Opinion **Quantum technologies**

Fun facts about quantum computing

Our writer sets out to understand the mysterious technology. Here is what he learnt

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Inside a Bluefors quantum chip cooler at University College London

Jonathan Margolis OCTOBER 17, 2018

I have been trying to educate myself about quantum computing. I read plenty about what it offers — computers millions of times more powerful than those we have now; work that previously took years will be done in minutes, and so on.

But my knowledge went little beyond the fact that quantum computing exploits quantum mechanics. And I could not have explained what that really means if I were asked at a dinner party.

So in a quest to improve my understanding I visited two quantum computing experts at the Technical University of Delft's QuTech department: Jim Clarke, director of quantum hardware at Intel, which has a facility there, and Lieven Vandersypen, a leading quantum nanoscientist.

Explainer: how does quantum differ from conventional computing?

Instead of "bits" being a binary 1 or 0, quantum's hallmark means bits can be in a state — or

> "superposition" — of on, off or in-between all at the same time.
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> The building block — the bit — of a quantum chip is called a qubit. It is not really electronic. "Transistors work on a stream of electrons, whereas these work with a single electron spinning about in the qubit," says Jim Clarke, director of quantum hardware at Intel.
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> But they are powerful. "With 50 qubits you can solve problems beyond the fastest super computers today," says Professor John Morton of University College London. "With 300, you would have more states than there are atoms in the universe."
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> Quantum computing is largely abstract and theoretical and, despite tens of thousands of researchers working on it, it will not be in use for at least a decade. When it is, it will be in areas such as computer modelling and large-scale logistics.

I also went to University College London's Centre for Nanotechnology to meet John Morton, an authority on nanoelectronics and nanophotonics.

The result: I am a little clearer about how quantum computing works — and have discovered some fascinating facts for use at dinner parties. Here is some of what I learnt:

- Quantum computing can be imprecise. In some ways it imitates nature and, like the human brain, it can be illogical and make mistakes. But this can also be a strength — brute logic is not always right.
- Quantum computing may not be great for analysing big data as we now produce it. "Classical" computing — using the machines invented by Alan Turing and their descendants — remains better at that. But quantum computers may struggle with big data from conventional computers. It is almost as if they are different species.
- Quantum chips only work at temperatures typically 100th of a degree above absolute zero — far lower than outer space. BlueFors, a Helsinki start-up, makes the "dilution refrigerators" needed to build a quantum computer. It sells three units a week, at a cost of between €200,000 and €500,000 each, an indicator of the scale of the global scramble for quantum computing.
- There are several competitor quantum qubits in development. Intel's palm-sized chip has 49 "superconducting" qubits, but Professor Vandersypen also has a silicon-based "spin qubit", which is small enough for hundreds of millions of them to be crowded on to a centimetre-square chip. Oh, and according to the professor, spin qubits have individual personalities, which perhaps takes quantum weirdness almost too far.
- Microsoft's qubit-in-development is reportedly based on a particle so elusive that some believe it does not exist, which is also quite weird.

- In 2020 TU Delft plans to show a working demonstration of quantum internet — distributing around the Netherlands uncrackably encrypted information using photons in fibre optics, which will utilise quantum entanglement — Albert Einstein's "spooky action at a distance".
- One of the first applications of quantum will be in materials modelling — not as dry as it sounds. Your iPhone 27 may not be a quantum computer, but its battery may be designed by one.
- Some argue that quantum computing will ruin blockchain by being able to decrypt everything. But Professor Morton says this would require quantum computers with hundreds of millions of qubits. And quantum resistant encryption is also a major research focus today.

I could go on.

I also learnt that quantum computing is not without problems. We are not going to see it in use for at least a decade. Almost nobody reading this will live to have one in their home, or carry one in their pocket. And even people working in quantum computing admit it may not work out. Other advanced concepts are being developed that could consign quantum to being the Betamax of computing.

More worrying is that very few people understand quantum computing and that could give great power to those who do. Most have never even heard of it. Justin Trudeau's ability to give a credible, off-the-cuff explanation at a science event in Ontario probably makes him unique among politicians.

Science is getting more complicated and real understanding of things to come is increasingly limited to elites. The geek may truly inherit the earth.

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