Throughout, the experts were asked to put aside their favorite hypotheses and instead act as impartial evaluators of various theories. For example, they were asked to consider multiple models of how a particular volcanic process works, rather than solely their preferred model, although their final estimates weighted each model. This stepping back from previously held positions is "not scientists' accustomed role," says Allin Cornell of Stanford University, a statistician who advised the study, "but they warm up to it."

In the end, only one-third of the uncertainty in the final estimate was due to the conflicting opinions among experts, while two-thirds stemmed from the uncertainties perceived by each expert. In fact, the conflict over recent volcanism didn't have much effect. For example, whether Lathrop Wells was 20,000 or 140,000 years old didn't matter as much as the fact that a dozen volcanoes had peppered the area at unpredictable intervals of 100,000 years to 3 million years. "You're swamped by the uncertainties of your limited database," says Crowe.

The power of expert judgment elicitation to cut through such misperceptions has a strong appeal to many scientists. "It's hard for me to think of a better way to go about this," says volcanologist William Melson of the National Museum of Natural History, who tracked the process closely but was not on the panel. "The final result has a lot more value than one or two opinions."

A crucial part of the process, of course, is the choice of panel members. Geologist Eugene Smith of the University of Nevada, Las Vegas (UNLV), who is funded by the State of Nevada to check up on DOE's work, notes that one panel member, Crowe, was a team leader in DOE's earlier evaluations of Yucca Mountain. Apart from that, even Smith says "they did a very nice job of choosing panel members."

He does have some other reservations, however. "The diversity of opinion among panel members was tremendous," he says. "There were probably four or five different opinions about how to define a volcanic event, for example. I was flabbergasted that so much diversity could result in much the same probability" from each of the 10 experts. He and mathematician Chih-Hsiang Ho of UNLV have suggested that averaging expert opinions, when each opinion is itself an average of several different models, will lead to an unrealistically narrow range of probability. Their concern will be considered in agency critiques of the report. Meanwhile, expert elicitation is already proceeding apace: A few weeks ago, Geomatrix and other consultants began this type of analysis for the seismic hazards at Yucca Mountain.

–Richard A. Kerr

DEPARTMENT OF ENERGY

Weaponeers Cultivate Academics

LIVERMORE, CALIFORNIA—The government's nuclear weapons program is getting ready to build new bridges to U.S. universities on a scale not seen since the start of the Cold War. A half-century ago, universities and the military hurriedly formed the alliance that developed the atomic bomb. Then the vast weapons machine turned inward, doing research in large, secret laboratories and maintaining only selective ties with university researchers. Now, in an initiative that could funnel as much as $100 million to basic researchers next year, the $3.9 billion weapons program is reaching out again.

Last month in Dallas, university research administrators met with top officials from the U.S. Department of Energy's Office of Defense Programs and the directors of the three nuclear weapons laboratories for the first workshop on expanding their relationship. DOE's goals include shoring up waning academic programs in areas of keen interest to nuclear weaponeers, such as radiochemistry and nuclear engineering. One aim, says Victor Reis, head of nuclear weapons programs for DOE, is to ensure a supply of "the right kind of people" to recruit for the national labs. "We have to think now about those people and engage the universities in the science aspects of [the nuclear weapons] program," he says.

The increased interest in university ties reflects a fundamental change in the character of that program. For 50-plus years, the labs focused largely on applied science and engineering, because they could always check their bomb designs by testing them. But in 1992, the United States halted nuclear testing, and this September President Clinton signed a global test ban. Maintaining the nuclear weapons stockpile without testing will require a strong base in fundamental disciplines such as plasma physics and materials science along with powerful computer models. And that means that the labs "want to be sure they have their ear to the ground for exciting new developments. Those typically show up first in universities," says William Happer of Princeton University, a long-time consultant to DOE's weapons programs.

> **The labs "want to be sure they have their ear to the ground for exciting new developments."**
>
> **–William Happer**

As a first step, DOE floated a proposal at the Dallas workshop to bring universities into the Advanced Strategic Computing Initiative. The computing initiative, part of the new "stockpile stewardship" program, aims to develop the hardware and software needed for massive computer simulations. As part of that effort, the weapons program now wants to fund a handful of university computation centers that would specialize in developing simulation techniques in areas such as hydrodynamics and turbulence, which are crucial for predicting the performance of nuclear weapons. University scientists would actually do their work on a new generation of supercomputers at the weapons labs themselves, says Philip Morris, associate director of Penn State University's Institute for High Performance Computing Applications.

DOE is expected to solicit competitive proposals for the centers this month. A preliminary schedule calls for a decision by February on a couple of centers that would be funded out of DOE's current budget at $1 million to $2 million apiece, according to Morris. Eventually, DOE officials have said, they would like to fund a total of five centers at an annual cost of between $3.5 million and $5 million apiece. And they say they are in it for the long haul: They are discussing 5-year contracts for the centers, renewable for 10 years.

Howard Birnbaum, who heads a materials research laboratory at the University of Illinois, Champaign-Urbana, says DOE officials also discussed awarding $50 million to $100 million from next year's appropriation for a range of other university research activities. "None of this is set yet," he says. The agency plans a larger meeting in the spring to discuss specific areas of potential collaboration.

DOE and lab officials are careful to describe the initiative as an outgrowth of a long history of lab-university collaboration. "We always had, individually at the labs, a very strong association with universities," says Los Alamos National Laboratory Director Siegfried Hecker. "This is not a second Manhattan Project," adds Robin Staffin, head of research and development for DOE defense programs.

For universities facing a squeeze on funding, having a new suitor—even one regarded as unsavory in some circles—is a happy prospect. Says Birnbaum: "When you're entering an increasingly dark era, a few bright spots are nice to see occasionally."

–Peter Weiss

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