CITIES

The Invention of Waterloo

Canada's Technology Triangle has spawned more than 450 high-tech companies, including BlackBerry pioneer Research in Motion. But it didn't just happen: an upstart university had the brains to embrace mathematics

BY DON GILLMOR
PHOTOGRAPHY BY JAIME HOGGE

IN THE SURFACE, Canada's Technology Triangle — comprising the twin cities of Waterloo and Kitchener, Ontario, and Cambridge to the immediate south — reflects the development Richard Florida described in his 2002 bestseller, *The Rise of the Creative Class*. In 2007, Waterloo, with a population of roughly 120,000, was named Intelligent Community of the Year by the Intelligent Community Forum, which cited the region's 334 technology companies (now listed as more than 450), its post-secondary institutions (the University of Waterloo, Wilfrid Laurier University, and Conestoga College), the co-operation between business and academia, and the high levels of philanthropy and local reinvestment.

The Waterloo region's evolution followed a familiar North American pattern. It started as an agricultural community, grew into an industrial base and urban hub, achieved rapid expansion (in 1965, Kitchener was the fastest-growing city in Canada), then watched as its industries died and the downtowns hollowed out. The area started with gristmills, and proceeded through tanneries, breweries, television plants, and shoe factories, most of them gone now. Waterloo has been named both the Button Capital and the Rubber Capital. But the city lost manufacturing jobs to offshore concerns, to economic and cultural shifts, and to the rise of the Canadian dollar. Unlike hundreds of similar cities that dot America's Rust Belt, though, Waterloo went on to flourish.

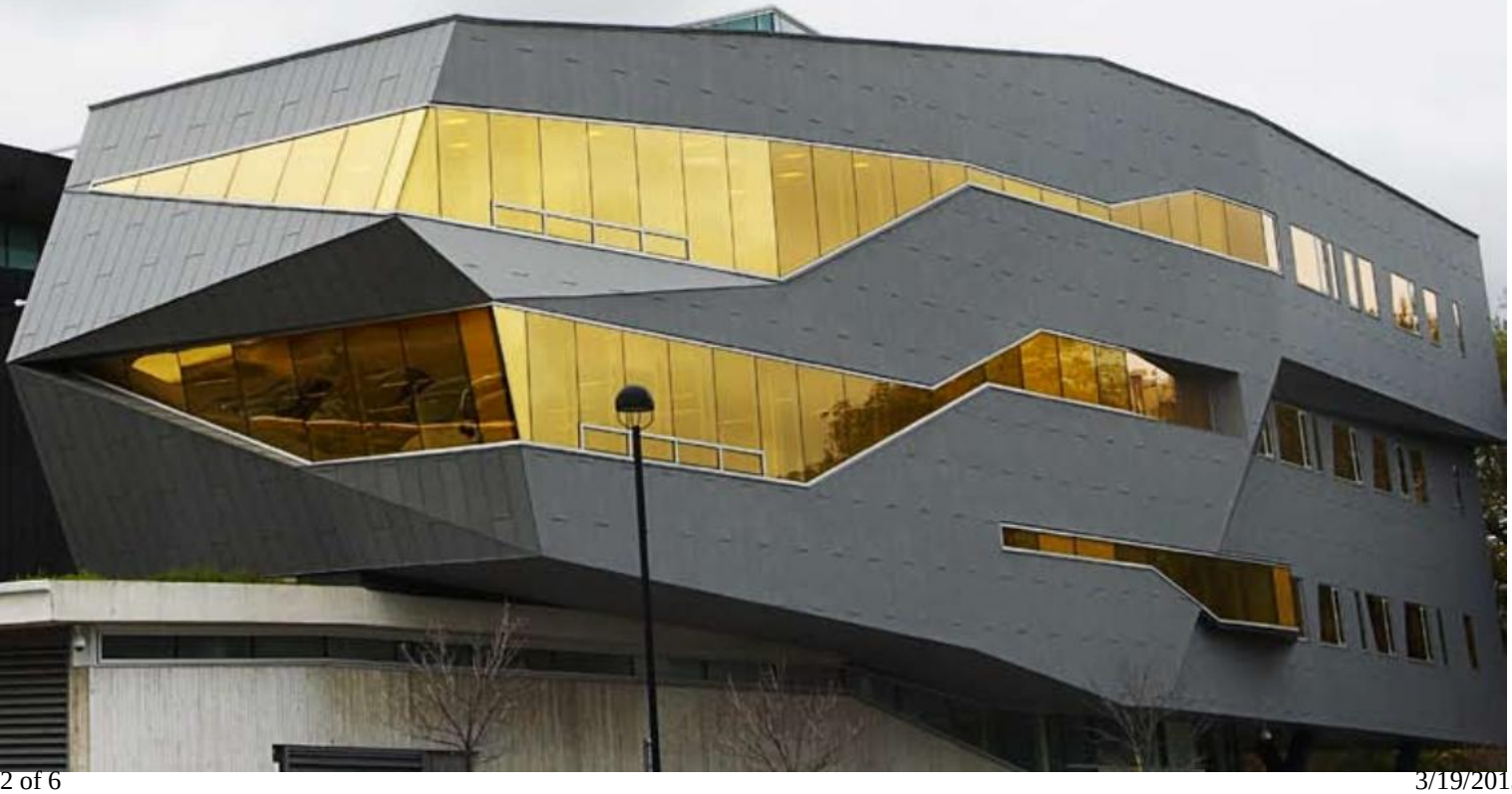
Part of this has to do with the region's curious historical combination of conservatism and entrepreneurial spirit, its ability to adapt to new industries as old ones die. Manufacturing remains the largest employer, but it also registered the largest sector decline between 2001 and 2006. The technology sector, while smaller, is the fastest growing.

Technology is viewed as the holy grail of modern economies. It brings in jobs and money; it brings the future. A lot of energy is spent attracting it, growing it, and nurturing it, with varying degrees of success. Waterloo's tech sector is often equated with BlackBerry pioneer Research in Motion, which has its headquarters there. The two are viewed in lockstep, the way General Motors was linked to Flint, Michigan. But, in fact, Waterloo's technology boom began more than fifty years ago, and at the centre of it stood the University of Waterloo.

THE UNIVERSITY was established in 1957 by two local businessmen. One of them was Gerry Hagey, a public relations man for the B.F. Goodrich tire company who became the university's first president. UW's initial focus was on producing actuaries for the local insurance companies, and engineers to accommodate the postwar industrial boom. Hagey implemented a co-op program that had engineering students enter the workforce for four months of the year while they earned their degrees, a course of study that began in the early '60s and eventually expanded to other disciplines at UW. He had seen versions of the program in the US and thought it would work at UW. But the university was just getting started, and the curriculum was greeted with disdain by established institutions. At the time, a deep sense of distrust existed between industry and academia: universities considered industry a crude, bottom line culture, while industry found academics irrelevant and out of touch. Both groups had a case, and Hagey thought each would benefit from exposure to the other.

Most Canadian universities began with either a religious affiliation or an emphasis on the humanities. The University of Waterloo began with engineering, mathematics, and science, at a time when these weren't especially prized. In the early '60s, math (like philosophy and English literature) was studied by people who loved the discipline; it had little practical application other than teaching like-minded thinkers who came afterward. But the head of the math department, Ralph Stanton, had the vision to see that his field would become increasingly integral to modern life. He had written a textbook on numerical analysis, a branch of mathematics that is closely aligned to computing. In 1960, the university established its Computing Centre, and suddenly math had a practical application. The department grew so quickly it was expanded in 1967 into a separate faculty, the first in North America.

At this point, computers were still mostly bungalow-sized machines that sat in large, locked, heavily cooled rooms. The centre was run by Wes Graham, who was innovative in letting undergraduates use the equipment. IBM credited him with democratizing what was still an esoteric and largely elitist world, and he eventually received the Order of Canada for his contribution to computer science. Given access to the machines, students responded by designing early computer languages (WATFOR and WATFIV) that were later adopted by universities around



the world, including the Massachusetts Institute of Technology. He also formed a campus group to distribute the software, and that evolved into a computing company, Watcom, the first of many to be spun out of the university.

By 1984, UW claimed one of the world's largest computer science programs. At the time, universities were among the biggest markets for computers, and manufacturers courted them heavily, assuming students would end up buying whatever they had used at school. IBM was the giant then, and it offered computers to universities at 80 percent discounts. Digital Electronic Corporation, an IBM competitor, upped the ante in 1984 by giving UW $25 million worth of equipment, further expanding students' access.

The school continued to develop its science and technology base through several proactive presidents, including Doug Wright, who served from 1981 to 1993 and had been with the engineering department since the beginning. He and another engineering professor initiated a policy whereby students and staff retained the intellectual rights to whatever they developed. This turned out to be a critical decision. Some universities (Stanford, the midwife to Silicon Valley, being the notable example) follow the same policy, but others (like the University of Toronto and Harvard) retain some intellectual rights. However, Wright says, schools that give up patent rights tend to gain more net benefit than those that don't. The practice creates incentive, and there's little downside, as a single patent isn't much use. "You need an armload to open a business," he says. The arrangement also helps foster a symbiotic relationship between the outside world and the school; UW has spawned more than 250 science and tech companies.

OpenText turned out to be one of the most important. In 1984, UW secured a contract from Oxford University Press to computerize the *Oxford English Dictionary*. Wright received a letter from a British friend who had noted the approaching end of the *OED*'s copyright and was looking into digitizing the twenty volumes. "The publisher realized that the technology was very important," Wright told me, "and that English was becoming the international language for business and technology." He went to England and met with IT personnel at Oxford University Press, and said UW had the expertise to take the *OED* into the digital age. No one had heard of Waterloo, and there wasn't much enthusiasm for using a Canadian university. Back home, the tech people at UW were equally unenthusiastic. They had no interest in the seminal dictionary, and were unconvinced the project would be a worthwhile exploration of computer science.

It turned out otherwise. Through Wright's efforts, the university won the contract (beating out IBM and Lockheed, among others), though it took months of convincing on both sides. But the search technologies UW developed led to the founding of OpenText, which went on to become Canada's largest software company, with 4,400 employees. Those search technologies were later adapted by Yahoo!, giving it the ability to search every word on every Web page.

That same year, Mike Lazaridis, a UW engineering student who had grown up in Waterloo, asked Wright if he could leave the program to pursue his business interests; he felt he could always return and finish his degree. As president, Wright officially counselled him to finish but privately offered encouragement for his business plan. In March 1984, Lazaridis, along with a childhood friend, Douglas Fregin, incorporated Research in Motion.

RIM grew into a multibillion-dollar tech powerhouse, bringing highly paid employees (estimated at between 7,000 and 8,000) to the area, and fostering a strong relationship with UW, where it has found many recruits. Equally important was how the executives chose to spend their new wealth. Lazaridis has given $170 million of his own money to establish the Perimeter Institute for Theoretical Physics. The idea behind Perimeter was to create an environment for the world's leading physicists to pursue super string theory or inflation theory, or to figure out what exactly banged during the big bang, with no commercial pressures—though, as Lazaridis pointed out to the institute's first director, Howard Burton, the BlackBerry was essentially based on nineteenth-century physics. "Imagine," Lazaridis said, "what we could do with twentieth-century physics or twenty-first-century physics."

While Lazaridis was trying to reconcile the fundamental laws of nature, his co-CEO, Jim Balsillie, decided to address world politics and government. In 2001, he donated $20 million to establish the Centre for International Governance Innovation in Waterloo. In 2009, he gave $50 million to UW, nearby Wilfrid Laurier University, and CIGI, as part of an initiative to found the Balsillie School of International Affairs.

CIGI is housed in what was once Seagram's barrel warehouse for aging whisky. The building was erected in 1857, and in 1928 Joseph Seagram sold it to Sam Bronfman. When Prohibition was repealed in the US in 1933, profits soared and Seagram's became the world's largest distiller, with Waterloo a prominent centre of its operations. In its heyday, Seagram's employed

PREVIOUS SPREAD The Perimeter Institute for Theoretical Physics in Waterloo. RIGHT The University of Waterloo's Institute for Quantum Computing; and one of its mobile units.

250 people. But Sam's sons watched the distillery business fade in the '70s, as people turned away from whisky and vodka in favour of wine. By the '80s, the industry was in decline. Edgar Bronfman Jr. decided to get out of the business, and Seagram's closed its doors in 1992. Edgar went on to embrace the creative class, buying into media and entertainment, and lost much of the family fortune in his bet on Vivendi Universal. Not all creative classes are created equal.

Now the site has been effectively repurposed, the new economy replacing the old. Two of the beautiful old stone Seagram's buildings were converted into condos, CIGI occupies the barrel house, and the ambitious Balsillie campus is slated to be built adjacent to it. When finished, the complex will cover the entire block.

In 2002, Lazaridis followed the Perimeter Institute with the Institute for Quantum Computing, to which he contributed $100 million. It will be housed in the newly built Mike and Ophelia Lazaridis Quantum-Nano Centre on the UW campus, to facilitate interaction with the mathematics and engineering faculties. The centre is an extension of Lazaridis' interest in physics and is devoted to pure science, but it, too, holds out the possibility of commercial revolution. Classical computers, as they are called by quantum physicists, use silicon chips to facilitate calculations. These chips have grown smaller and faster, but even the fastest classical computer only performs one calculation at a time. Rather than silicon chips, quantum computers use quantum particles, such as atoms, and the advantage is that they can make many calculations simultaneously. For simple problems, the difference is minor, but for certain complex ones the gains will be extraordinary. It will cause a revolution in security, for one thing. "Quantum computing," the institute's website reads, "has the potential to revitalize a host of existing technologies and generate new ones, to open new windows on the nature and origin of the universe, and to change the way we think about information and reality itself." This, the site states, is the beginning of an Alice in Wonderland parallel universe era, where cats can be both dead and alive at the same time. And where Scotty could, perhaps, beam you up.

MOST CANADIAN UNIVERSITIES BEGAN WITH A RELIGIOUS AFFILIATION OR AN EMPHASIS ON THE HUMANITIES. WATERLOO BEGAN WITH ENGINEERING, MATH, AND SCIENCE. IN 1960, IT ESTABLISHED ITS COMPUTING CENTRE. IN 1967, THE MATH DEPARTMENT WAS EXPANDED INTO A SEPARATE FACULTY, THE FIRST IN NORTH AMERICA.

Ray Laflamme, executive director of the Institute for Quantum Computing, is a lithe, athletic man originally from Quebec, and a former protege of Stephen Hawking. He convinced Hawking that in a contracting universe, time wouldn't run in reverse, and he has been a world pioneer in quantum information. Waterloo has a twelve-qubit (an amalgam of "quantum" and "bit") quantum computer, the world's largest, and Laflamme showed it to me.

The future is housed in what looks like a RadioShack storeroom, with steel shelves holding generic-looking electronics. The computer—a large canister with wires coming out of the top, surrounded by a knotty pine fence—resembles a moonshine still. Extremely sensitive to noise, light, and vibration, quantum computers are cumbersome and touchy. Using atoms to perform calculations is like asking a large class of extremely gifted kids who all suffer from separate conditions (peanut allergies, paranoia, passive-aggressive tendencies) to tackle a problem collectively. A fifty-qubit computer would be as powerful as the largest existing supercomputer. A 1,000-qubit quantum computer could solve in a few days complex problems that all the world's supercomputers combined could not. "With quantum mechanics," Laflamme says, "we are learning how to speak the language of atoms and molecules. Before, we could look at the effects, but we could hardly control them. Now we have the right language, the right tools, the right methods of controlling them."

A commercial quantum computer isn't imminent, but when it does arrive, in ten or twenty (or fifty) years, Silicon Valley will be eclipsed by Quantum Valley, and Waterloo will be poised to capitalize on the moment. In part through Lazaridis and Balsillie, Waterloo has a focus that is both global and universal, and that looks to the future. But the local and the present are still where everyone lives, where Balsillie and Lazaridis live. What kind of city does the creative class create?

WATERLOO, LIKE HUNDREDS of other small North American cities, experienced a golden moment when its main street bustled, when its architecture was comforting brick, and its people were employed and churchgoing and filled with optimism. But this proved transitory; the city grew on the fringes, and the schools moved to the edges, followed by residential and commercial development. Big boxes stores sprouted on farmland, and the main street crumbled. Industry withered, jobs disappeared, and young people fled to the big city.

Walking down King Street, the historical artery that snakes southward through Waterloo and Kitchener, you see the usual signs of urban decay: tattoo parlours, second-hand stores, dollar stores, and that harbinger of poverty, the cheque-cashing outlet. These are leavened by hopeful restaurants, by ambitious architecture, such as Kitchener City Hall and UW's School of Pharmacy building, and by the successful repurposing of older industrial structures into other uses—shoe factories and distillery buildings converted into lofts, tanneries into retail and commercial space. At the corner of Erb and Caroline Streets stand three complexes that have won the Governor General's Medal in Architecture: the Perimeter Institute, the Canadian Clay and Glass Gallery, and CIGI. The city is recovering from the blight familiar to every urbanite.

"Fifteen years ago, the cores were in disrepair," says Rick Haldenby, director of UW's School of Architecture, as well as of the Centre for Core Area Research and Design, which looks at the particular challenges facing mid-size cities. "Kitchener was a basket case," he says. "When we started the mid-size centre, we focused completely on core area redevelopment and revitalization. In Kitchener, they tried to fix the problem by building two malls downtown. Both of them were disastrous. Waterloo built a suburban mall downtown, with parking around it." It looks pristine and bereft. The mall solution didn't work. Nineteen were built in small Ontario cities in the past two decades, and all of them failed. The faux suburban lost out to the true suburban.

"We need a far more integrated view of urban planning, a greater quantum approach," Haldenby says. Cities are essentially binary; they are arguments with themselves (rich versus poor, core versus suburbs, cars versus public transit). Caleb Rosado, a professor of urban studies at Eastern University in St. Davids, Pennsylvania, argues that quantum physics, with its holistic qualities, is the way to approach urban planning. "The erroneous prevailing world view limiting urban studies and urban transformation," he writes, "emerges from classical physics...Quantum physics with its non-dualistic approach to life provides an approach that will enable urban workers to literally think outside their prevailing paradigms...one that shifts thinking from fragmentation to wholeness."

Cities are already quantum, in the sense that everything happens at once: death, sex, final sales, zoning infractions, Starbucks, soul-destroying commutes. But they tend not to be holistic. The suburbs were created as a means of separation, to provide an oasis for the middle class away from the ills of the city. But now the world is about integration; from university disciplines to urban planning, the move is to link everything, to cross-pollinate.

Malls, which are hermetic and predatory, didn't work in the Technology Triangle. What did was introducing post-secondary schools into the core. The architecture school itself was a cure, or at least the beginning of one. Cambridge lured it away from the UW campus with the promise of money and a great building, a converted early twentieth-century former silk mill on the Grand River. A key donation came from the Musagetes Foundation, started by Michael Barnstijn and his wife, Louise MacCallum, both former RIM employees. A gifted software engineer, Barnstijn joined the company in 1985 and was rewarded with a 20 percent stake. He left in 1998, and his contribution to local culture forms another philanthropic ripple that extends outward from the RIM centre. Four hundred and fifty students attend the architecture school, and most live within walking distance. The number of residential units in downtown Cambridge has more than doubled since the school opened in 2004, and amenities have sprung up to service them, bringing life to the picturesque core.

Kitchener used the same approach as Cambridge to restore its downtown core, luring UW's pharmacy school to a prominent intersection. The building, a festive modernist box with images of leaves and flowers and medicinal herbs on the exterior, was designed by Hariri Pontarini Architects. In 2006, Wilfrid Laurier University located its Faculty of Social Work in downtown Kitchener.

In Waterloo, where civic life congregates mainly around the campuses, some research centres (Perimeter and CIGI) have moved off site. The point isn't just the effect of bringing students to the core, but the impact of the buildings themselves. Using architecture as a force for urban renewal isn't new, but it has been

IN CITIES, EVERYTHING HAPPENS AT ONCE: DEATH, SEX, FINAL SALES, ZONING INFRACTIONS, STARBUCKS, SOUL-DESTROYING COMMUTES. BUT CITIES TEND NOT TO BE HOLISTIC. THE SUBURBS ONCE PROVIDED AN OASIS FOR THE MIDDLE CLASS, AWAY FROM THE ILLS OF THE CITY. TODAY THE WORLD IS ABOUT INTEGRATION.

RIGHT Waterloo's Centre for International Governance Innovation, housed in a nineteenth-century Seagram's building; and its new, contemporary entrance.

bowdlerized by a wave of trophy projects that attract attention while neglecting the urban fabric. They provide fleeting interest but do little for city building, and in the worst cases look stranded, conveying the sense that the circus has left town.

One of the principal firms involved in Waterloo's physical renaissance is Toronto's Kuwabara Payne McKenna Blumberg Architects. Its relationship with the region began in 1989 when Bruce Kuwabara designed Kitchener City Hall, with a welcoming public square and a skating rink to provide an anchor on a street that was losing ground. The firm also did the Grand Valley women's prison outside Kitchener, an innovative and controversial experiment in changing behaviour through environment. The massive, 26,000-square-metre Quantum-Nano Centre, which will house the Institute for Quantum Computing, was designed by Marianne McKenna and Mitchell Hall of KPMB and is set to open in 2012.

Kuwabara and his partner Shirley Blumberg are now doing the Balsillie Campus, which is clustered around the old Seagram's building downtown. "Every building implies a city," Kuwabara says from the open boardroom of his Toronto offices. "If you put in big boxes, you imply suburban. But now the urban is being restored."

Today the world is about connectivity and sustainability, and KPMB designed the buildings to promote those qualities, connecting among different disciplines as well as between school and city.

One key to Waterloo's success has been the integration—economic, geographic, and cultural—between the universities and the city. Like the engineering and computer faculties, the architecture school is integrated into the community. "We are involved in almost everything," Rick Haldenby says, "every major committee in Cambridge, Kitchener, and Waterloo. We've advised on virtually every major development in the region." Kuwabara suggests that the UW architecture school is the best in the country.

It is the only non-metropolitan one in Canada. "It's a question of scale," Haldenby says. "It wouldn't make a difference in Toronto, but it does here. Here you can change the course of history, and we have." Like the area itself, the school is pragmatic.

A light rail transit system is being built to link the three cities, and, perhaps more critical, distribute students around the region; many now congregate near the UW and Wilfrid Laurier campuses. "There are 50,000 students in the area," says John Jung, CEO of the regional development entity Canada's Technology Triangle Inc. "We'd like to spread them around. Transit is key."

WATERLOO'S SUCCESS is anomalous: the modern era hasn't been kind to small cities, and it is increasingly a case of go big or go home. The megalopolis constitutes the twenty-first century's most potent urban form. The Greater Toronto Area, an hour away, has roughly five and a half million people. The world now has fourteen cities with populations of 11 million or more, and that figure is climbing quickly. At the other end lie cities that are losing population, that are becoming small, but not by choice. Buffalo has 270,000 people, fewer than in 1900; Cleveland is half the size it was in 1950. Detroit is less than half its former size and may never recover; one proposal suggests returning parts of the city to farmland. But the people leaving these cities aren't going to smaller centres; they're going to the big city. The US is littered with Rust Belt casualties.

It wasn't supposed to happen this way. A few decades ago, small cities were touted as the future. As big cities became uninhabitable, plagued by crime, congestion, pollution, and sagging infrastructure; as the Internet made it possible to work from anywhere; as Wall Street and Bay Street were decentralized into the ether, we would choose to live in small, livable cities because we could. But we didn't. We huddled in large centres.

Especially in Canada, where cities have the ineffectual political sway of a municipal utility, some of them are hampered by overlapping jurisdictions, by competing interests (suburban versus urban), by short-sighted decisions, and, most potently, by indecision. Greatness has eluded all of us. The case for smaller centres has once again become compelling, though we need imagination, political will, and the resources to pull it off.

The resources in Waterloo have come partly in the form of philanthropy: the hundreds of millions the RIM executives have contributed, which has prompted others to donate. It helps, too, that they have chosen specific targets involving not just meaningful architecture, but institutions that could have a significant impact on both science and the local economy.

Of course, the quantum revolution may fizzle; Laflamme admits it may not be the key to understanding nature. RIM, like Nortel, may crumble, its new technology unloved, its management hounded out of office (shares have plummeted by more than two-thirds in less than a year). But whatever its fate—bought and dismantled by foreign vultures, protected as a national resource (the IT version of potash), succumbing to quiet decline, or undergoing an unexpected renaissance—the lessons for city building remain. The management of resources (youth, technology); the tangible benefits of architecture; and the integration of academia, government, and the private sector serves as a valuable model, one that big cities should emulate.