Quantum possibilities

Commercial quantum devices are in their infancy, but the growing industry targeting quantum technologies is already having a tangible effect on the job market.

At the March meeting of the American Physical Society in Los Angeles this year, the Google Quantum AI lab presented Bristlecone, their newest quantum processor and the latest development on the road towards a quantum computer[1]. The machine boasts 72 qubits, but it's possible that many young physicists at the meeting were more interested in the fact that Google was also throwing a so-called quantum AI party. With IBM and Rigetti Computing hosting similar events, it would seem that now is a good time to be working on quantum computing.

These companies belong to a burgeoning industry looking to develop and commercialize quantum technologies. No matter how different the physics of a quantum device may be with respect to its classical analogues, the business landscape that is taking shape around this technology looks fairly standard in its makeup. The dominating forces seem to be the quantum research arms of well-established computing companies, surrounded by an ecosystem of start-ups and university spin-offs. These join companies such as ID Quantique and D-Wave, pioneers from a previous wave of investment in quantum technologies[2] around the year 2000.

There is something for all tastes: from the manufacturers of quantum computers on a variety of platforms (the ones that regularly make the headlines) to developers of quantum sensors or cryptographic devices. But there are also companies creating quantum algorithms, with varying degrees of classical hybridization and machine-learning thrown into the mix. And there are also consultants tasked with addressing difficult problems by dipping into the quantum world as the need arises, perhaps with the help of a quantum annealer. These are complemented by an array of intermediaries seeking to help existing companies understand how they could benefit from the looming quantum revolution — or avoid being caught off-guard by it. To get a feeling of the diversity of companies involved in this endeavour, the program of the Quantum Computing for Business conference provides a good example[3].

What form a commercial quantum revolution might take, or indeed whether there will be one at all, is the sort of question investors bet on. But the rapid expansion of the industry in pursuit of a revolution means that there are plenty of job opportunities for quantum physicists eager to start their careers beyond academia.

The symbiosis between academia and high-tech companies has been a reality in many fields of physics for decades — a well-known example being the semiconductor industry. Nonetheless, just a few years ago it would have been difficult to imagine a flourishing job market or widespread commercial prospects to be strong points in favour of starting a PhD in quantum information. Perhaps slightly more unusual is this sector's thirst for theorists: the Quantum Information Processing (QIP) conference, an event traditionally focused on theoretical work, hosted an industry session this year, with career opportunities in prominent display. The promise of quantum advantage for solving optimization problems and the need to develop native quantum programming languages for future quantum computers, however, explains it all.

Proficiency in quantum mechanics is an unavoidable requirement for those who wish to develop the quantum technology of tomorrow. However, the fast-paced environment of a research field on the verge of a technological turning point poses challenges that the average quantum physicists may not be trained to tackle — even to make progress within academic research. Since Stephanie Wehner, professor of quantum information in Delft, and her team set about developing a quantum internet, they are faced with problems that traditionally fall in the remit of computer science. These included, for example, the development of packet-routing protocols: a task that has little to do with quantum physics itself, but requires that one takes into account the quantum nature of the underlying information carriers.

The need for professionals with a more varied skillset that includes, but is not limited to, quantum physics, has led to the creation of tailored degrees. "Industries want people with this ability to function effectively in an interdisciplinary team, because not everyone is going to have the same training or background when working in quantum tech. We think that this has benefits for the research field as well," explains Peter Turner, director of the Quantum Engineering Centre for Doctoral Training at the University of Bristol, UK: "For the students, even the exposure to the questions posed by these engineering challenges makes a big difference."

The first cohort of Bristol-trained quantum engineers started their doctoral course in 2014, and several similar programmes have been set up around the same time elsewhere in the UK. Of course, the opportunities to obtain training that is well-suited to research in the world of quantum technologies don't stop at bespoke PhD programs or in the UK: aspiring quantum technologists can already choose between a quantum computing professional certificate from MIT, a Master in Science at QuTech Academy Delft or a junior quantum engineer program hosted by Rigetti computing. No doubt many other courses will follow.

Although there are plenty of reasons to celebrate these working and learning possibilities, as often happens in the presence of large-scale changes driven by massive investments, eyebrows have also been raised. It's not uncommon to encounter, half-whispered at conferences, that inevitable scepticism born out of the concern that sizable commercial interests may somehow compromise the purity of the fundamental scientific endeavour. Moreover, there is also the danger that the industry's potential better remuneration and career opportunities may start to systematically siphon the most brilliant students away from academic quantum research. After all, choosing industry over academia no longer requires a step away from the quantum world.

Regardless of how one feels about the rapid expansion of this industry, it's fair to say that the mixture of excitement and investment in the quantum technologies industry seems to be all to the students' advantage. Graduates now have access to a growing quantum-focused job market that provides concrete alternatives to an academic career — a possibility that was not always available to their older colleagues. ❐

Published online: 6 April 2018
https://doi.org/10.1038/s41567-018-0125-9

References

1. Kelly, J. A Preview of Bristlecone, Google's new quantum processor. *Google Research Blog* (5 March 2018); http://go.nature.com/2IKWLIo
2. *Nat. Phys.* **11**, 89 (2015).
3. https://www.q2b.us/