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Taking a break from study to work as an intern can put graduate students on the path to success.

TRAINING

A winning detour

Work placements can offer research students real-world experience and a valuable taste of their future career.

BY CHRIS WOOLSTON

While other members of his computer-science PhD programme were working on projects, Kory Mathewson took a Google break. Earlier this year, he attended a presentation on job opportunities at the company and spotted a mathematical puzzle on one of the slides. Solving that puzzle led him to a series of coding challenges that helped him to win the ultimate prize: a 12-week internship at the global technology giant that ended in June.

The placement offered Mathewson a different flavour of computer science, which he was already studying for his PhD at the University of Alberta in Canada. At Google, he was developing ways for computers to generate sounds through synthesizers based on neural networks, part of a project exploring the expression of art and music through machine learning. When Mathewson left in June, he walked straight into a second internship at Apple — and he is confident that his placements at the two tech leaders will now propel him into a research career in artificial intelligence. "Having non-traditional training helps set you apart," he says. "You have to round yourself out."

Taking time out for an internship can give a PhD student a fresh perspective on their research and their careers. These positions, which typically offer a few weeks or months with a company or other organization, provide a first-hand view into a professional field (see 'Know before you go'). Many of these placements in science and technology-related fields are paid. There are downsides, of course: stopping or pausing PhD work can be tricky, and there's often a risk of getting sidetracked or falling behind. But for students who find the right opportunity and secure the support of their institution and supervisor, an internship can be a winning detour.

Nobody tracks the total number of science-based internships available to PhD students, but it's clear that the model has spread to all fields and all parts of the world. It's also clear that competition for such positions is often intense. A spokesperson for Google in Mountain View, California, says that the company receives thousands of applications for internships every year. But even at lower-profile organizations, hopefuls will probably have to play to the strengths that will make them valuable assets to such employers.

Rachael Treharne, an ecology PhD student at the University of Sheffield, UK, promoted her scientific experience when she sought and won a three-month internship as a climate-change policy analyst. At her interview, she emphasized her research in the field, which had included sampling and experiments in the Norwegian Arctic and the boreal forest of Canada. "Having a grounding in the natural sciences was a really big advantage," she says. "I could see during the interview that that angle was working, so I pushed it quite a lot."

Her stint at BirdLife International, a non-profit conservation consortium based in Cambridge, UK, turned out to be a dream job, if only for the short term. "I wanted to find out what it was like working at a non-governmental organization, and I loved it," she says. "It's very different from the specific knowledge that you get from a PhD."

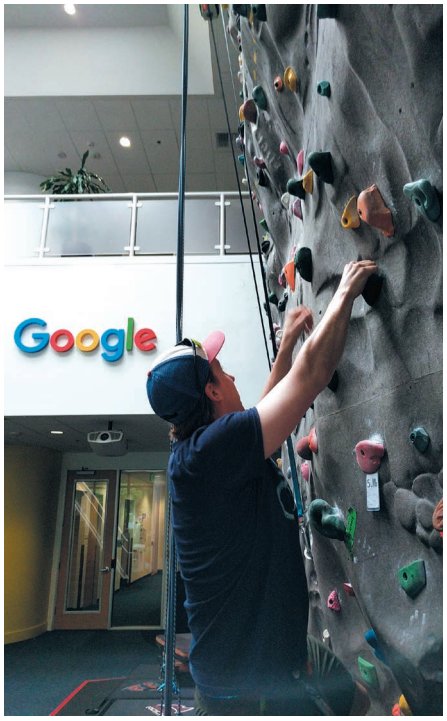
Treharne says that in a perfect world, she would get back to policy work after she graduates. Such permanent positions are relatively scarce and highly competitive, but she feels that she now has an advantage over competing applicants. Not only does she have real-world experience, she has a roster of people to call for advice, answers and, most importantly, references. "I'd be much more worried about what I was going to do if I didn't have the contacts that I have now," she says.

Margot Paez didn't have deep reserves of scientific experience when she applied for an internship at the Jet Propulsion Laboratory (JPL) in Pasadena, California. She was a former ethnomusicology major who had just taken her first physics class as an undergraduate at a two-year college. She showed such promise in that class that her professor encouraged her to apply to the Consortium for Undergraduate Research Experience, a US National Science Foundation programme that awards paid internships to promising undergraduate students from community colleges in and around Los Angeles, California. That professor's hunch paid off, and Paez ended up contributing to the data analysis for SHERLOC, a new spectrometer for the 2020 Mars rover. She also developed a web-based repository for samples to be collected by SHERLOC.

Paez thinks that her music background and computer-programming skills helped her to land the position. "They wanted someone who is interesting and well-rounded," she says. "You'd think the kid who went to California Institute of Technology right out of high school would be the one they want at JPL, but in my lab that's not the case."

Paez continued her JPL internship part-time even after she relocated to Atlanta, Georgia, where she is working on her PhD in robotic physics from the Georgia Institute of Technology. These days, she visits the JPL lab while staying at her parents' house during brief breaks from studying. "My goal is to reintegrate with the lab at JPL once I'm done with my PhD," she says. Spending summers and winter breaks in California may slightly slow her PhD work, but Paez says the time away is worth it. "My advice is to try everything, and don't worry if it takes longer than you think," she says.

However, balancing the demands of an internship while pursuing a PhD can be a challenge. Treharne felt extra pressure to catch up on her doctoral work when she returned. "I had a couple of months of blind panic," she says. She now feels that she's been able to make up for the lost time, thanks partly to skills that she picked up at the internship, including the ability to multitask. "I've worked much more efficiently since I came back," she says.



KEYFER MATHEWSON

Kory Mathewson learns the ropes as a Google intern.

Some of the largest science companies in the world are tapping into the intern market. In 2016, the German-based chemical company BASF hired roughly 300 interns in its research and development department; most of them are based at the company's headquarters in Ludwigshafen. The majority of interns at BASF are pursuing PhDs in Germany, but the company also hires interns from other parts of Europe as well as from the United States, says Barbara Jessel, a research chemist and member of the firm's recruitment team. "We look for committed people with different experiences and perspectives," Jessel says. "The interns take part in real projects and are full members of the team. They gain an insight into how the company works and get the chance to build up a personal network."

Internship opportunities also exist beyond North America and Europe. The technology company Intel, for example, hires PhD interns at branches in Cairo, Beijing, Jakarta and Hong Kong, among other places. CRCC Asia — a company founded by graduate students from the universities of Oxford and Cambridge, UK — connects interns (including PhD students in technology and science) with more than 600 companies in Beijing, Shanghai and Shenzhen.

The Australian government recently allocated Aus$28 million (US$21.3 million) to the Australian Mathematical Sciences Institute (AMSI) to expand its own internship programme. Clients range from small start-ups to large banks, mining operations and telecommunications companies. "The goal is to make PhD students ready for work," says Glen Sheldon, the national programme manager. "We want them to see the opportunities that they have."

The internships, which last an average of five months, should help to create new options for the country's glut of doctoral students, Sheldon says. "Australia pumps out a huge number of PhDs, and that number has been increasing dramatically over the past few years," he says. About 125,000 students in Australia earned graduate degrees in 2015, more than double the

KNOW BEFORE YOU GO

What to ask about internships

Internships vary widely from one organization to another, so be sure to ask the right questions before taking a position, says Katherine Horner, assistant director of graduate programmes, assessment and off-campus internships at Clemson University in South Carolina. Here are some of the key things to find out about.

- **Renumeration** Job seekers are often told that it's bad form to ask about money in the first interview. That's true for internships, too — unless that first interview is the only interview. Some internships pay much less than others, so have this conversation early, before you commit yourself.
- **Mentorship** For a successful internship, you need a supervisor who is willing to show you the ropes and offer guidance where necessary. Otherwise, you could get overlooked: "You may discover that there's no desk or computer," Horner says. "You'll wonder if anyone even knew you were coming." So identify someone early on, or in advance if possible, who can help in this way.
- **Job prospects** Many internships are essentially extended job trials. Ask how many interns end up working at the organization. The answer will tell you much about the quality of the internship and perhaps give you a glimpse of your own future.
- **Track record** Some of the best internship programmes have been around for a number of years, long enough for them to develop well-established systems. If you're one of the first PhD interns at an organization, you might not have a chance to really put your talents to work.
- **A day in the life** Some organizations hire interns to handle mundane and unpleasant tasks, so it's important to find out exactly what they expect you to do on a daily, weekly or monthly basis. If the job description says "other tasks as necessary", try to work out what's really involved.
- **Testimonials** Seek out people in the organization and ask about their experiences — particularly those who did an internship themselves. What do they like about coming to work? What are the biggest challenges? The answers will give you an insight into working life there. C.W.

tally from 2001, according to Universities Australia, an association that represents the nation's institutions. "Not all of them are going to end up teaching at a university. We have to find a way to put them into the broader economy," Sheldon adds.

The intern programme also addresses a lack of collaboration between academia and industry, Sheldon says. "We do research really well," he says. "But when you look at transferring knowledge, we're stone-cold last." Inserting PhD students into companies can only help to encourage collaboration, he says.

Internships in some fields have a reputation for being a source of cheap or even free labour for employers. According to the non-profit group Brussels Interns NGO, often known as B!ingo, more than half of all student internships in Europe are unpaid, and some PhD students do end up taking unpaid positions, especially in conservation and ecology (see *Nature* **522,** 131; 2015). But many PhD interns in the sciences are compensated for their time and efforts. The AMSI interns, for example, receive a stipend of Aus$3,000 a month. Treharne says that she continued to receive her usual stipend through the UK Natural Environment Research Council (NERC) while she interned at BirdLife International. "That was crucial," she says. "Otherwise I couldn't have done it." The site glassdoor.com, which collects salary data for many companies, suggests that Google interns generally earn in the range of US$6,000–$7,000 a month.

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Students also need the blessing and support of their home institutions before they can take time off for an internship. Treharne says that both the University of Sheffield and NERC made it easy for her to put her PhD work on hold. Mathewson says that he had to take the initiative. "It took a little bit of perseverance and self-motivation to find a position and connect with a company," he says. But once he was offered an internship, his supervisor and the university were accommodating, he says.

Mathewson says that, as is the case for many students, the lessons from his internship will help to power him through his PhD — and beyond. "People at Google are productive and know how to use their code and pipelines in a way that I hadn't seen before," he says. "I'm learning incredible practices." ■

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BOSTON CHILDREN'S HOSPITAL

TURNING POINT
Data miner

Harvard University epidemiologist John Brownstein was always interested in health, but rather than heading to medical school, he decided to wed his interests in ecology, statistics, geography and computer science to predict disease dynamics. Brownstein, who is also chief innovation officer at Boston Children's Hospital in Massachusetts, has partnered with Google and Uber to harness new data sources.

You opted out of medical school. Why?
I spent a semester in east Africa while I was an undergraduate student at McGill University in Montreal, and I saw how closely the environment is tied to health. It reinforced my interest in working out how to bring multiple fields together to understand the health of populations. I got my PhD in epidemiology at Yale University in New Haven, Connecticut, researching the impact of climate change and landscape transformation on Lyme disease, West Nile virus and other infectious diseases. I also spent time at NASA and realized that there was a huge opportunity to explore satellite imagery and other data sets in epidemiology.

Where did those ventures lead?
Recognizing that I was interested in population health and disease surveillance, I got excited by large data sets, such as electronic medical records, that could model infectious-disease dynamics. When I came to Harvard and Boston Children's Hospital, I began modelling adverse drug events and influenza in patient populations and turned to the Internet where data was much more available at large scales. I developed a research team to harness data to track disease, and we created HealthMap, a public-health website that mines the Internet for signs of disease outbreaks.

Describe your first forays into industry.
There were commercial opportunities around the data-mining technologies we created. We spun off a company called Epidemico, which monitors conversations on social media and elsewhere for insights into disease outbreaks, food and drug safety and patient experiences. I also founded a company called Circulation, which works with Uber to get patients to medical appointments.

How did you link up with Uber and Google?
These connections don't just drop out of the sky. With Google, we had an intern at Boston Children's Hospital who'd been at Google before and was able to produce the right connection there. We got in front of the right people, pitched to them and won what turned out to be seven years of funding. With Uber, we responded to a request for feedback on a trip receipt. We said that our ride was fine but that they should consider expanding their market to those who need health care. They responded and we ran a campaign called UberHealth, which experimented with delivering health-care services, such as flu vaccines.

Any advice for early-career researchers who want experience at big technology companies?
I've always found that the more a person can refine the research they are interested in, and target people at companies that have those same interests, the higher the rate of success. It's important to find a way to personalize enquiries. A vague one-line e-mail doesn't offer the recipient much to follow up on. At the same time, nobody's unreachable. If you have a story that is compelling and connects you to the person you want to reach, it makes all the difference. The worst that could happen is that you get no response. Also, don't forget about the many available internships at smaller start-ups that are trying to solve one particular problem.

Are academics reluctant to approach industry?
Yes. Most of them wait for a formal request from potential funders. I don't think people in academia realize that they can create their own funding opportunities. You don't have to go through a structured fellowship application and be one of a thousand applicants. You can talk to a person in industry and come up with a proposal in which you are the only applicant. ■

INTERVIEW BY VIRGINIA GEWIN

This interview has been edited for length and clarity.