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Linda Strausbaugh (center), with Bo Petraszkiwicz (left) and Ranyelle Craig—instructors in the modular PSM laboratory classes.

PROFESSIONAL SCIENCE MASTER'S DEGREES

By Diana Gitig

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Now over a decade old, Professional Science Master's degrees are proving themselves to be a practical and valuable alternative to a Ph.D. Today there are nearly 200 PSM programs. Some 2,500 students are enrolled—well over half of them in the life sciences—and an equal number have graduated.

Academia is not for everyone. Just ask **Linda Strausbaugh**, a professor of genetics and genomics and the director of the Professional

Science Master's Degree in Applied Genomics at the University of Connecticut. "I believe there is a deep talent pool of students who love science and math, but are not interested in, or well suited to, academia," she asserts. Their options are limited; she is concerned about what happens to them. She considers it a national priority to keep them enfranchised, as otherwise the notorious lack of a science work force in this country will become a self-fulfilling prophecy. "If we don't give them an avenue to pursue their love and talent," she muses, "they'll get lost."

Michael Teitelbaum, a program director at the Alfred P. Sloan Foundation, could not agree more. That is why the Sloan Foundation decided to fund the first Professional Science Master's (PSM) degree in 1997.

Teitelbaum noted that certain scientific fields, such as geology, environmental sciences, and of course engineering, still have high regard for master's degrees. But he pointed out that "in other sciences, in the past half century the Master's degree has been relatively undervalued in favor of the Ph.D." **Carol Lynch**, director of Professional Master's Programs at the Council of Graduate Schools, elaborated on that idea. She added that "other countries really emphasize traditional thesis-based Master's degrees as a preview for a doctoral education—as a credential to demonstrate that an individual has the aptitude for a research degree."

That is not the case here. Yet 80 percent of science and math majors do not go on to graduate work in their field; rather, most go into the work force. The Sloan Foundation perceived a gap between Bachelor's level math and science education and the level of expertise required by employers in industry. It created the PSM degree to provide a pathway for science and math majors directly into jobs, configuring it in response to employers' desires.

PSM curricula describe themselves as "science plus."

Typically 60–70 percent of their courses are science classes, usually the same classes that doctoral students take. The "plus" element consists of business classes. These stress project and business management, ethics, leadership, communication skills, and the ability to work in teams across disciplines. More specialized courses—for instance in government regulation or intellectual property—can be added depending on the field. These courses are heavily influenced by an employer advisory board comprising representatives from local industries who work very closely with the students. They can act as adjunct faculty members, give seminars, serve as mentors, and direct group projects. All students must also work in an internship, and the degree often culminates in a team project in lieu of a thesis.

In 2007, the National Science Foundation was authorized to establish a PSM initiative by the America COMPETES (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education and Science) Act. In the American Recovery and Reinvestment Act of 2009—otherwise known as the stimulus bill—the NSF received \$15 million of federal funds to create more PSM programs and to improve those that already exist.

There are currently over 190 PSM programs at more than 90 universities; they are in 27 states and the District of Columbia. Roughly 2,500 students are enrolled annually, and there are about 2,700 graduates to date. The programs cover a diverse range of disciplines: mathematics, physics, biology, computational sciences, forensics, chemistry, and geographical information systems. According to **Stephen Lemire**, the former executive director of the National PSM Association (NPSMA), approximately half of PSM students are in the life sciences. The NPSMA completed its first alumni employment survey in August 2009. It revealed that graduates are in high demand by employers, with multiple job offers and a median salary of \$60,000–\$65,000 a year. When asked to report their salaries, 19 percent of those who responded checked "More than \$90,000 a year."



Photo: Alfred P. Sloan Foundation

Michael Teitelbaum

A NICHE FOR EVERY SCHOOL

There are different types of PSM programs, appealing to different kinds of students. Certain schools target people fresh from their undergraduate degrees, who are seeking a tertiary education and training; others cater to professionals who are working full time but find they need specific abilities to progress. Programs are tailored accordingly. Lynch refers to a “PSM personality” as social and entrepreneurial, and Teitelbaum qualifies PSM students as risk takers, perhaps not surprisingly, as they opted to get a 10-year-old degree.

The Illinois Institute of Technology (IIT) was one of the first schools to establish a PSM program, in 1996. It was designed for working people looking to advance their careers. According to **Elizabeth Friedman**, its program director and the president of NPSMA, this evolved because one of IIT’s first faculty members, Walt Eisenberg, had been an analytical chemist in industry and knew very well that employees needed higher education—they were sorely lacking in business skills—but that they did not need independent research skills or the ability to write a thesis.

IIT began accommodating them by broadcasting their classes via satellite television so those who worked in local industries could attend classes remotely—they didn’t even have to leave their places of work. Since 1998 classes have been streamed live over the Internet. This online approach has been very successful and has been emulated by other schools. A notable example is the California State University system, which enrolls a lot of veterans. Of course, classes with a laboratory component must be attended on campus.

The University of Maryland University College, a primarily online institution, is popular with those in the active military to help ensure that they are qualified to pursue rewarding careers when they are done serving. Thus students are dispersed all over the globe. UMUC received a grant from the US Department of Education’s FIPSE (Fund for the Improvement of Postsecondary Education) program to set up online mentoring. After a year was spent establishing the online interaction platform, the first set of mentoring pairs was connected in the fall of 2009.

Students in their second or third semesters are introduced to mentors in industry, and they are required to meet once a month. But according to **Rana Khan**, director of biotechnology programs at UMUC, most of the 39 working pairs currently established meet once a week, sometimes by e-mail and sometimes over the phone. Khan said that “the most remarkable part is how generous the volunteer mentors are with their time. They tell their colleagues about it, and then their colleagues ask to join.” Another way that Khan recruits volunteer mentors in industry is through LinkedIn. Virtual internships are also available in UMUC’s five PSM programs. Other programs at UMUC are hoping to set up similar online mentoring programs by next fall.

VOICES FROM THE FIELD

Lakshmi Subbarao graduated from University of Delaware in 2004 with a bachelor of science in chemistry. In June 2006, she decided to enroll at IIT. The distance learning program allowed her to continue working full time while earning her degree. She graduated in December 2008 with a Master’s in chemistry. A month later, Subbarao accepted a position as an applications chemist for Waters Corporation in Newark, Delaware. She attributes her career growth to the solid knowledge base obtained through the IIT PSM program.

Dmitry Royhman, currently studying to get his PSM in cell and molecular biology at IIT, says, “The reason I chose to do the PSM instead of the traditional Master’s degree was because the

M.S. would have restricted me more toward research, and I was not sure that was the path for me." Even so, he continues, "I chose to go to IIT because of their high emphasis on research. I started doing research here in a molecular biochemistry and biophysics lab, and I discovered that I really enjoyed doing it. Right now I am applying into the Ph.D. program here for molecular biochemistry and biophysics." A number of PSM students in all of the fields find that, contrary to their initial misgivings, research is very much to their liking and they continue on to a Ph.D. program.

Rice University's PSM program is focused on integrating the university with the surrounding community. It is perhaps not surprising then that the internship component of the program was the aspect that most appealed to the students there. **Danny Mills** got his PSM in environmental analysis and decision making from Rice. He notes, "I was especially drawn to the program because of the internship requirement, in lieu of a traditional research-based thesis, and the interdisciplinary nature of the degree. I was also attracted to the program because it stressed the importance of communications in addition to technical knowledge." Mills is now a sustainability manager at the design firm HOK in Houston.



Liang Ge

Shilpi Desai is currently a student in the same track. She says, "I chose to get a PSM because I was already working in the industry and I knew that a research degree would not suit my interests. I wanted to enroll in a program that was aimed at sending graduates to work in corporations, not colleges. I did not want to pursue a Master's in business because my scientific aptitude was the one I wanted to further." **Liang Ge** is currently studying subsurface geoscience at Rice. He says, "Compared with regular thesis Master's or Ph.D. programs, PSM's internship feature is the key reason I chose it. I am not very interested in academic research, so a Master's degree is enough for me to begin my career in industry."

The University of Connecticut has three PSM programs. About half of the students in its Applied Genomics track come straight from their undergraduate studies. Strausbaugh attributes this to the program's very active outreach to other schools in the area. **Eric Carita** graduated in 2005 and, like Royhman from IIT, is now pursuing his Ph.D. Carita says, "The wide range of classes offered within the PSM program enabled me to gain the advanced education required by a variety of professional institutions. The internship I received at the Connecticut State Forensic Science Laboratory allowed me the opportunity to witness how a professional laboratory functions, and gave me the experience required to gain a permanent position following graduation."

Maria Bonatsakis, who got her PSM in applied genomics at U-Conn in 2009, says, "I knew I wanted to continue my education, but I wasn't confident I could commit the time and effort for a Ph.D., so I decided on a Master's program for starters. It has met every one of my expectations. I found a job immediately, and my group leaders at my company have praised the program as well." **Kali Bogaard** got her PSM from U-Conn in 2008 and worked for two years at Genomas, where she did her required internship. Then she decided to pursue a Ph.D. in human genetics at Baylor College of Medicine. Bogaard notes, "I was drawn to this program because I was not fully decided on what I wanted to do in the field, and the PSM program let me explore the many avenues that science can offer outside of academic research."

Although the Internet-based, remote component of these programs has been growing, not all universities choose to follow that model. In 1997, the William M. Keck Foundation established the Keck Graduate Institute of Applied Life Sciences, an independent college within the Claremont Colleges in California. It has a Master of Bioscience program that, in contrast to many others, requires residence at the campus; classes are not available online. Its goal is to ensure that there is a pool of scientific talent that knows the commercialization process, as stated in promotional materials: "Students learn to catalyze development of basic life sciences research into useful new products, processes, and services." Keck also introduced a unique Postdoctoral Professional Master's in bioscience management to help scientists with Ph.D.s attain management and business skills.

Of course, not all students looking for a Master's degree in the sciences need apply for a PSM; terminal Master's degrees are still available. A Master of Science in biotechnology is popular at many schools, including The University of Pennsylvania, Johns Hopkins University, and Northwestern University.

Based on the pilot data from the NPSMA 2009 Alumni Employment Survey Report, the Sloan Foundation's Teitelbaum was excited to report that "the PSM movement is doing very well right now. We are seeing a lot of enthusiasm from faculty, student interest, support from industry and state government, and new support from the federal government." Carita's words certainly confirm that sentiment, and are representative of many students' feelings: "Without my PSM I would not have the career I do today; I would not be the scientist I am today; and I would not be the person I am today. I would highly recommend the PSM program to any student who dreams of one day working within any scientific field."

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Taken for Granted: An Alternative to the Ph.D. Track - [dx.doi.org/10.1126/science.caredit.a0900083](https://doi.org/10.1126/science.caredit.a0900083)

Mastering the Job Market - [dx.doi.org/10.1126/science.caredit.a0800033](https://doi.org/10.1126/science.caredit.a0800033)

Education Forum: Professional Science Master's Programs Merit Wider Support - [dx.doi.org/10.1126/science.1171209](https://doi.org/10.1126/science.1171209) (www.sciencemag.org/cgi/content/full/323/5922/1676)

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