

CAREERS

TURNING POINT Neuroscientist's fishy finding helps to improve data interpretation **p.437**

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INNOVATION

Brushing up on business

Entrepreneurship training can open up new avenues for scientists. And it doesn't take a business degree.

BY NEIL SAVAGE

After 15 years as a practising cardiologist, Catherine McGorrian enrolled in a PhD programme at University College Dublin (UCD), studying family risk factors for sudden cardiac death. To fulfil her credit requirements, she chose to undertake an optional course in entrepreneurship for scientists. "It just struck me as something really different," she says, "something that wasn't a skill you would pick up just anywhere."

Her class attended a presentation from the Irish Marine Institute, based in Oranmore, about SmartBay — a network of sensors and communications technology attached to buoys and undersea cables that gathers oceanographic data and transmits them to researchers. McGorrian wondered whether similar technology could be applied to one of her own interests: the portable defibrillators that are used widely to deliver regulating electric shocks to people having heart attacks.

In an emergency, McGorrian wondered,

how would someone know where to find a defibrillator, or whether it was charged and in working order? "I just thought, 'There are these buoys in the ocean talking to each other and here I am on land, and I can't tell if there's a defibrillator in the next room.'"

So, taking what she had learned in the course and drawing on the resources of the Innovation Academy, a joint programme of the UCD and Trinity College Dublin, McGorrian put together a business plan for defibrillators that would transmit information on their location, their maintenance schedule and whether their batteries were charged. She entered it into a competition held by Enterprise Ireland, a government organization that promotes business growth. She didn't win, but is still talking to business people about implementing her idea. The experience has convinced her that she will have other marketable ideas in future.

In addition to McGorrian's course, the Innovation Academy has launched a graduate certificate in innovation and entrepreneurship, which takes the equivalent of seven weeks of study. It is one of a growing number of academic programmes aimed at teaching scientists and engineers how the fruits of their research can become commercial products or seed companies. The development of such programmes has been promoted by governments, which see the creation of businesses — especially technology-focused ones — as an economic driver.

BREADTH NOT DEPTH

Scientists who want to learn about entrepreneurship can spend one or two years of full-time education earning a master's degree in business administration (MBA). But many institutions offer more focused options, with programmes that teach enough finance, marketing and management for scientists and engineers to learn how to apply their strengths to the commercial world. "We're not going to make them into financiers. We're not going to make them into marketers," says Jeanne Simmons, associate dean of the Graduate School of Management at Marquette University in Milwaukee, Wisconsin. "We're not trying to give them this full-blown MBA. We want to give them the knowledge to ask the right questions." Such focused options range from a course or two during or after a normal degree programme to a certificate in entrepreneurship (see "Training top-up").

Business courses are often geared towards bioengineers, biomedical researchers and ►

► computer scientists. But good ideas can come from anywhere, and entrepreneurship classes can be useful for people from any discipline. More important than background, say educators, is a willingness to take risks, to think



“We want to give them the knowledge to ask the right questions.”

Jeanne Simmons

in new ways and to put up with the lack of security and support that comes from being self-employed. Entrepreneurship is hard for most faculty members, says Alistair Fee, who teaches business in the School of Mechanical and Aerospace Engineering at Queen’s University Belfast in Northern Ireland. “It is different from research and publishing. It moves at a fast pace,” he says.

A business degree costs a lot of time and money. An MBA in the United States, for example, can require 45–50 course credits — four semesters of work or more. Marquette offers a more accessible option: a Certificate in Entrepreneurship that takes only 16 credits. The first set of students graduated in May. Simmons says that the course provides a grounding in the basic principles of entrepreneurship, helping scientists to decide, for instance, whether a product actually fills a need in the marketplace or can be sold at a reasonable price. It also helps researchers to hire the right business people, should they build a company that grows.

Courses and certificates of this type often offer more breadth of knowledge than depth, focusing on skills such as forming market strategies, finding venture money, creating teams and managing cash flow. “I’m not an expert in any of these things,” says John Melas-Kyriazi, a graduate student in materials science and engineering at Stanford University in California and an alumnus of the Mayfield Fellows Program, a nine-month work–study course run by the Stanford Technology Ventures Program. “I know a little bit about a lot of things,” he adds. Melas-Kyriazi, who wants to develop better storage systems for wind and solar power, appreciates what the programme taught him about founding and running a business. “If you’re looking to change the world and make a positive impact,” he says, “one of the ways of doing it is commercializing your technology.”

Entrepreneurial education need not lead to a start-up, says Tim Keane, entrepreneur in residence at Marquette, who helped to develop the university’s entrepreneurship programme. Business skills and knowledge make scientists more attractive to venture-capital firms looking for advice about promising technologies. “Helping people understand what the game

is, even if all they do is go work for an entrepreneurial company, I think that is a big deal,” says Keane, who has founded and sold a web-analytics company, Retail Target Marketing Systems, and launched a venture-capital fund called the Golden Angels Network.

“It’s also about being more entrepreneurial no matter what they do,” says Karen Wilson, an adviser and board member of the European Foundation for Entrepreneurship Research, which is headquartered in Hilversum, the Netherlands. She adds that business courses can promote willingness to take risks, think creatively and lead rather than follow. “It’s not only for the Bill Gateses and Richard Bransons of the world.”

CHANGE YOUR THINKING

At their core, these courses teach science-related problem solving, says Matt Harvey, content and communications editor for Stanford’s entrepreneurship courses, which cover how to choose an idea and license intellectual property from a university. Harvey says that Stanford doesn’t measure success in terms of how many start-ups its graduates found, but how well they learn to identify, fill and profit from an unmet need in the marketplace. He mentions Stanford graduates Kevin System

and Mike Krieger, both of whom were Mayfield fellows. They founded the online photo-sharing service Instagram, which they sold to Facebook this year for US\$1 billion. But Harvey insists that the value of their education doesn’t lie in that one sale, however lucrative: “The story is not about Kevin and Mike founding Instagram. The story is what are they going to do for the next 10, 20, 30 years, because they’re problem solvers,” he says.

In his own course, Fee uses a poetry contest to help engineers think in ways they’re not used to. “I’ve had young men in tears in my office saying ‘I can’t write poetry,’” he says. “The point is to get the students to explore their emotional soul, if you like.” He feels that poetry heightens awareness of language, helping people to learn when to be precise and when to be imaginative. Fee also emphasizes the importance of drawing connections between disparate subjects. He argues, for example, that connecting ideas from origami and cardiology led to the creation of stents that can be folded to fit into an artery.

Learning creative problem-solving often requires hands-on classes, not passive lectures. Accordingly, entrepreneurship courses seldom run on the model of the large lecture courses that are common in undergraduate science. Students “don’t sit in a classroom listening to us

COURSE OPTIONS

Training top-up

There are plenty of programmes and other resources for scientists and engineers who want to sample entrepreneurship without pursuing a business master’s degree.

In the United States:

- Rensselaer Polytechnic Institute’s Lally School of Management and Technology in Troy, New York, runs a one-year master of science in technology commercialization and entrepreneurship.
- The Child Family Institute for Innovation and Entrepreneurship at the University of California, Davis, has a one-year business development certificate for graduate students and postdocs in science and engineering.
- The Maryland Technology Enterprise Institute at the University of Maryland, College Park, runs courses and online programmes including a degree minor in technology entrepreneurship.
- The Marshall School of Business at the University of Southern California in Los Angeles offers a graduate certificate in technology commercialization.

In Europe:

- The Innovation Academy at University College Dublin and Trinity College Dublin offers PhD students a graduate certificate in

innovation and entrepreneurship.

- The Management of Technology and Entrepreneurship Institute at the Swiss Federal Institute of Technology in Lausanne lets master’s students from other university departments minor in management, technology and entrepreneurship.
- The Strascheg Center for Entrepreneurship in Munich, Germany, together with Munich University of Applied Sciences, provides entrepreneurship courses including a two-semester certification programme in innovation and entrepreneurial spirit.
- The Centre for Entrepreneurship at Delft University of Technology in the Netherlands offers courses in finance, product development and marketing.

Available globally:

- The Kauffman Foundation in Kansas City, Missouri, runs the Global Scholars Program, which allows graduates in science, engineering and technology from around the world to study with successful entrepreneurs in the United States for six months.
- The Stanford Technology Ventures Program at Stanford University in California offers free videos of talks by entrepreneurs at <http://ecorner.stanford.edu>. **N.S.**

tell them what we think. They're out experiencing things," says Suzi Jarvis, a UCD biophysicist and co-director of the Innovation Academy.

Keane divides students into teams with different disciplinary backgrounds, and describes real-life financial and personnel issues that have faced the founders of Zipcar, a car-sharing service based in Cambridge, Massachusetts. The students have to come up with ideas about how to address those issues — first individually, then as a team. It is often hardest for them to grasp that there is no one correct solution, says Keane.

To learn how creativity translates into business success, students often hear talks from accomplished entrepreneurs. Not only do such talks provide important networking opportunities, but they can also give students a different perspective on entrepreneurship. "If people in engineering and science don't have any exposure to entrepreneurs, they may think 'That's only for business people. That's only for people with MBAs. That's only for people who aren't like me,'" says Wilson.

IDEAL APPROACH

For scientists interested in entrepreneurship, Wilson recommends dipping a toe in with a single course, or searching the web for one of the many conferences held on the subject every year. The website TechCrunch, for instance, runs the biannual Disrupt conference, at which start-ups can demonstrate their technology and compete for a monetary prize. The Kauffman Foundation, based in Kansas City, Missouri, joined with Enterprise UK in London to create Global Entrepreneurship Week, which covers a variety of events around the world. O'Reilly Media in Sebastopol, California, a publisher of computer-related books, holds regular Ignite events, at which people give 5-minute talks about their passions, which could include start-up ideas.

Wilson strongly suggests getting some work experience before trying to start a company. Although famous successes such as Facebook give the impression that graduates can immediately build a billion-dollar company, most successful entrepreneurs actually have a decade or more of business experience. Wilson herself studied applied mathematics as an undergraduate, and after working for a couple of years, went to Harvard Business School in Boston, Massachusetts. Her only regret is that she didn't work for longer, perhaps gaining experience at a second company. "Go and make all your mistakes at somebody else's expense," agrees Fee. "Learn how difficult it is to get projects off the ground." ■

Neil Savage is a freelance writer based in Lowell, Massachusetts.

TURNING POINT

Craig Bennett

Craig Bennett, a postdoc in cognitive neuroscience at the University of California, Santa Barbara, has highlighted the prevalence of statistical errors in interpretations of functional magnetic resonance imaging (fMRI) data. He showed that such errors can lead to ambiguous and sometimes absurd results, such as registering brain activity in a dead salmon (C. M. Bennett et al. J. Serendipitous Unexpected Results 1, 1–5; 2010). On 20 September, Bennett accepted an Ig Nobel Prize — a riff on the Nobel prize that recognizes unusual research — for his work. He describes how the fishy findings have affected the field and his career.



Did you conduct a 'dead salmon' experiment?

No. We do a lot of calibration and testing before undertaking fMRI studies, to make sure that the scanner is working before we put a human into it to measure their brain activity. One of my PhD advisers and I made a game out of finding all kinds of things to scan, from a pumpkin to a game hen to a salmon. But there was no reason to dig into the results until about five years ago, when my other adviser was lecturing on false positives and asked me to find some good data. It was pure luck that we found them in the salmon's brain.

How did the story evolve from there?

False positives in fMRI studies had caused increasing concern in neuroscience. The dead salmon was a good example of how an improperly corrected threshold value — which separates the signal from noise — could compromise results. We submitted our findings as a poster to the 2009 Human Brain Mapping conference in San Francisco, California, and at first colleagues thought it was a joke. Ultimately they included it, but we realized that we would face challenges in trying to publish.

What sort of challenges?

We knew that the article could mean that our statistics would receive closer scrutiny. We have experienced some of that, but it keeps us on our toes. Our work has improved — we are meticulous about analyses.

What happened when you submitted the dead-salmon paper?

We tried to get it published in two major neuroimaging journals. One rejected it and the other sent it out for review. One reviewer said it was fantastic; the other gave us a hateful, livid review that sunk it. But less-mainstream journals were clamouring for the paper. We

went with the *Journal of Serendipitous and Unexpected Results*, which led to other publications and fostered a debate on statistical errors.

Has the field changed?

In the salmon paper, we did a meta-analysis of major journal articles and found that 25–40% of neuroimaging papers that we studied were not properly correcting for threshold values. We surveyed a couple of journals last year as a follow-up, and found that fewer than 10% of people are now using incorrect statistics. The decline is not all attributable to the salmon paper, but it is all progress. We gave the field a kick in the pants — and I've heard that a lot of groups reviewed the paper in lab meetings.

Are you concerned that being an Ig Nobel winner might harm your career prospects?

We were a tad worried, given that the Ig Nobel's original criterion was to recognize research that "cannot or should not be replicated". We didn't feel that the salmon fell into that category. But when we got a call from Marc Abrahams, founder of the awards, he described their new context: recognizing science that "first makes people laugh, then makes them think". That seemed appropriate, and we worried less.

What is next for you?

I am keeping track of job openings while I complete some research. I'm convinced that a big part of a successful job search is shaping your personal story. You need a coherent thread of research. I study how teens and adults make decisions, and I am interested in how best to analyse fMRI data to answer these questions. I just co-authored a big review on fMRI reliability, and I will make clear in interviews that all my work tells a coherent story — otherwise I would just be the 'dead fish' guy. ■

INTERVIEW BY VIRGINIA GEWIN