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Ned Allen: the man who took quantum computing into the real world

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This is a non-technical and personal perspective on the history of the evolution of quantum computing from a purely academic discipline to a global race to build the first commercially viable quantum computer. It focuses on explaining the relatively unknown but vital and foundational role Ned Allen played in kickstarting this transformation.

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The good news: Left and Right do agree on something. I'm referring to the quantum realm – a world typically smaller than a bacterium where the rules of Newtonian physics go out the window. It's an ultracold world where electrons are particles with wavelike properties that occupy many states at once, thanks to the quantum superposition principle.

It's a world that, if properly controlled, will allow devices to solve certain problems of growing size in a time exponentially shorter than the greatest supercomputers ever built. The quantum computer.

In December 2018, the $1.25 billion National Quantum Initiative was signed into law in a rare show of bipartisan support. Why have both Blue and Red joined together on this one issue?

Part of it is fear. Quantum computers have the potential to break what were thought to be unbreakable codes – those that shield our bank accounts, power grids, corporate and state secrets, the data that powers our world. On the flip side, we also know how to use quantum encryption to make truly unbreakable codes.

But the most thrilling potential for quantum information processing is to answer some of the toughest computational problems facing the world today.

Problems that might take classical computers the age of the universe to answer. Can millions of potential drug therapies be efficiently simulated before they are submitted for clinical trials? Which materials become superconductors at room temperature so that we may build truly frictionless transportation systems? What molecules will create the solar panels that will make the sun our chief energy source? Can new types of elementary particles be predicted by simulating the complicated equations of nuclear physics?

To be clear, this is not science fiction. The age of commercial quantum computers is already here, even if it is still in a state of relative infancy. I would like to share with you the story of the person whom I hold most responsible for the remarkable transition of quantum computing from academic obscurity to special purpose acquisition companies (SPACs).

In 2010 – a time when the number of quantum computing companies could literally be counted on the fingers of one hand – Ned Allen walked into my office at USC. He introduced himself as the chief scientist of Lockheed Martin, a rather large defense contractor. Ned had a fiendishly hard multi-billion-dollar problem. As it turns out, Lockheed was spending a significant fraction of the F-35 jet fighter budget searching for bugs in millions of lines of code, a problem called verification and validation ("V & V"). All sophisticated hardware, from a Tesla to a MacBook, has lots of code. When an operating system fails, it's a minor annoyance. But when a F-35 Joint Strike Fighter has software bugs, it's mission critical.

I wasn't particularly interested in jet fighters. But I was intrigued by the general problem of how to ensure a computer program is bug-free, and I reasoned that quantum computers might someday be able to help if we could cast the problem in terms of machine learning or optimization. Ned was looking for a radical solution and wanted to know if somewhere, someone had already built a quantum computer that might be able to help. At the time, quantum computers weren't for sale, anywhere. Academic labs were tinkering with a few qubits each, and nobody had built a system that was even remotely up to the task in which Ned was interested. I told Ned I didn't think quantum computing was his panacea, but that a Canadian company, D-Wave, promised "the world's first commercially available quantum computer." To me, this seemed like a great research opportunity. I wanted to know whether D-Wave's pitch would stand up to rigorous scrutiny. To Ned, it seemed like a steppingstone to making quantum computing a solution to his problem, and perhaps much, much more.

This led, thanks to Ned's awesome powers of persuasion and boundless enthusiasm, to the first-ever sale of a commercial quantum computing system, the D-Wave quantum annealer. It led simultaneously to the creation in 2011 of the USC Lockheed Martin Quantum Computing Center (QCC), the first (and so far, only) university-based research center to physically house a commercial quantum computer [1,2,3]. The QCC has since been home to four generations of D-Wave quantum annealers and has made significant contributions to our understanding of the power of quantum annealing.

Two years after the establishment of the QCC, Google purchased the second D-Wave quantum annealer and placed it at NASA Ames [3]. I was told at the time by the founders of Google's Quantum Artificial Intelligence lab that this would likely not have happened without the USC-Lockheed precedent. Los Alamos National Lab followed suit in 2016 [3].

It was Ned's vision and energy that set the wheels in motion. He saw the potential for taking quantum computing out of the lab and into the real world, where it would be tested against demanding and urgent applications. Without its quantum annealing experimentation, Google might have delayed its entry into quantum computing, IBM might not have felt the same pressure to commercialize its quantum efforts, and the whole quantum snowball might have been postponed by many years. Ned ignited the fire behind these developments.

Today, there are many other established companies and dozens of startups in this space that are working to build general purpose quantum computers. Quantum computing cloud services are proliferating. These efforts aren't limited to the U.S. or Canada: China, Japan, the European Union, Russia, and Australia, among others, all have robust quantum computing efforts, with many companies and nations vying to build the first truly useful quantum computer.

Quantum computing of course has its skeptics. Some claim quantum computers will never work, but often for the wrong reasons, such as ignoring the power of quantum error correction by equating QCs with analog devices. Quantum computing researchers have figured out clever ways to overcome such objections. One day, when quantum computer components cross a reliability threshold, quantum error correction will – at least in theory – allow quantum computing to scale up indefinitely.

To be clear, the era of "practical quantum advantage" is still an unknown number of years away. This is the point at which a quantum computer has the edge in a real-world application over the classical computers of tomorrow. Meanwhile, the global quantum computing race is on, and while there is no clear frontrunner yet, the first to cross the threshold of solving a practical problem that no classical computer can solve faster, stands to win a truly grand prize, and make history.

Ned Allen played a pivotal, foundational role in this turn of events. I hope that recounting this story here will help cement his legacy.

REFERENCES

[1] R. Perkins, Operational Quantum Computing Center Established at USC, Oct. 29, 2011. https://viterbi.usc.edu/news/news/2011/operational-quantum-computing334119.htm

[2] USC-Lockheed Martin Quantum Computing Center. https://en.wikipedia.org/wiki/USC-Lockheed_Martin_Quantum_Computing_Center

[3] D-Wave Customers. https://dwavefederal.com/customers/