# King Quantum

*Geordie Rose wants to change the world through quantum computing—and beat IBM to it.*

BY ROBERTA STALEY The first thing you notice about Geordie Rose are his Colin Farrell eyebrows—then his tree-trunk chest and shoulders, testimony to 12 years of freestyle wrestling, notching up national medals year after year. His "signature move" during a stellar career, Rose says, wagging his bristling brows in a way that hints he may, or may not, be serious, was the "Greco-Roman eye pinch."

The 32-year-old has since exchanged pinning his opponents for spiking meteors during beach volleyball competitions at Kits Beach. But underneath his surfer dude appeal, Rose has geek cachet; he's an engineer with a PhD in theoretical physics from the University of British Columbia. He's also the CEO and president of D-Wave Systems in Vancouver, the only privately owned company in the world devoted exclusively to creating a quantum computer for commercial purposes.

Its head office, home to a clutch of quantum theorists, each bursting with complex equations and calculations, is located in a squat beige building on West Broadway, kitty-corner to a liquor and grocery store. "We want to be the Manhattan Project of quantum computing," says Rose.

And so he's pitted his company against scientific and corporate leviathans such as Microsoft, Lucent Technologies and IBM in the United States, as well as top universities including MIT, Stanford and Oxford, all of whom are racing to create a viable, functioning quantum computer.

Rose's signature moves in this latest Olympian endeavour? A locker-room-honed, one-of-the-guys affability, and a knack for making a mind-boggling technology comprehensible to hoi polloi.

Speaking of such, what is it that Rose is selling? What exactly is a quantum computer and why are such big guns pursuing it so fiercely?

WITH QUANTUM COMPUTERS, THE devil, indeed, is in the details, in nature's Lilliputians—atoms and subatomic particles—which exist not as solid objects but as waves, particles or even probabilities.

Today's computers operate using silicon chips, which store information as tidy strings of ones and zeros—switches that are either on or off. But the laws of quantum physics dictate that particles can be in more than one state at a time—on *and* off, in essence—which would allow a quantum computer to hold

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A wrestler and an engineer, Rose is using his salesmanship and personal charm to take on the big boys in the scientific race of the century.

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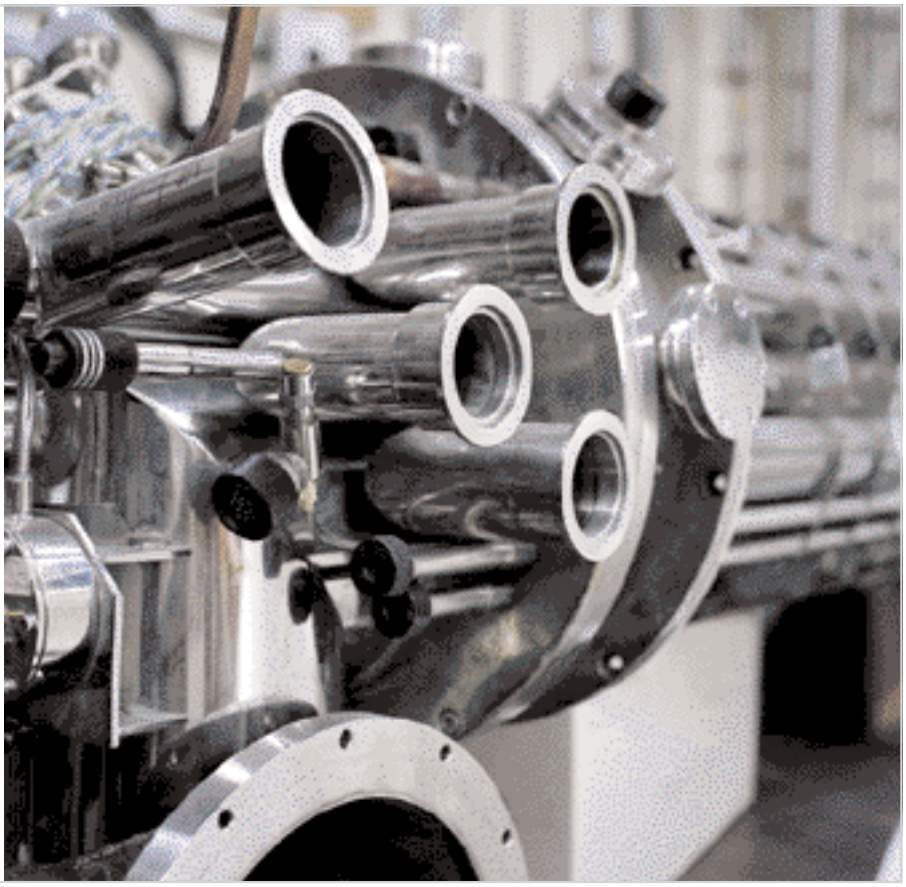
and manipulate much more information, using particles called qubits.

But this is more than just slapping together a few qubits and putting them in a nice plastic case: "When you make a machine out of electrons...the machines don't operate at all like what we're used to," says Rose.

Unfortunately, for scientists, atoms and photons in a quantum state have an unbearable lightness of being. Unless isolated from outside disturbances such as light, they lose the quantum properties that allow them to exist in several states simultaneously.

Building a quantum computer is, says Rose, "the hardest engineering project that has ever been attempted in the history of man."

THE MOST RESPECTED SCIENTISTS IN THE FIELD concur. Isaac L. Chuang, an associate professor at MIT, led a team several years ago that created—out of a single molecule—a seven-qubit quantum computer that was able



D-Wave's gear: building a quantum computer is "the hardest engineering project ever attempted."

to execute a simple mathematical calculation. (D-Wave's stable of about 20 collaborators, scattered around the globe in research and university laboratories, have so far only managed to create a two-qubit computer.)

Chuang's experiment, conducted at IBM's Almaden Research Center in Silicon Valley, has still not been matched by other researchers. However, even it is as far removed from a working machine as Leonardo Da Vinci's sketch of a primitive helicopter is to a modern chopper. "Now," says Chuang, "we have the challenge of turning quantum computation into an engineering reality."

D-WAVE, FOR ITS PART, IS FOCUSSED UPON creating quantum computer hardware that will simulate molecules, the building blocks of all matter—virus, bacterium, chemical, plant, animal or mineral—and then have them interact with other molecules. During the simulations, the molecule models would act exactly as they would in real life, thanks to the power of quantum computing. With such software, experiments mixing millions of different substances could be simulated breathtakingly quickly and with precise results on a quantum computer—rather than in a laboratory. Flasks, test tubes and microscopes would become dusty relics. All the myriad experiments currently being carried out—laboriously, by scientists all over the world—experiments that might determine the effect of a drug on cancer cells, for example, could be done in a fleeting moment on a quantum computer.

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Rose sees his technology as a step in eradication of disease. It is this objective—lofty as achieving world peace—that inspires many to back D-Wave when logic dictates that such a small company will be, at best, a straggler against the world's keenest brains and their portly R&D piggy banks.

THERE IS STILL SOME QUESTION, HOWEVER, about whether creating a working quantum computer is within the realm of possibility. Microsoft Research (MSR) senior researcher Christian Borgs points to the fragility of a computer that runs using molecules, saying the system would likely require elaborate error correction, which may, or may not, ever be practical.

Turning theory into reality is feasible if done one baby step at a time, says Rose, who often arrives at D-Wave meetings rumpled and jet-lagged from yet another trip to the U.S. or Europe to meet investors and the diaspora of collaborators who work in laboratories throughout Europe. He and other D-Wave executives discuss what bright lights to hire, and where and how to access new sources of revenue—private, government or venture capital—for ongoing

research. D-Wave's credibility and standing in the scientific community, necessary for wooing new investors, is maintained by publishing their latest discoveries in science journals and pursuing patents to protect intellectual property, which is key to financing. (D-Wave has 14 American patents, while another 40 are pending.)

It hasn't been easy. Since its incorporation five years ago, the company has survived on about $20 million; Rose is optimistic he can raise $100 million over the next few years. (A financial coup, last year, was investment by venture capital firm Draper Fisher Jurvetson of California. D-Wave is the first Canadian company DFJ has ever invested in.)

When compared to the plump coffers of other high-tech corporations, D-Wave's budgets seem chump change. IBM has annual R&D expenditures of $5.5 billion, Microsoft $6.8 billion. (Spokespersons couldn't say what percentage is specifically allotted to quantum computer research.) But Rose, who still remains as competitive as in his Greco-Roman wrestling heyday, isn't daunted by such corporate brawn. D-Wave is second rate to no one, says Rose.

Such faith, apparently, can beget faith. "Rose's absolute faith in the science is magnetic," says Bob Wiens, who admits going 16 months without a pay cheque after becoming the company's CFO early in 2002. Rose, too, has foregone pay, as have many of D-Wave's researchers at various times. "Twice in my first year here I loaned the company a quarter million dollars so it could meet its payroll," says Wiens, a former managing partner at the accounting firm of Arthur Andersen in Vancouver.

The reason for shelling out? "Quantum computers will absolutely turn the world on its ear," Wiens says.

Of course, they said that about cold fusion too, once touted as the energy source of the future but eventually dismissed as a pipe dream. And that's not even to mention the tiny size of D-Wave compared to its competitors.

Still, history shows us that monumental scientific breakthroughs, such as the discovery of penicillin or the double helix, can come either from one person or a tiny collaboration of individuals. "The thing with science is that brilliance overcomes numbers," says Rose. "If you have one

great scientist who is a genius and is a master at using experimental equipment, that cannot be beaten by numbers. Developing a quantum computer requires insights and creative jumps, and those things are trapped within a very few brains on this planet."

ROSE ISN'T SUGGESTING D-WAVE WILL UNVEIL a quantum computer, a fait d'accompli, ready to place on someone's desk. Rather he is focussed upon incremental breakthroughs that will help advance the technology and prove to investors that the company is healthy, viable, credible and worthy of continued financing. D-Wave's discovery of a system for moving information in and out of a qubit, which appeared last August in the highly respected physics journal *Physical Review Letters*, "isn't sexy," says Rose, but is one such example.

Maybe someday D-Wave will have its eureka moment. D-Wave co-founder, Ukrainian quantum physicist Alexandre Zagoskin, firmly believes it will happen; he predicts that the company will trot out a commercially viable quantum computer in five years. (IBM, on the other hand, predicts a working quantum computer won't be ready until 2020.)

As the long shot in a field of well-financed thoroughbreds, eureka would indeed taste sweet. But there are many things that could happen until that moment comes. For instance, can D-Wave resist selling out to a bigger company like IBM if the price were right?

Rose insists, rather gruffly, that is unlikely. "We are not building this company to position it solely for an acquisition. What I really want is a company that can make product, make a lot of money and make things better for people in some real way."

The key to this achievement, Rose continues, is finding "a very small group of brilliant folks and give them all the things they need to succeed in building this type of technology." This includes, he adds, bringing such lofty intellects together under one roof in Vancouver.

But until that happens, Rose continues to believe in himself and his company. If there is one thing the wrestler has learned, it's that if you don't believe in yourself, no one else will.