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INTERDISCIPLINARY STUDIES

Seeking the right toolkit

Many researchers are exploring the boundaries of established disciplines. But does this cutting-edge approach lead to job opportunities?

BY BRYN NELSON

When David Camarillo begins his tenure-track job in the engineering department at Stanford University in California later this year, it will represent not only a career milestone, but a validation of some unconventional training.

Camarillo enrolled as a mechanical-engineering PhD student at Stanford, but an interest in medicine led him to train in a medical-robotics lab affiliated with both the surgery and computer-science departments. He benefited from a fellowship awarded by Stanford's Bio-X programme, which encourages interdisciplinary research and education. Camarillo also did a year-long internship at a start-up biotechnology company midway through his schooling, and joined the company after graduating, before returning to academia.

Camarillo concedes that an interdisciplinary training route isn't for everyone. "In my case it has worked out OK so far," he says. "I've seen some people do the interdisciplinary path and then go back to their bread and butter."

No one can blame researchers for retreating to a more conventional scheme. Interdisciplinary research institutes are springing up around the world, giving graduate students and postdocs many opportunities for cutting-edge research and cross-fertilization, but employers often prefer to hire scientists who have stayed in established research disciplines.

Barry Bozeman, a policy analyst at the University of Georgia in Athens who studies scientists' career trajectories, says that for now, an interdisciplinary background is "very rarely an advantage" when looking for a faculty position. Biotechnology and pharmaceutical firms might be more accommodating, as long as the applicant's unconventional research fits within the company's overall scientific aims. But formal interdisciplinary training may be less important than informal learning experiences in labs, institutes and universities that encourage the intermingling of a broad range of ideas.

MIXED MESSAGES

Interdisciplinary graduate programmes have been around for decades. But until Bio-X began awarding fellowships in 2004, most ▶

programmes did not attempt to integrate the biological and physical sciences, and many served mainly to funnel undecided students toward specific departments.

This year, a white paper co-authored by researchers at the Massachusetts Institute of Technology (MIT) in Cambridge called for a more ambitious fusion of disciplines, seeking to combine technologies and know-how into a powerful model of innovation (P. A. Sharp *et al. The Third Revolution: The Convergence of the Life Sciences, Physical Sciences and Engineering* MIT, 2011). That ideal has been embraced by a host of research centres that house researchers from a mixture of fields in shared facilities that promote interaction.

Such institutions include the Clark Center at Stanford, home to the Bio-X programme. The centre's open-plan building hosts 44 labs spanning the gamut of disciplines, although faculty members housed there retain their departmental appointments. "Think of it like Noah's ark. The idea was to put two of everything in there, and let them breed and see what happens," says Carla Shatz, director of Bio-X.

Bozeman says that boundary stretching is most welcome in research fields that have seen a lot of change in recent years, such as biology and engineering. Other fields that might accept an interdisciplinary mindset, such as mathematics, are in relatively low demand by employers. The chances of making practical use of an interdisciplinary degree may be best, says Bozeman, when that research focus evolves into an established field of its own. Booms in synthetic biology, biophysics, nanobiology and systems biology over the past few years suggest that being in the right place at the right time can pay off for a nascent career.

"People who establish interdisciplinary degrees are also more likely to hire people with interdisciplinary degrees."
Barry Bozeman

Some universities are trying out hiring initiatives that will benefit unconventional researchers. For example, Michigan Technological University in Houghton has based some of its recruitment decisions over the past five years not on individual departments, but on multidisciplinary research themes. The first of these, sustainability, brought in seven faculty members with nontraditional joint appointments such as social sciences paired with forest resources and environmental science. "They will be the catalysts of increased interactions between the departments," says Max Seel, the university's provost and head of the hiring initiative. Other themes include computing innovation, energy and health.

Interdisciplinary graduate-training programmes are less common. The few that have been established include Bio-X, the Integrative Systems Biology Doctoral Training Centre (DTC) at the Interdisciplinary Biocentre (MIB) of the University of Manchester, UK, and the Biodesign Institute at Arizona State University in Tempe.

Bio-X fellowships are given to students who have already been accepted into specific departments at Stanford; they receive a training grant but stay in their adviser's home department. "We're not really taking them off their route, but what we're doing is training them to think more broadly," says Heideh Fattaey, executive director of operations and programmes for Bio-X.

The approach has paid off, says Fattaey. Camarillo has been academically successful; and one former Bio-X fellow who worked with an ophthalmologist and a chemical engineer to develop an artificial cornea has since started his own biotech company. A current fellow is working with a mechanical engineer and a physicist on a new method for measuring muscle motion.

Manchester's interdisciplinary training programme has been running only since 2006. Even so, says Nigel Scrutton, director of the MIB, graduates are highly employable and have found jobs in small spin-off biotech firms and large multinational companies alike. And despite the tough economic climate, he says, graduates have excelled in securing externally funded academic fellowships. Many have been hired at Manchester, particularly at the MIB, where faculty members are in a prime position to spot emerging talent.

Most PhDs in Britain take three years, but one at the systems biology DTC takes four: the first year is spent learning subjects ranging from the dynamics of nonlinear systems to eukaryotic transcription and translation. For Ben Small, a PhD student at the DTC, committing to an additional year has been worth it. "It's given me a unique perspective on biological problems and the way that you can approach them," he says. "I never hesitated or had any doubt that this would be the right route."

After his undergraduate degree, Small conducted preclinical and clinical drug-discovery research in the United Kingdom at pharmaceutical companies Eli Lilly in Windlesham and AstraZeneca at Alderley Park. He saw a need to use the tools and techniques of the predictive sciences in pharmacological research, so he enrolled in the DTC and has joined a neurosystems lab to focus on the chemical and computational biology of inflammation.

Small is set to receive his PhD in 2012. After that, he hopes to start a research career in either industry or academia, focusing on systems-biology-based pharmacology. For now, his first lead-author paper has been accepted by *Nature Chemical Biology*, and he isn't worried that his interdisciplinary training will limit publication possibilities. It's fortunate, he says, that systems biology is more established than many other research combinations, already attracting its own share of dedicated journals such as *Molecular Systems Biology* and *Systems and Synthetic Biology*.

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"If people think that what you're proposing to do is vigorous and interesting, then you will get the job."
Polina Anikeeva

Polina Anikeeva, newly hired as a materials scientist at MIT, plays down the benefits of an interdisciplinary background for securing a faculty post. "If you have ideas that the department likes and people think that what you're proposing to do is vigorous and interesting, then you will get a job," says Anikeeva, who did her postdoctoral research at the Clark Center. "I don't think it really depends on if you have interdisciplinary training or not." But she acknowledges that she was drawn to her Bio-X-affiliated lab by the opportunity to break into the medical-devices arena without previous biology training. At the Clark Center, Anikeeva built implantable devices that can measure electronic signals from individual neurons. Last year, she landed two tenure-track job offers, one from MIT and another from the Swiss Federal Institute of Technology in Lausanne, to expand her work on designing implants and prosthetics.

HOME BASE

Bozeman cautions that although it is relatively easy for universities to hire people with interdisciplinary backgrounds for postdocs, it is much harder to get interdisciplinary faculty positions. That could lead scientists without a history of close affiliation with an established department to serial fellowships and postdoc limbo, or job-hunting challenges in the broader market.

"If they're in an interdisciplinary programme, there may be concerns about whether they can teach at the undergraduate level, whether their research is really in a specific area that's relevant to that [hiring] department," says Jonathan Dordick, director of the Center for Biotechnology and Interdisciplinary Studies at Rensselaer Polytechnic Institute in Troy, New York. "Falling through the cracks may in fact be fairly common, and it may be more difficult for people like that to be able to get a faculty position."

Recognizing such difficulties, the Interdisciplinary Studies Graduate Program at the University of British Columbia in Vancouver,

Canada, warns students that they must have a home department. This "gives them full citizenry in terms of access to financial and physical resources", says the programme's website. And when they complete their graduate studies, students are "strongly advised to be strategic about their post-doctoral placement, since most must find a job in an existing more traditional field".

FRINGE BENEFITS

Despite the caveats, pursuing a course that defies traditional boundaries can still yield valuable, if subtle, benefits. Sam Hay, a biophysicist at the University of Manchester, wasn't intent on interdisciplinary studies when he sought a postdoctoral position five years ago, but the MIB was one of the only places hosting research that really interested him: studying the quantum mechanics of biological reactions. "There was a lab set up and running, doing what I wanted to do," says Hay. But "the best things about it are the sort of things you don't really expect", he adds.

Those unexpected benefits include communal spaces and seminar programming designed to foster the creative intermingling of ideas. "You walk into a seminar or lecture and realize it's somebody working on a technique that's a hell of a lot better than the one you've been trying to wrap your data around," says Hay. That atmosphere, he says, contributed to the success of his postdoc. Last September, he received a coveted academic fellowship at the biocentre, an entry route to the equivalent of a tenure-track research position. "There are quite a few people floating around here that don't obviously fit in any one department," says Hay. "Ultimately, time will tell whether this is a fad, but I suspect it probably won't be."

Fattaey laughs when asked whether the concept of interdisciplinary training is gaining in popularity. "Today I have already talked to three groups that want to do this on a daily basis," she says, citing delegations from South Korea, Belgium and Denmark. She also lists universities or consortia in five US states that have requested her advice on launching programmes similar to Bio-X.

Even sceptics concede that the increase in popularity could pay dividends for graduate students and postdocs. "People who establish interdisciplinary degrees are also more likely to hire people with interdisciplinary degrees," says Bozeman. Fattaey foresees a thriving network of like-minded universities and researchers, further adding to the talent pool and job prospects. "We're not going anywhere if all of us don't work together," she says. ■

Bryn Nelson *is a freelance writer based in Seattle, Washington.*

COLUMN

Scientists for sale

There are ways for researchers to sell themselves — but they shouldn't overdo it, says **Mariano A. Loza-Coll**.

It all started well. At an interview for a faculty position, a colleague of mine provided an account of his work as a postdoc. Afterwards, a member of the recruiting committee praised him and provided feedback on his presentation. Then he said it: "Great job, but you should sell yourself better."

When I was growing up in Argentina, before the advent of online commerce, people would place empty cans on the roofs of their cars to indicate that a vehicle was for sale. When I hear stories like my friend's, I chuckle at the thought of showing up to job interviews with an empty plum-tomato tin on my head.

P. GILLIGAN

I've heard the sales argument before. As scientists, we need to 'sell our work' (or, my favourite, we need to 'make it sexy'). I get what that means; we need to highlight the most salient findings and implications of our work without hiding its caveats and limitations. Instead, we should turn them into mere blemishes under the flattering light of our discoveries.

But how should we go about that? Or, more importantly, how can we avoid overdoing it? When I hear that I need to sell my work, my grant proposal and even myself, I can't shake the fear that if I push too hard, I will start sounding like the proverbial used-car salesman.

I decided to approach the question as any sensible scientist would: I googled 'key steps to a successful sale'. A few tips caught my eye, because scientists tend to overlook them. They can be used when applying for a faculty position or research grant, or when pitching a paper to an academic journal.

First, be realistic and make sure that your product fits the needs of your target audience. Sales associates understand that they will not be able to sell everything to everyone. I don't only mean trim the sub-par science; a tough sale won't always be overcome by polishing your product. Even your most elegant science may not fly with an audience 'not in the market' for it, so be sure to pick your target wisely.

Second, a sales meeting is a conversation. All the tips I found stressed that the salesperson must listen to potential buyers to understand their needs. It might seem obvious, but it got me thinking about how often we scientists make the process mostly about ourselves (my CV, my publications, my recommendation letters, me, me, me …). Some experts even advise forcing the conversation if it isn't part of the interview or application process. For example, they might arrange a series of phone interviews to get to know their 'buyers' — the hiring committee, the grant makers, the journal editors — before the interview or submission. But remember that looking up faculty members online doesn't count as a conversation.

Finally, explain clearly what will happen after the sale. Buyers need to know how they will put you, the product, to use. Think of yourself as a new printer. Are you 'upgradable'? Your prospective employers might want to know how easily you can scale your lab up or down, or move it between floors or buildings if necessary. They may also appreciate knowing that you're ready to lecture on several subjects at a moment's notice. Do you come with a 'service contract'? Try to demonstrate that you can count on a network of collaborators in case of problems. What are your 'consumables'? If your research involves the use of unconventional materials, make sure that you show that you have thought carefully about how to secure them. Do you come with 'pre-installed drivers'? Be honest about what you need to get started. It's best to tell your department about the particle accelerator you'll need in your basement before the fleet of moving trucks arrives.

These universal sales principles won't apply to every case, but they could come in handy, especially in a tough job market or funding climate. Of course, should everything else fail, you can always break out the car-salesman routine. Look the search-committee members squarely in the eye, give them your widest grin and ask, "Say, what will it take for me to get this job today?" ■

Mariano A. Loza-Coll *is a postdoc in genetics at the Salk Institute for Biological Studies in La Jolla, California.*