each year, according to Woolf's count. These totals deviate significantly from the mean number of publications by scientists at most major universities, which Woolf estimates as fewer than 10 a year.

"These scientists are clearly operating in very different ways from the mainstream of science," Woolf said. "One can argue that excellent science has always been out of the mainstream, but when there are significant deleterious effects on younger co-workers in their laboratory and eventually impacts on scientific research in America as a whole, we have a responsibility to question the wisdom of those research and publishing practices."

Mention was also made at the symposium of related but lesser problems characterized as scientific "fakery" by Edward J. Huth, editor of the *Annals of Internal Medicine*. Included were instances of false authorship, repetitive publication, and so-called "divided publication" in which research is published piecemeal so as to lengthen a list of personal citations. John Bailar, a statistician and former editor of the *Journal of the National Cancer Institute,* also described methods by which research results are frequently distorted, including the use of post-hoc hypotheses and inappropriate statistical tests, false treatment of dependent data, and the reporting of experiments with low statistical power.

Lesser instances of unethical behavior are fairly common, Huth and Bailar indicated, while cases of outright fraud remain fairly rare. William Raub, deputy director of the division of extramural research and training at the National Institutes of Health, went so far as to

describe the proportion of researchers who engage in such activities as "vanishingly small." Only two reports of fraud are brought to NIH's attention each month, and nearly half are found to be erroneous.

A paper presented at the meeting by June Price, a graduate student in the psychology department at UCLA, suggested that some instances of fraud may remain undetected. In a survey of science faculty at a major unnamed university, Price found that one-third of those who responded had suspected a colleague of falsifying data, but that only half of these had ever acted to verify or remedy the deception. More than half of the respondents believed that an unequivocal case of fraud would be resolved quietly by university administrators, with no public notice.

Marcia Angell, deputy editor of the *New England Journal of Medicine*, proposed two reforms to limit the incidence of scientific fraud. First, federal grant cycles might be extended, thereby diminishing pressures to publish prompt, piecemeal research reports. Second, scientists might somehow be barred from citing more than three publications per year in applications for promotion or funding. These reports could be subjected to substantial scrutiny, thus making fraud "more difficult to hide."

Raub endorsed these recommendations, and noted that NIH is presently considering a proposal to institute 7-year funding cycles for selected researchers on a variety of topics. Already, he said, the National Institute of Neurological and Communicative Disorders and Stroke has approved 100 such grants. "From NIH's point of view, we would welcome a limitation of the number of permitted citations," he said, "but I am skeptical that the broader scientific community would find it acceptable." He hastened to add that such a rule would not be imposed by the government.

NIH is, however, planning to institute a new rule governing notification of the government when fraud is suspected at an institution receiving federal funds. "It's not that we're missing cases, but that in a number of instances, we are brought in later than appropriate," Raub explained, "particularly when the media finds out first." The rule, which is to be circulated for comment later this summer, will require that universities notify NIH at the point that academic officials decide to begin a formal on-campus investigation—not when the investigation has been concluded.—**R. JEFFREY SMITH**

Scientific Secrecy

An Unhealthy Trend

The Reagan Administration's efforts to restrict the release of scientific data with national security implications are beginning to rankle top weapons researchers. Arthur H. Guenther, the chief scientist at the Air Force Weapons Laboratory near Albuquerque, New Mexico, said at a symposium entitled "Lasers and the Interplay of Science and Technology" that he and some of his colleagues fear that such restrictions are part of "an unhealthy trend" that will ultimately impede scientific progress and interfere with the pursuit of key military objectives.

"The new restrictions on the dissemination of unclassified or sensitive information with military applications are making it difficult for us to recruit and retain the best people," Guenther said. "How can they grow professionally if their work cannot be widely discussed or presented for peer review? How can they be rewarded without the opportunity to publish in the open archival literature? What this means is that we have a great deal of difficulty acquiring experienced people. We have to grow them ourselves."

Citing the recent flap over the presentation of research results at a meeting of the Society of Photo-Optical Instrumentation Engineers (*Science*, 26 April, p. 471), Guenther said that he is "very concerned and disturbed by what I see as a tendency for people to prevent us from talking to one another." At the Pentagon's request, roughly 40 papers on sensitive but unclassified topics, including some written by Air Force Weapons Laboratory employees, were either withdrawn from the meeting or presented to audiences composed only of U.S. citizens or approved foreigners. "I agree that we have to protect manufacturing technology," Guenther said. "But we have much to learn from researchers in other countries, particularly in areas that historically have been unclassified."

Guenther, who says he wrestles with the classification issue "on a daily basis," was particularly critical of a recent expansion in the list of militarily sensitive technologies that cannot be disclosed to foreigners. "The list is unwieldy and the topics are not sufficiently defined," he said. "Because it is subject to different interpretations, people are prone to err on the side of conservatism. It has to be fine-tuned."

The session at which Guenther spoke was organized to mark the twenty-fifth anniversary of the successful operation of a laser by Theodore Maiman at the Hughes Aircraft Company. Several of the participants, including Guenther, remarked that laser research would not have progressed so rapidly had it been subject to the security constraints in existence today. "I think everybody would agree that we can whip anybody as long as we . . . don't impede our own progress," Guenther said. But the present restrictions are "without question impeding synergism" between research at universities, corporations, and military labs.

One program that may suffer is the President's Strategic Defense Initiative, popularly known as "Star Wars" and aimed at development of a comprehensive ballistic missile defense. To manage the research, Guenther says, the laboratory needs top-notch, well-informed scientists. Yet the secrecy constraints make it difficult to hire such people, because they lessen the appeal of working for the government. The problem, he concludes, is that those who write the rules "don't have the perspective of the scientist, technician, or engineer."

—**R. JEFFREY SMITH**

Nuclear Proliferation

Trouble Ahead

A forthcoming international conference on nuclear nonproliferation matters is expected to pose significant problems for the United States, according to current and former U.S. diplomats appearing at the AAAS annual meeting. The summit, to be held in Geneva during the week of 27 August, will be the third and possibly the most rancorous to be held under provisions of the Nuclear Nonproliferation Treaty of 1968.

The overall aim of the treaty is to limit the spread of nuclear weapons, and on that score it has been modestly successful. There are, for example, no recent setbacks on the scale of India's public detonation of a nuclear device in 1974. But significant debate is expected over less dramatic, but still worrisome, activities by two clients of the United States: Israel and Pakistan. Both have recently been implicated in schemes to obtain a large number of high-speed electronic switches known as krytrons, which can be used as triggers for nuclear weapons.

In the case of Pakistan, the scheme was uncovered in time to prevent shipment of the krytrons outside the country in violation of U.S. export controls. In the case of Israel, however, the scheme apparently began in 1981 and remained undetected until last January, with the result that 810 krytrons are now in the hands of the Israeli defense ministry. U.S. officials have publicly accepted Israeli claims that the krytrons were intended for use in tests of nonnuclear weapons, such as lasers and antitank projectiles. Privately, they are skeptical that such a large number could be needed for such tests. Efforts are under way to reclaim roughly 400 of the devices, all that the Israelis say they can presently lay their hands on.

Leonard Spector, a senior associate at the Carnegie Endowment for International Peace and a specialist on nonproliferation, said that despite the discovery of this scheme early this year, the Reagan Administration has since "agreed to establish a free trade zone with Israel, to provide it advanced technology for the Lavi fighter, and to allow it to participate in the R&D phase of the Strategic Defense Initiative." According to Gerard Smith, an ambassador at large for nonproliferation under President Carter, these actions expose the United States to charges that it has followed a double standard by failing to seek punitive sanctions similar to those applied to other proliferators. "Here's a case where we've had lots of early warning. We have acquiesced in this program and . . . you may be sure we'll hear" about it in Geneva.

Archelaus Turrentine, deputy assistant director of the bureau of nuclear weapons control at the Arms Control and Disarmament Agency, responded that although "the United States is obviously very concerned about the Israeli nuclear program and nuclear capability . . . private, quiet diplomacy is frequently more effective than public posturing." He added that a variety of nuclear issues and concerns had been discussed with the Israelis "at senior levels."

Along with others at the symposium, Turrentine agreed that the United States will face "an extensive and tough debate" in Geneva over compliance with a provision of the treaty that commits the superpowers to substantial limitation of their nuclear arsenals. Frustrated by the lack of progress in this area, the delegation from Sweden is apparently planning to offer an amendment to the treaty that sets a specific timetable for weapons reductions. The delegation from Japan is expected to push for a reduction in the existing limit on nuclear test yields. The Reagan Administration is working furiously behind the scenes to dissuade both groups.

Turrentine says that the Administration's goals at the conference will be modest: "To seek a reaffirmation of the treaty and to preserve as positive an attitude toward it as possible." Smith, however, believes that the U.S. delegation will be entirely preoccupied with mere "damage limitation."

—R. JEFFREY SMITH

TV Scientists

More Good Than Bad

Scientists are warmer and more attractive, but less sexy, than other professionals, and they are rational beings. They tend to be a bit older and "stranger" compared to other professionals and they carry with them a more foreboding image "touched with a sense of evil, trouble, and peril." At least that is the portrait of fictional scientists conveyed by television, according to a University of Pennsylvania study reported at the AAAS meeting.

The findings were reported at a panel discussion on the image of science and scientists on television and in film. The participants included Leonard Nimoy, who plays Mr. Spock in the "Star Trek" movie series.

On the whole, scientists come across with a positive image in prime time television, according to the study, which was headed by George Gerbner, dean of the university's School of Communications and was funded by the National Science Foundation. The study was based on a review of 2 years of prime time television and a national survey of more than 1600 people.

For example, for every villainous scientist in a major role, there are five virtuous ones. The image of physicians fares even better. "Television doctors are the most valued characters in prime time," the report stated. For every bad doctor, 19 are good. (For every bad law enforcer, 40 are portrayed as good.) Curiously, television scientists are killed more often compared to soldiers, private investigators, and the police.

In films, science and innovation are rarely a central theme, according to Syracuse University researchers. George Comstock and Ni Yang found that only about 4 pecent of the films made between 1938 and 1984 dealt with these two subjects based on a sampling of 6700 films. More often, film-makers made use of the products of innovation or fantasized about them in science fiction movies.

Nimoy, who both directs and acts in the Star Trek films, says that he strives for scientific credibility and, in fact, has personally interviewed scientists from Harvard and Massachusetts Institute of Technology and other campuses to get ideas. But, he says, entertainment is the primary goal.

An official from the National Broadcasting Company, J. Ronald Milavsky, told the audience not to worry about the image of scientists on television, which is a positive one, he said. Instead, scientists should be more concerned about informing the public about science. "There is a great scarcity of people to communicate it to the public," he said. "Scientists need to get involved in the production of news reports. There is considerable interest in science and technology."

Whether scientists are interested in their image or the depiction of science in the arts is unclear. Out of about 150 people who attended the panel discussion, only about 15 scientists were present by a show of hands.

—MARJORIE SUN

Biotechnology

Focus on Viruses

With the help of genetic engineering, scientists are now trying to exploit certain properties of viruses to produce a broad range of commercial products for agriculture and medicine. Farmers eventually may replace some chemical pesticides with genetically modified viruses that are toxic to pests, and pharmaceutical companies may use viruses as biological factories to produce drugs such as interferon, according to scientists who spoke at a session on biotechnology at the AAAS meeting. So far, most commericial development in biotechnology has focused on the use of bacteria rather than viruses.

A key to the development of products based on the manipulation of viruses is whether they can be safely released into the environment, an issue that some scientists at the Environmental Protection Agency (EPA) are beginning to address.

Of the wide range of viruses that commonly exist in nature, one type of virus,

called baculovirus, has attracted attention by researchers as a potential commercial pesticide. Lois K. Miller of the University of Idaho and Max D. Summers of Texas A&M University noted that baculoviruses infect and kill a variety of insects, including species of caterpillars, gypsy moths, and mosquitoes. Miller is studying the regulation of baculovirus DNA, which could lead to a better understanding of how to enhance the virus's toxic characteristics and expand its host range as well.

Summers also noted that baculoviruses may help produce commercial quantities of biologics. Biotechnology companies are already using bacteria and yeast to pump out large yields of biological material, but baculoviruses may prove to be more efficient. These viruses naturally produce a substantial amount of protein and Summers and others are probing the genetic makeup of the virus to tap into this system with foreign genes coding for other proteins. In fact, Summers reported that he and colleagues have succesfully modified the virus to produce beta-interferon at high levels.

Scientists are also studying the use of viruses in the transmission of genes to alter the germ cells in mammals—for example, to enhance milk production in cows.

While the research appears promising, EPA scientist Daphne Kamely is concerned about the potential impact of modified viruses on human health and the environment. Kamely, who is in the Office of Research and Development, noted that the fate of baculoviruses and retroviruses is not well understood. Studies are now being conducted at Harvard and at the National Institutes of Health to develop risk assessment models that may help EPA to evaluate the consequences of the release of viruses into the environment. Bernard Fields of Harvard observed that based on his studies, "the more one modifies a virus, the more attentuated it is in the host and the more weakened it becomes in the environment."

Kamely said she is collaborating with scientists at Johns Hopkins in studies of the environmental fate of these viruses.

EPA has not received any requests to field-test modified baculoviruses, but several companies and researchers are seeking permission to test microbial pesticides made through gene splicing.

David Miller of the Genetics Institute, a Boston-based biotechnology company, noted that much more research will need to be conducted before viral pesticides become commercially useful. He said that the environmental stability is not long enough and the viruses do not act fast enough to satisfy farmers. But the tools of genetic engineering may change that. "This is an area of burgeoning interest," he said.—**MARJORIE SUN**

High Energy Physics

Hard Sell for SSC

A proposal by European physicists to build the world's next big particle accelerator went over like a proverbial lead balloon at a symposium organized by their U.S. counterparts at the annual meeting of the AAAS. "Scientifically, I think it would be better for everyone to cooperate on the construction of a new accelerator in the United States," said Leon Lederman, director of the Fermi National Accelerator Laboratory.

Lederman and four other eminent particle physicists organized the symposium in an attempt to convince the U.S. scientific community that a mammoth new accelerator, known as the Superconducting Super Collider or SSC, will be worth its estimated $4- to $6-billion cost. Congressional approval will not be sought until 1987, but already those involved are a bit defensive because, as Lederman explained, scientists in many other fields, such as astronomy, are seeking substantial new appropriations, and some fear that the government will insist on compensating cutbacks in existing research.

Not surprisingly, the greeting for a proposal by the European Laboratory for Particle Physics (CERN) to construct a similar accelerator at one-sixth the cost was not warm (*Science*, 24 May, p. 968). "We don't think it addresses the crucial scientific problems," Lederman said. He and Stanley Wojcicki, chairman of the Stanford physics department, emphasized that the design of the CERN accelerator would necessarily limit its power to a fraction of that planned for the U.S. device, allowing it to reach the level of greatest scientific interest with scarcely any safety margin. "If you're going to spend billions of dollars, you want to address the problems solidly," Lederman said. "We will have a considerable safety margin in both power and luminosity," which may be needed to detect the most basic particles.

The participants agreed that it is unlikely for both a U.S. and European machine to be built. "We certainly would welcome European participation in all phases of our design," as well as in experimentation, Wojcicki said. Along with the others, he used terms such as "scientific imperative," "impasse," "scientific drive," and "scientific crisis" to describe the set of events that gave rise to the accelerator idea. Specifically, Lederman said, research with less powerful accelerators had revealed defects in common understandings about the composition of matter. The concept of a new accelerator, capable of operation in the range of 40 TeV collision energy, was endorsed in 1983 by a federal advisory panel headed by Wojcicki, who is now deputy director of the accelerator design group.

The AAAS symposium was actually only the latest effort in a long -running sales campaign. Other aspects include the publication of glowing articles by the principal scientists in *Scientific American*, *Physics Today*, and *American Scientist*, as well as wide distribution of a colorful booklet on the accelerator with chapters titled, "The cosmic connection," "Particle physics and society," and "SCC and the environment." The publisher is Universities Research Association, the primary recipient of federal funds for the accelerator's design.

—**R. JEFFREY SMITH**

Future AAAS Meetings

Changes in the Wind

This year's meeting focused attention on a troubling question about the future of broad-based scientific gatherings such as this. Attendance at the meeting, the 151st sponsored by the AAAS, was the lowest in more than 5 years, the latest reflection of steadily dropping enthusiasm and sharply rising costs associated with such a large, multidisciplinary, conference.

Paid registration was only 2300, which meant that at some sessions, journalists outnumbered scientists. Some of the speakers attended only their own session. A daylong seminar on the 1990 census, held on the final day of the conference, attracted an audience of one.

"We have some basis for believing that some people attended without registering," says William Carey, Executive Director of the AAAS. "But the attendance was clearly less than it should have been." A study committee, composed largely of AAAS section officers, has been formed to recommend improvements in the meeting format and management.—**R. JEFFREY SMITH**