

detractors also objected to its subsidizing large corporations.

Over the years, the ATP received at least 29 reviews by the Government Accountability Office or the Department of Commerce's Office of Inspector General. In a detailed 2002 audit, even the Office of Management and Budget gave the program high marks for its planning, program management, and results. But the OMB called for the ATP's termination on the grounds that it wasn't needed, that it was too small to have an impact, and that it overlapped with other federal programs.

That the ATP survived as long as it did speaks to the power of at least one well-placed lawmaker. From his perch as the top Democrat on the relevant appropriations subcommittee, Senator Ernest Hollings (D-SC) singlehandedly rescued the ATP more than once. When Hollings retired in 2005, opponents almost killed the program; no new grants were awarded in fiscal years 2005 and 2006, but the ATP was left to complete projects begun in prior years.

Congress appropriated \$65.2 million for TIP this fiscal year, with most of that going to finish work on the 56 ATP grants that were awarded in 2007.

To ease the corporate subsidy concerns, TIP will exclude bids from large companies, defined as those listed among the Fortune 1000. Universities, which previously could participate in the ATP only as part of an industry-led team, will be eligible in 2009 to compete for TIP grants on their own. The maximum grant size for TIP awards to single companies has been raised to \$3 million over three years, compared with the ATP's \$2 million maximum. But joint ventures can receive up to \$9 million in TIP funds over five years. President Bush's FY 2009 budget request includes zero for TIP, but lawmakers are likely to continue funding it.

No shortage of advice

TIP managers do not lack for advice on how to spend the meager budget. At a 24 April symposium convened at the National Academies, Stanley heard two dozen presenters from industry, government, national laboratories, and universities pitch their ideas about critical national technological needs. Stanley said he will also be tapping his eight program managers, an external TIP advisory committee, the National Research Council, and other sources for advice, in addition to studying papers he's commissioned from three NIST fellows.

At the National Academies event, Peter Lee, head of the computer science

department at Carnegie Mellon University, said TIP could consider funding new technological approaches to shrink microprocessor feature size. He suspected that the gambles Intel Corp and other chip manufacturers have made in taking a multicore architecture approach may not pay off as they hope. Anna Barker, deputy director of the National Cancer Institute, saw a critical national need in getting cancer biologists and clinicians to appreciate the potential of nanoscience to fight the disease. The NCI has established several university-based interdisciplinary centers for cancer nanotechnology excellence, where researchers are trying to put nanomaterials to work diagnosing and treating the disease.

Thomas Bowles, science adviser to New Mexico Governor Bill Richardson, recommended that TIP projects contribute to workforce development and to improving public understanding of science, technology, engineering, and mathematics. Richard Stulen, chief technical officer at Sandia National Laboratories, noted a pressing national need for all sorts of remote sensors and power sources for them. New methods

for deterring cyberattacks are also needed, he said, as is greater use of models and simulations to cut US manufacturers' product development times.

Stanley admitted that the task of picking a few projects to address a mountain of challenges will be daunting. Plans call for focusing on one of the seven needs categories for this year's TIP competition. A request for proposals should be issued sometime this summer, with awards expected in November.

Begun during President George H. W. Bush's term, the ATP thrived in the early Clinton years, peaking at \$414 million in 1995. But the Republican takeover of Congress that year brought a reversal, and with the exception of one year, funding never topped \$200 million again. Through September 2007, a total of \$2.4 billion in ATP money had been committed for 824 projects involving 1581 participants, with the awardees contributing \$2.2 billion in matching funds (see table on page 23). Small businesses of fewer than 500 employees took half of all awards, but their share increased in recent years; 53 of the 70 awards made last year were to small firms.

David Kramer

Lawmakers fret over health, safety impacts of nanotechnology

As Congress reauthorizes the National Nanotechnology Initiative, groups petition the Environmental Protection Agency to step up its regulation of nanomaterials.

Congressional overseers and outside experts are pressing the Bush administration to direct more of the \$1.5 billion nanotechnology research program toward resolving the environmental, health, and safety issues raised by the manufacture and use of a rapidly growing number of nanoscale materials.

Since its 2000 inception, the multi-agency National Nanotechnology Initiative has included an R&D component for EHS concerns. But the NNI has yet to come up with a well-designed plan that is both adequately funded and effectively executed, says Representative Bart Gordon (D-TN), chairman of the House Committee on Science and Technology. Although Gordon threatened to mandate that 10% of the NNI funding go to EHS research, the provision was not part of legislation approved by the committee on 7 May to reauthorize the NNI. The White House had opposed the mandate, but it has proposed upping EHS spending to \$76 million in the next fiscal year. That would be twice the FY 2005 level and 5% of the NNI.

Meanwhile, a coalition of environmental groups headed by the International Center for Technology Assessment (ICTA) filed a petition with the Environmental Protection Agency (EPA) on 1 May demanding that the agency begin to regulate the most widely used nanomaterial today. Silver particles are used in a wide range of consumer products, mostly to impart an antimicrobial surface. But two recent studies have found that socks impregnated with nanoparticles of silver leach the particles when laundered. Silver is toxic to fish and other aquatic organisms, and researchers have found the nanoparticles in streambeds. What isn't known is the extent to which the nanoscale form increases silver's toxicity.

The ICTA's petition came less than two months after the EPA fined Iogear Inc, a California maker of computer mice and keyboards, more than \$200 000 for failing to register its nano-silver products as required by federal law and for making unsubstantiated claims about their products' antimicrobial properties.

By the ICTA's count, more than

Proposed FY 2009 NNI funding by program area (millions of dollars)

	Fundamental phenomena & processes	Nano-materials	Nanoscale devices & systems	Instrument research, metrology, & standards	Nano-manufacturing	Major research facilities & instrument acquisition	Environment, health, and safety	Education & societal dimensions	NNI total
DOD	227.8	55.2	107.7	3.6	12.8	22.1	1.8		431.0
NSF	141.7	62.5	51.6	16.0	26.9	32.1	30.6	35.5	396.9
DOE	96.9	63.5	8.1	32.0	6.0	101.2	3.0	0.5	311.2
NIH	55.5	25.4	125.8	5.9	0.8		7.7	4.6	225.7
DOC (NIST)	24.5	8.5	22.7	20.9	15.3	5.7	12.8		110.4
NASA	1.2	9.8	7.7			0.2	0.1		19.0
EPA	0.2	0.2	0.2				14.3		14.9
NIOSH							6.0		6.0
USDA (FS)	1.7	1.3	0.7	1.1	0.2				5.0
USDA (CSREES)	0.4	0.8	1.5		0.1		0.1	0.1	3.0
DOJ				2.0					2.0
DHS			1.0						1.0
DOT (FHWA)	0.9								0.9
Total	550.8	227.2	327.0	81.5	62.1	161.3	76.4	40.7	1527.0

DOD, Department of Defense. DOE, Department of Energy. NIH, National Institutes of Health. DOC, Department of Commerce. EPA, Environmental Protection Agency. NIOSH, National Institute for Occupational Safety and Health. USDA, Department of Agriculture. FS, Forest Service. CSREES, Cooperative State Research, Education, and Extension Service. DOJ, Department of Justice. DHS, Department of Homeland Security. DOT, Department of Transportation. FHWA, Federal Highway Administration. Source: National Nanotechnology Initiative.

260 products incorporating silver nanoparticles, including toys, household appliances, and clothing, are being sold. More than 600 products containing nanomaterials of all kinds are now on the market, compared with 212 just two years ago, according to David Rejeski, director of the Project on Emerging Nanotechnologies (PEN) at the Woodrow Wilson International Center for Scholars. About half of the products sold fall under the purview of the Consumer Product Safety Commission, whose involvement with nanotechnology last year was limited to a \$20 000 review of the scientific literature, Rejeski told the Senate Committee on Commerce, Science, and Transportation in April. That committee is also preparing legislation to reauthorize the NNI.

Calls for \$150 million

Andrew Maynard, PEN's chief science adviser, told the House Science Committee in April that the NNI should devote \$50 million annually to "targeted research directly addressing clearly defined strategic [EHS] challenges." Another \$100 million should fund "exploratory research that is conducted within the scope of a strategic research program." That "top-level, top-down" program would identify the information needed to regulate or oversee development and use of nanotechnolo-

gies, determine which agencies will lead in addressing specific research issues, and decide how the research will be funded (see PHYSICS TODAY, November 2007, page 29).

E. Floyd Kvamme, the venture capitalist who cochairs the President's Council of Advisors on Science and Technology, called a mandated percentage set-aside approach "arbitrary," "overly prescriptive," and "problematic in both practice and principle." It's not feasible to designate research projects to be exclusively EHS in nature, he told Gordon's committee. Moreover, the NNI functions as only a policy and planning coordinating mechanism, he said; funding levels are established by the individual agencies through the annual budget process. The fraction of NNI funding devoted to EHS topics is likely to continue climbing anyway, Kvamme added, as industry picks up more of the applications research and as government involvement moves increasingly to regulation.

But Maynard argued that EHS spending esti-

mates provided by the NNI were inflated by the inclusion of marginally related research. The Government Accountability Office concurred, judging in a report released in April that \$7 million of the \$37.7 million reported by the NNI in FY 2006 was incorrectly labeled EHS. PEN found just \$13 million of the NNI research that year had been "highly relevant" to EHS but conceded that an additional \$16 million was "substantially relevant." By comparison, European nations devoted \$24 million in 2006 to research that is highly relevant, according to PEN.

P. Lee Ferguson, professor of chemistry



Andrew Maynard, chief science adviser to the Project on Emerging Nanotechnologies at the Woodrow Wilson International Center for Scholars, holds a jar of nanomaterial as he testifies to the House Committee on Science and Technology in April.

ALEX PARLINI, PROJECT ON EMERGING NANOTECHNOLOGIES

at the University of South Carolina, told the Senate Commerce Committee hearing that at least 10% of NNI funding is needed for developing methods to detect and characterize nanomaterials in the environment, standardize testing methodologies to assess the toxicity and biological uptake of nanomaterials, and assess human and ecological exposures from releases of nanomaterials.

Highly reactive materials

Nanoparticles are worrisome because their size allows easy passage into and out of individual cells. Many nanomaterials are designed to be highly reactive, but their potential interactions with biological material are mostly unknown. Normally inert gold, for example, becomes highly reactive at the nanoscale, noted Kristen Kulinowski, executive director at the Center for Biological and Environmental Nanotechnology at Rice University. CBEN is one of six NSF-funded academic centers focusing exclusively on nanotechnology EHS research issues. NSF provides the largest share of EHS funding; the administration has requested \$30.6 million for FY 2009. The EPA is in store for a nearly 50% increase, to \$14.3 million, while NIST, which received less than \$1 million this year for EHS, is slated to receive \$12.8 million.

Briefing congressional staffers in April, Kulinowski said Congress should reconsider whether decisions on regulatory actions and risk assessments should continue to be based solely on the chemical compositions of nanomaterials, without regard to their size or structure. Most nanomaterials are subject to the Toxic Substances Control Act, which lists 75 000 regulated chemical substances. Charles Auer, director of the EPA's Office of Pollution Prevention and Toxics, told the staffers that most of the 35 new nanomaterials submitted to the EPA through "premanufacture notices" since 2005 have not displayed properties or behaviors that differ from their non-nano forms. Ten US chemical and materials manufacturers to date have committed under a stewardship program to voluntarily submit information to the EPA on nanomaterials they develop.

Computational models that can predict how nanoparticles will interact with organisms top a list of EHS research needs unveiled on 1 May by the International Council on Nanotechnology, a stakeholder group housed at Rice. The NSF-funded ICON study estimated that those models will require 10 years or more of R&D.

PEN, ICON, and others have warned that EHS issues need to be resolved if nanotechnology is to thrive and avoid a repeat of the public backlash that accompanied commercial introduction of genetically modified foods during the 1990s. With new ap-

plications appearing at the rate of three to four per week, Rejeski cautioned, "If government and industry do not work to build public confidence in nanotechnology, consumers may reach for the 'no-nano' label in the future."

David Kramer

Ehrenfest letters surface

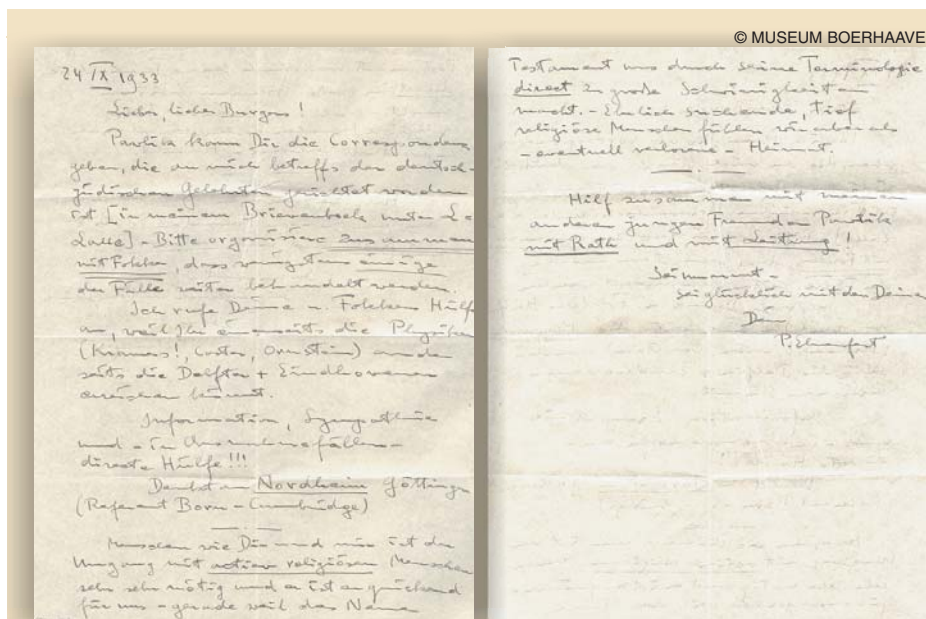
"And so it is that most likely in the coming school year, to finally free up my position in Leiden, the only way out left to me is to kill myself."

The Austrian-born theoretical physicist Paul Ehrenfest wrote that to some of his former PhD students on 15 August 1932, about a year before his suicide at age 53. In the letter, he tells them that "each of you has been, during some stretch of your life, something like my own child" and "I have you much more to thank than you realize. Your affection, your consistent wish to give me confidence in myself made it possible until just recently for me to maintain my enthusiasm. Forgive me that it is now over."

That letter is one of four given in 1992 to the Museum Boerhaave in Leiden, the Netherlands, by the descendants of Ehrenfest's first student, Johannes Burgers, who is perhaps best known for the eponymous equation for nonlinear diffusion. The letters went unnoticed until the museum's new director, Dirk van Delft, happened on them recently. "The most important one

is the last one in the set," says van Delft. "Very probably it was Ehrenfest's last letter. It was written on the 24th of September 1933. The next day he committed suicide."

One of the letters, dated 21 August 1918, is to Burgers's fiancée, Jeannette Roossenschoon. In it, Ehrenfest writes: "Maybe it's wrong, but you know that my wife and I are convinced that the key to a lasting marriage is common love for something other. Usually the others are the children, but for a man like Jan [Johannes] for whom intellectual work is so much a source of happiness, it is very, very good, in my view, if his wife is a true [waschechte] physicist." In that letter, he also mentions the birth of his son Vassily. On 21 October 1918, he tells Burgers—complete with sketches—how to label the envelopes with his dissertation in preparation for his defense. In the 1932 letter to his students he writes: "My belief in the absolute (unanalyzable) worth of the natural and mathematical sciences grows unabated! That I myself have completely lost contact to it, THAT is the



Paul Ehrenfest wrote this letter to his former student the day before committing suicide.