GLOBAL DREAMS, REALISED IN CANADA

From organs-on-chips to quantum simulation of molecules, University of Toronto scientists are PUSHING TECHNOLOGICAL BOUNDARIES.

Everyone else seemed satisfied, but Milica Radisic was not. Radisic, a professor of biomedical engineering and chemical engineering, had asked pharmaceutical researchers how sure their companies usually were of a drug's safety before testing it on patients with heart disorders. The answer was not reassuring: just 75-95% sure.

"In engineering, that's a very low number," Radisic says. "In school they teach us your safety factor has to be at least 100%." Meanwhile, 800,000 patients were having heart attacks in North America each year, and new drugs for cardiac disorders were urgently needed.

To hasten drug development, companies needed more reliable testbeds for cardiac drugs. Radisic focused on building organs on chips — microfluidic tissue-culture devices that reproduce the physiology of living human organs. To create a heart on a chip, she needed a talented team with expertise in physiology, stem cell biology and bioengineering, and she needed advanced microfabrication facilities. She found what she was looking for at the University of Toronto.

Founded by royal charter in 1827, the University of Toronto is now a global destination for researchers seeking to propel their careers. The grand St. George campus has an illustrious history, which includes the discovery of insulin, but today scientists are drawn to the university largely because of its resources. Its three campuses house more than 44 libraries with more than 19 million physical volumes and close to six million electronic ones.

Researchers have access to world-class facilities including the Ted Rogers Centre for Heart Research, Medicine by Design, the Donnelly Centre for Cellular and Biomolecular Research, and the Vector Institute for Artificial Intelligence.

"There are thousands of scientists all in one place, and access to an almost unlimited talent pool," Radisic says. The infrastructure for science is excellent, and Toronto's central location is a hub for flights to Europe and the West Coast of North America, she adds. "In Toronto, my imagination , and time, were the only limitations."

A QUANTUM LEAP

The University of Toronto's talent pool was also a draw for Alán Aspuru-Guzik. The University consistently stands among the top five in the world for research output, along with Harvard and Stanford. Aspuru-Guzik was a professor of chemistry at Harvard, investigating advanced materials for energy technologies to abate climate change. The United States had supported such research, but when Donald Trump was elected president, Aspuru-Guzik saw the writing on the wall. The next day, he called a colleague in Toronto, and before long he was on a plane to scope out the University.

"IN TORONTO, MY IMAGINATION WAS THE ONLY LIMITATION."

"The University of Toronto is one of the top research institutions on the planet," says Aspuru-Guzik, who is now a professor of both chemistry and computer science there. "It has strengths in many, many fields." What's more, Canada has not wavered in its commitment to climate change research. It co-leads the Materials Acceleration Platform, an international effort Aspuru-Guzik is deeply involved in, which aims to integrate artificial intelligence (AI) and high-throughput methods to develop advanced materials for clean energy technologies. "Canada is seriously addressing these challenges," he says. "That was a big draw."

Another draw was Canada's strength in quantum computing. Aspuru-Guzik's team also develops quantum computing algorithms to model chemicals and materials. "Molecules are quantum mechanical in nature, so quantum computing will simulate molecules exactly," he says. By contrast, classical silicon-based computers simulate them approximately. For this reason, quantum computing could dramatically speed development of new materials and chemicals.

Yet another research programme Aspuru-Guzik runs could accelerate discovery even more. In a March 2019 article in *Trends in Chemistry*, he and two colleagues described how a combination of robotic experimentation platforms and AI could create autonomous chemical laboratories. These self-driving laboratories would learn from outcomes of previous experiments, design better ones, and conduct them in an iterative loop to derive new chemicals and materials with the properties needed for particular applications.

Like many ambitious scientists, Aspuru-Guzik and Radisic have launched companies to commercialize their inventions, and both have found the University of Toronto and the city itself a welcoming place for entrepreneurs. Radisic cofounded TARA Biosystems to commercialize her Biowire heart-on-a-chip technology,

CHRIS SORENSEN, U OF T NEWS

Chemist Alán Aspuru-Guzik is using quantum computing and AI to model materials.

Milica Radisic, a biomedical and chemical engineer, builds organs on chips.

NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL OF CANADA

SCHWARTZ REISMAN INNOVATION CENTRE RENDERING PROVIDED BY WEISS/MANFREDI

The Schwartz Reisman Innovation Centre, soon to be built at U of T, will anchor Canada's largest cluster of artificial intelligence and biomedical experts and U of T's world-class entrepreneurship network.

which could help pharmaceutical companies better predict which new cardiac drugs will be safe and effective. Aspuru-Guzik's two Boston-based start-ups, the quantum-computing company Zapata Computing and Kebotix, which is commercializing self-driving laboratory technology, will open offices in Toronto.

The university's community of entrepreneurs have created more than 500 companies that have collectively secured more than C$1 billion (US$750 million) in investments over the last decade. Ranked as Canada's most innovative university by Thomson Reuters, Toronto's strong innovation and entrepreneurship network supports ten incubators. These help develop startups in disciplines from med tech to clean tech, AI to energy, blockchain to fintech and more. "You're walking around on campus and you see different types of incubation programmes," Aspuru-Guzik says. "The university has this kind of spirit. It's like a magnet, making the city a more entrepreneurial place."

Entrepreneurial places attract entrepreneurial researchers and Aspuru-Guzik hopes that his quantum chemistry and materials research could point the way to more efficient solar panels, better energy storage for renewable electricity, improved antibiotics, and better water filtration. "My goal is to provide scientists with methods to find solutions to problems of the 21st century."■

UNIVERSITY OF TORONTO