

including whether the telescope would stay on Jelm Mountain, in Wyoming, or be moved to Colorado, were still being ironed out at press time.

Unintended consequences

Even as the department struggles to make improvements, however, the feeling among faculty and students is that the administration is undermining their efforts. The five-year plan, Johnson says, "gives us less leverage to hire the highest quality research faculty." Adds astronomer Robert Howell, "Raising undergraduate enrollment is reasonable. Having a consortium run WIRO is reasonable." But the hard-nosed approach, Howell says, "is exacerbating problems. The administration has destroyed the minimal level of trust that has to exist between faculty and administration. All of us are looking around at other options. Unless [the administration is] willing to make a long-term commitment to the department, how can they expect one from us?"

The academic planning process is taking a toll on students, too. "It hits us all really hard," says Jennifer Cash, who is working on a PhD in astronomy. "It's had several effects on me personally. First and most unfortunately, my research adviser decided to accept a position at another university due to the uncertainty of the department's future and the lack of respect for scientific research shown by the administration." Cash also expects that she and other graduate students will have to take on heavier teaching loads, "and this will probably increase the time it will take for me to finish my PhD." That's unlikely, says Johnson, although advanced graduate students are being asked to teach two classes for double pay. And, he adds, "Prospective undergraduates have been scared away. Physics has been the centerpiece in the media. High school students know what's going on here."

Stephen Bieber, a statistics professor who sits on the faculty academic planning committee, agrees that the moratorium on admitting new physics and astronomy graduate students will make it more difficult and costly to rebuild the programs later. The university should either say outright that the programs are being closed, or delay any action and consider physics along with the rest of the graduate programs, he says. "This middle ground is unacceptable. I think the physics graduate programs are being scheduled for elimination." But Dubois insists this isn't so: "If we wanted to do that, we would have left the first draft [of the five-year plan] unchanged."

The university would do better to keep its physics graduate programs,

says Brian Schwartz, a physicist at City University of New York, who has offered to mediate, which he's done for other universities in similar situations. (Most notably, as part of a team from the American Physical Society, he helped James Madison University save its physics department in 1995; see *PHYSICS TODAY*, March 1995, page 81, and October 1995, page 57.) "Right now, almost all state universities are involved in regional economic development. If graduate physics is eliminated, high-technology development will be weakened," says Schwartz. And since the other sciences at Wyoming currently offer the PhD, he adds, "if physics doesn't, it will be a second-class citizen within its own university. Theoretically, it's possible to have only an undergraduate physics program. But

psychologically, it's difficult. It's the intangibles. . . . And there are always unintended consequences."

But on 3 May, the faculty senate endorsed the university's plan, and also defeated a bill to "put a moratorium on moratoria," reports Johnson. "My hope now is that we can put together a committee that has credibility with both sides, perhaps with members from the department, the administration, industry, and APS," and lay out a clear plan of what the administration and the department will each do to bolster the physics and astronomy department. "We need realistic criteria, instead of just saying, 'It will be evaluated'—the faculty worry that could mean anything. To rebuild the department, we will have to build trust."

TONI FEDER

Professional Master's Degrees Promise Quicker Entry into Industry Jobs

Although the need to reform graduate education in the sciences has been widely debated for much of this decade, actual changes have been slow to occur. Given the shortage of research jobs for PhD scientists, much of the attention has focused on making the doctoral degree more "practical." But a few reform-minded schools are instead recasting the master's degree—typically either a stepping stone to the PhD or a consolation prize for students who drop out of doctorate programs—as a respectable diploma in its own right. Comparable to an MBA or a law degree, but with a technical component, these new professional master's degrees are intended to prepare students for careers outside of academia—managing industrial research projects, for example, or dealing with intellectual property rights, or working as a liaison between a company's R&D and business operations.

There are now about 50 professional master's degree programs in science and mathematics in the US, according to Sheila Tobias, a longtime advocate of science education reform and currently an adviser to the Alfred P. Sloan Foundation, which is funding the startup of such programs at five universities. This new breed of master's tends to be in an emerging or interdisciplinary field, such as biotechnology, says Tobias, or it may apply scientific training to some nontechnical application, such as financial mathematics.

Four of the Sloan-funded schools will offer degrees in physics or physics-related disciplines: the University of Southern California's physics for business applications program; the

University of Arizona's applied and industrial physics program; Michigan State University's program in physics applications; and the University of Wisconsin—Madison's environmental monitoring program. USC and Wisconsin will enroll their first students this fall, MSU and Arizona the following year.

From school to work

While few would argue that the PhD is still the degree of choice for the professoriat, there is growing recognition that it is not the most appropriate or the most efficient path to many nonacademic jobs. That's the message being sent by both employers and students. University of Arizona physicist Michael Shupe says the impetus to revise the master's program in his department came from alumni. "In some years, close to half of our graduates go directly into industry," says Shupe. "They know what it's like to work there, and they've encouraged us to go in this direction."

Boosters of the professional master's degree say the two-year programs will groom students to become research managers in industry, as well as at national labs and government agencies. "What we've been hearing is that there's a tremendous demand for people who not only are technically proficient, but can plan and manage a project, particularly with a commercial orientation," says Tim Olsen, who is coordinating the Wisconsin program.

Indeed, a common complaint from business employers is that PhDs fresh out of school have trouble adapting to a corporate environment, says Hans Bozler, a physicist at USC. "It just

doesn't occur to them that they were hired to make money for the company." One way to get students thinking about the bottom line is through internships, an important component of the professional master's curriculum. Students at Arizona, for example, could be placed with a company in Tucson's burgeoning optics industry, and Shupe expects many graduates to end up at the same companies where they intern.

MSU's professional master's is designed for "people who aren't interested in spending their lives doing basic research but who want to do a bit more physics and are impatient to get into the industrial world at a high level," says Phillip Duxbury, who is overseeing the new physics degree. The curriculum offers two concentrations: One introduces the characterization and fabrication techniques used in commercial R&D labs, and the other focuses on computation. In addition, students will take a ten-weekend workshop on business fundamentals, such as accounting and patent law.

The idea behind the Wisconsin program is to familiarize students with remote sensing technology, and then show them how to apply those techniques to environmental problems in transportation, land use, and other areas, explains Olsen. Many places are seeking that kind of expertise, from satellite manufacturers, to developers of image processing software, to utility companies, he adds. In fact, two companies have already expressed an interest in hiring graduates, although the first class won't enroll until this fall.

At USC, a pair of courses, in complex systems and computational methods in physics, have been specifically developed for the new master's curriculum, which also includes course work in the business school. Bozler says that in designing the new degree, "We asked [employers], 'Well, why do you hire physicists?' The answer was their ability to organize disparate information and develop models of all sorts, and to do something that's predictive with those models." Bozler hopes that a few of the professional master's students will go on to the PhD. "The biggest concern [among faculty] was that we not do anything to jeopardize our PhD program," by siphoning off students or resources, Bozler says. "I think we were able to convince them that it's not a zero-sum game, that this could actually increase the flow of good students through the department."

Hopes and hurdles

Recruiting students to the new, untested programs may take some doing. The drastic drop-off in physics bachelor's degree recipients in recent years

APS Time Line Celebrates a Century of Physics

High schools around the country—8000 and counting—have received this time line, a wall chart entitled *A Century of Physics*. Unveiled at the American Physical Society's 100th birthday meeting in Atlanta this past March, the time line highlights physicists and their discoveries over the past century, as well as some of the applications spawned by scientific advances.

Five color-coded themes thread across the time line's eleven panels: discoveries in physics at the cosmic (blue), human (pink), and atomic (green) scales; technological advances (red); and interfaces of physics with biology and medicine (yellow).



Peppered throughout the time line are historical nuggets. For example, the time line notes that around when quarks and cosmic background radiation were discovered, the Vietnam War was "tearing at the fabric of America" and the Beatles "were conquering the world."

APS teamed up with Lucent Technologies, the Department of Energy, the National Science Foundation, and United Parcel Service to offer every US high school a gift of the time line, along with a teacher's guide (paid for by the Richard Lounsbery Foundation). The team has also sent free copies to all of the nation's universities, two- and four-year colleges, and science museums. A Web version (supported in part by IBM), which APS plans to continue to expand and update, can be found at <http://www.timeline.aps.org>. And copies of the time line can be ordered for \$35 each (\$80 for overseas delivery) on the Web at <http://www.aps.org/timeline/main-order.html>.

means there is already fierce competition for students among the existing graduate programs. "They're trying to snap up every undergrad they can," notes Bozler. "They're thinking in terms of staffing their own PhD programs, and not thinking too much about alternatives." The new programs are therefore looking to draw students from other disciplines, "who may not have thought of applied physics as a career," says Arizona's Shupe.

It's also not clear who will pay for tuition. Law and business schools expect their students to shoulder the cost of their educations, but will science students, who traditionally enjoy full support, do the same? At USC, Michigan State, and Arizona, the first few classes will be offered teaching assistantships, until some other kind of support—corporate-funded grants, for instance—can be worked out. The Wisconsin program plans to recruit mid-career professionals, who may be in a better position to pay, or whose employers may foot the bill.

As Duxbury sees it, the professional master's will ultimately be judged by "what kind of jobs the students get and how quickly they move up, how happy they are with those jobs, and how happy their employers are with them." In the longer term, Tobias hopes that "by supplying industry with such versatile people, they'll say, 'We want more people like that.' It's the reverse of the usual demand-supply equation. That's my theory at least, and only time will tell."

JEAN KUMAGAI

Duke Laser Lab Gets New Director

On 1 May, Glenn Edwards became head of Duke University's Free Electron Laser Laboratory. Edwards's most immediate goal "is to get light out of the pipe again," he says, referring to the lab's infrared free electron laser, which has been down for about a year.

The lab was founded in 1988 by John Madey, the inventor of the free