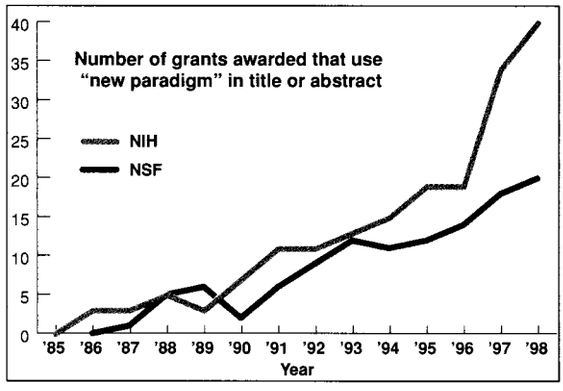
number of citations for papers published in the same journal during the same year. "So, the new paradigm fell flat, it would seem, for 31% of these 32 most cited papers," Pendlebury concludes.

Perhaps the problem lies in citation analysis itself: The new paradigms may be so radical that the rest of the scientific world, stuck in the old ways of looking at things, hasn't yet shifted to them, depressing citation counts. So *Science* turned to a time-honored, although less rigorous, evaluation: We randomly selected a few current papers and contacted independent experts to ascertain whether the papers indeed had revolutionized their views.



SOURCES: NSF, NIH

Asked to comment on a *Journal of Biological Chemistry* paper entitled "Regulated co-translational ubiquitination of apolipoprotein B100: A new paradigm for proteasomal degradation of a secretory protein," Daniel Steinberg, an apolipoprotein B100 authority who works at the University of California, San Diego, says it "is stretching the words very thin" to call this a new paradigm. The paper, says Steinberg, offers "an alternative hypothesis." Steinberg—who notes that he has much respect for the paper's last author, a former postdoc in his lab—may be an especially tough critic, however. He happened to have been at Harvard with Thomas Kuhn and had many discussions with him. "I thought we should reserve 'new paradigm' for Darwin, Freud, and Newton," says Steinberg. "Maybe we use it five times in a century."

Josef Penninger of the University of Toronto has a similar view of a paper published last August in the *European Journal of Endocrinology*, "Osteoprotegerin and its cognate ligand: A new paradigm of osteoclastogenesis." Penninger, who admits to similar paradigmatic offenses himself, says this paradigm once was new. But that was in 1972, when a paper in *Science* described the basic finding that a factor made by white blood cells could trigger osteoclastogenesis, the mechanism of bone reabsorption.

Even the new paradigm paper that ISI found had the most citations may involve a questionable use of the term. Published in *EMBO Journal* in May 1989, "Human atrial natriuretic peptide receptor defines a new paradigm for 2nd messenger signal transduction" had a big impact on its field, garnering 237 citations. But the paper, says Lincoln Potter of the Salk Institute for Biological Studies in La Jolla, California, essentially validates a controversial hypothesis put forward decades before by Earl Sutherland, who won the Nobel Prize in 1971 for his discovery of second messengers.

What, then, might account for the proliferation of new paradigms in the scientific literature? Nobel laureate Steven Weinberg, a physicist at the University of Texas, Austin, has one possible explanation. Weinberg—who attacked Kuhn's proposition that new paradigms displace old ones in a critique that ran last year in the *New York Review of Books*—suggests that the rise is linked to the increasing specialization of science. "It's harder and harder for scientists to make a splash that goes beyond their fellow specialists," Weinberg says. The term is an attention-getter, says Penninger. "I use it, too, sometimes, but really for political reasons—to make reviewers happy and for funding," he says.

One especially puzzling result of *Science*'s investigation is the nursing paradigm paradox: 67 of the 459 uses of "new paradigm" in the MEDLINE database from 1968 to 1999 involved nursing research. Patricia Grady, director of NIH's National Institute of Nursing Research, offers a simple explanation: "Nursing research is relatively new on the horizon of scientific research." The newer the field, the more new paradigms there are to discover. Grady says she personally eschews the phrase, however. "People often ask, 'What does that mean?' " says Grady. "I try to avoid speaking in ways that are mysterious."

Grady is not the only person who finds the term difficult. Kuhn himself had trouble precisely pinning down the meaning of paradigm. "Turn now to paradigms and ask what they can possibly be," wrote Kuhn in a 1969 postscript to the second edition of the book. "My original text leaves no more obscure or important question. One sympathetic reader ... prepared a partial analytic index [of the book] and concluded that the term is used in at least twenty-two different ways." To help solve this problem, Kuhn introduced yet another phrase with which to discuss a paradigm: "disciplinary matrix." A MEDLINE search on that term yielded only one hit: "Philosophic analysis of a theory of clinical nursing." **–JON COHEN**

PEER REVIEW

NIH Invites Activists Into The Inner Sanctum

Under pressure from advocacy groups to open up the grant-review process, the NIH is adding lay members to some study sections—to mixed reviews

For more than half a century, the holiest of holies at the National Institutes of Health (NIH) has been the peer-review "study sections"—the small panels of 15 to 20 researchers that weigh the scientific merit of more than 24,000 grant applications each year. Scientists whose ideas are turned down often criticize the study sections bitterly, but at least they know they have been judged by fellow scientists. "The important thing about peer review," says molecular biologist Keith Yamamoto of the University of California, San Francisco, "is that it's peers."

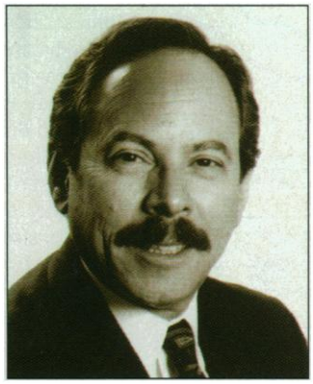
Now that's changing, fast. Under political pressure to listen more closely to specific-disease advocates and ordinary people, top NIH officials are pressing individual institutes to place patient representatives on some study sections—particularly those dealing with potential therapies. "No directives have been issued, but we're encouraging it," NIH director Harold Varmus said in a recent interview. "Our assessment is that under appropriate circumstances, having informed patients on study sections can be extremely useful." But some scientists worry that NIH is "diluting" expert advice.

The use of nonpeer reviewers isn't totally untried. Following a recommendation of the Institute of Medicine, the U.S. Army since 1995 has been including two "consumers"—that is, patients—on each review panel in its $210 million research program on breast, prostate, and ovarian cancer and neurofibromatosis. Scientists who have served on these panels say the process works surprisingly well.

Pressured by advocacy groups to become more open, the National Institute of Allergy and Infectious Diseases (NIAID) and the National Cancer Institute (NCI) have been seating patients on selected study sections for some time. Consumer panelists offer exper-

tise on such issues as clinical trial consent forms, recruitment, retention, outreach, and follow-up, says John McGowan, director of NIAID's Division of Extramural Activities. Over the past 10 years, consumer participation "has improved the science and the quality of what we fund," he says. Marvin Kalt, director of NCI's Division of Extramural Activities, which started using consumer panelists 2 years ago, says he's unaware of any researcher complaints.

NIAID and NCI have been the exceptions, but other NIH institutes are hurrying to catch up. The National Institute of Mental Health (NIMH) is already recruiting consumer representatives—patients, family members, health-care providers, or others—to serve on study sections that will review treatment-oriented grant applications in June. The National Institute on Drug Abuse (NIDA) may follow suit in May. The National Institute of Child Health and Human Development (NICHD) and others are weighing the idea.



"I was blown away" by activists' insights.

—Alan Leshner

"The train is definitely rolling," says Yamamoto. "I'm very uneasy about it. I don't like it." Yamamoto chairs the advisory committee of NIH's Center for Scientific Review (CSR), which operates the mostly basic science study sections that review about 70% of NIH grant applications. CSR doesn't plan to invite patient advocates onto these panels anytime soon, but that still leaves about 30% of applications—those reviewed by institute-run study sections—that might be subject to mixed-company reviews.

Yamamoto and other skeptical researchers argue that adding nonscientists to study sections is both unwise and unfair. "Every vote is very meaningful to the applicant," Yamamoto says. "Diluting that with people who can do no more than vote their impressions of the discussion is an injustice to those applications."

"I'm very uneasy about [laypeople in study sections]. I don't like it."

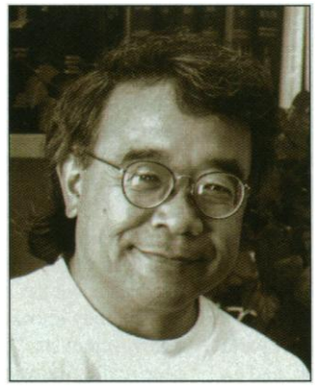
—Keith Yamamoto

No one expects placard-waving activists to break up meetings with shouts and demands. Where the process has been tried, program managers carefully select people who are knowledgeable about a disease, able to function in the calm give-and-take of a meeting, and willing to check their advocacy at the door. In the Army program, consumer and scientist reviewers are extensively briefed in advance on what to expect and what's expected of them, says Colonel Irene Rich, who directed the Army program. On scientific issues, proponents say, the patients usually vote with the scientists.

So what? counters Richard McCarty, executive director for the scientific directorate of the American Psychological Association. At a meeting of the NIMH Advisory Council on 5 February, McCarty dismissed proponents' contention that lay reviewers offer valuable insights and don't much change study section outcomes. "I don't find those issues especially compelling as a rationale for altering the scientific review system that has served NIH and the nation so incredibly well since the mid-1940s," McCarty said.

Even if lay panelists tend to go along with the scientific majority, their votes would "flatten" the results, Yamamoto warns, making it more difficult for creative but unorthodox projects to win funding.

Psychologist Joseph Campos of the University of California, Berkeley, a member of the NICHD Advisory Council, also has qualms. Although Campos says informed and interested laypeople "unquestionably" have a right to be involved in the grant mechanism, study sections aren't the place for them. On such small review panels, he says, the vote of one person who disagrees with the rest "may reduce the score or increase the score unfairly." He adds, "I have seen the problem occur with scientists who are against a certain type of research and have held up that type of research getting funded." As an alternative, Campos suggests inviting laypeople onto study sections as nonvoting observers. Or, he says, tabulate scores as a median rather than a mean, so that an outlier won't distort the outcome so badly.



Varmus acknowledges that "there are some concerns" about laypeople on peer-review panels. But he says the experience of the Army program and others "has been positive." "We're not talking about the average consumer," Varmus emphasizes. "We're talking about people who are experts just as our scientists are experts. Many patients who are not scientifically trained become very expert in many issues that are involved, particularly in clinical research, and can be very useful in helping to evaluate grants."

Exactly right, say scientists who have served with consumers on panels. "I probably was somewhat skeptical" before serving on several Army panels, says medicinal chemist Donald Bergstrom of Purdue University in West Lafayette, Indiana. "I felt they really can't contribute anything. That opinion changed pretty fast once we got involved in conversations." The Army experience has been an eye-opener for NIH leaders as well. NIDA director Alan Leshner changed his mind after he sat in on Army review panels. "I had been ambivalent about the issue," says Leshner, "but candidly, I was blown away" by the quality of the comments.

"They're a reality check," says cell biologist Howard Hosick of Washington State University in Pullman. "They bring up things that the scientists wouldn't have thought about." For example, Gary Pasternack, director of the division of molecular pathology at Johns Hopkins University School of Medicine in Baltimore, recalls a proposed breast cancer project that intrigued the scientists in the room but left the consumer panelists cold. "They said that because the perceived benefit was marginal, no one in their right mind would undergo it," he says.

Involving consumers in grant review puts a human face on the disease—and on the scientists, too. Richard DiAugustine of the National Institute of Environmental Health Sciences in Research Triangle Park, North Carolina, says the presence of two prostate cancer survivors on his review panel made him think hard about the real motives of applicants for prostate cancer fellowships. "I thought, 'I have two guys I have to answer to here. Are these [applicants] just going after money, or do they really want to have a career in prostate cancer research?' "

For researchers, the hours spent in meetings with lay reviewers can have unexpected positive side effects: Consumer panelists go back to their own constituencies as allies of scientists rather than critics. "When I've spoken to breast cancer groups, when I hear women who are angry, I try very hard to explain to them what this [scientific] process involves—that it cannot happen overnight," says Connie Gee of Brentwood, Tennessee, a

kindergarten teacher and first vice president of the Tennessee Breast Cancer Coalition. Jill Wagner of Lima, Ohio, a former General Dynamics Corp. supervisor, adds, "The most heartwarming thing for me about serving on the panel with all these esteemed scientists was to find out that they really, really wanted to be reminded that this disease is about people."

Virgil Simons of Secaucus, New Jersey, a textile industry executive and founder of The Prostate Net, says his view of researchers "absolutely" changed when he saw the constraints under which they operate. "You've got people who are going to ultimately save lives working for money that's far less than we pay garbagemen," he says. "We've seen some investigators whose salaries are around $35,000 a year. We've seen some senior people who are working for $50,000 or $60,000 a year. It's almost criminal."

Despite the obvious goodwill it fosters, the Army way of peer review isn't directly transferable to all that NIH does. Cell biologist Daniel Medina of Baylor College of Medicine in Houston notes that the Army panels concentrate on "very focused review areas, which is different from many NIH review panels, which cover a broad area of topics." But would the approach work on NIH study sections that are focused, such as those weighing responses to Requests for Proposals? "I don't know," says Medina. "I think you just have to try it."

That's what NIH is about to do.

–BRUCE AGNEW

Bruce Agnew is a writer in Bethesda, Maryland.

SCIENTIFIC COMMUNITY

EU Facilities Program Keeps Researchers on the Move

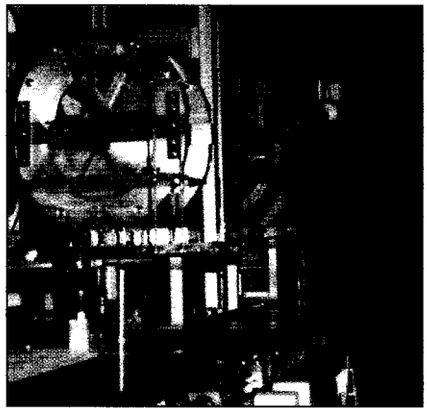
A European program to open up local facilities to scientists across the continent is winning plaudits from both young researchers and lab managers

DARMSTADT AND BAYREUTH, GERMANY— When Dolores Cortina-Gil was a physics postgrad at the University of Valencia in 1993, she faced a serious logistical problem: There were essentially no facilities in her native Spain for the kinds of nuclear physics experiments she hoped to conduct. So she packed her bags and moved to the GANIL heavy-ion research center at Caen in northern France to do her doctorate. After that, she moved on to a postdoc position at GSI, Germany's heavy-ion lab in Darmstadt, where she is now conducting her own nuclear structure studies with unstable nuclei.

Such scientific country-hopping is becoming more common in Europe, thanks to a European Union (EU) program called Access to Large-Scale Facilities (LSF). And it is about to get even easier: The EU's Framework 5 program, launched last month at a meeting in Essen, Germany, will spend $200 million on the LSF program over the next 4 years—a 50% increase over previous spending levels.

The program gives Europe's top researchers and young scientists an opportunity to work at the facility best equipped for their research, irrespective of who owns the facility or where it is located within the EU. The more than 100 facilities that are now part of the scheme get block grants to pay for travel, accommodation, and technical assistance for visiting researchers, and wear and tear. But much of the emphasis is on training and enabling young researchers to use top-notch facilities. "This is the easiest way to meet people and to make new collaborations," says Cortina-Gil, who is funded by the LSF program in part to provide technical help to visiting scientists using GSI's fragment separator. "To change from one European country to another would be very difficult without the financial support of the European Union."

Facility managers like the program too. Says Giorgio Margaritondo of Italy's ELETTRA synchrotron in Trieste: "The LSF program has been extremely effective and its impact very positive. ... The travel support of users has effectively removed the most serious barrier preventing scientists from using top-level facilities." Wouter Los from the Zoological Museum at the University of Amsterdam agrees. "One of the strengths of the program is that it identifies and 'recognizes' large-scale facilities in Europe."



Hands-on experience. Postdoc Dolores Cortina-Gil works on GSI's fragment separator.

CREDIT: SABINE STEGHAUS-KOVAC

LSF started out in 1989, during Framework 2, as a small program with a budget of $31 million. It was an immediate hit: 1600 researchers took the opportunity to visit the 17 participating physics facilities during the first 4 years. By the end of Framework 4 last year, it had mushroomed to encompass 116 facilities in a wide variety of fields, such as chemistry, engineering, and life and earth sciences, which were visited by more than 6000 researchers. The types of facilities have also evolved over the years. No longer are they just large, expensive pieces of equipment, but also collections of biological data, medical research facilities, or field study centers in ecosystems ranging from arctic to tropical.

The LSF program typically gives such a facility about $1 million for a period of 3 to 4 years to select and support visiting researchers. Often, facilities use the money to buy scientific equipment, computers, and materials, or to employ researchers to help the visiting scientists. Researchers submit applications directly to the facility, and from there they are passed to an independent international review committee. "The program is managed primarily at the facility level, eliminating needless and expensive duplications," says Margaritondo.

Although most facility managers who spoke with Science are enthusiastic about the LSF program, they have some gripes. From talking with other facility managers, Egil Sakshaug of Trondheim Marine Systems in Norway says "the most frequently mentioned complaints are financial, that the funds compensating for 'wear and tear' at the host institutes are not enough." Ross Angel of the Bavarian Geosciences Institute in Bayreuth, Germany, agrees: "We gain in the things we cannot quantify: new ideas and collaborations or teaching practice for our students. Purely financially we obviously lose."

Indeed, the opportunity to exchange ideas and techniques is the biggest draw for most facilities to participate in LSF. "Visitors bring their expertise here," says Angel. "Catherine Dupas, a postdoc from Lille [in France], came here with an LSF grant. She improved our technology in using transmission electron microscopy." According to Klaus-Dieter Gross, project manager at GSI, "the EU-funded researchers make a major impact on the research at our institute. It is hard to imagine the situation without them."

Many of the researchers who visit the facilities gain a lot more than just new ideas. For those like Cortina-Gil, who come from regions of the EU where major research fa-