BUILDING SMART SMART CITIES

PRIVACY, EQUITY AND DEMOCRACY
IN A DIGITAL AGE

THE ATKINSON
JOURNALISM FOR THE PUBLIC GOOD

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In late 2017, Sidewalk Labs arrived in Toronto with an intriguing buffet of futuristic plans for developing a swath of the eastern waterfront, dubbed Quayside, and the Port Lands.

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ABOUT JOHN LORINC

JOHN LORINC

2019-2020 ATKINSON FELLOW IN PUBLIC POLICY

John Lorinc is a freelance journalist who specializes in politics, urban affairs, the environment and business. For more than 30 years, he has contributed to numerous national and local publications including The Globe and Mail, The Toronto Star, Walrus, Canadian Business, Maclean's, and the Washington Post. John is a senior editor at Spacing, a quarterly magazine focused on issues affecting the public realm. He has won numerous National Magazine Awards for his feature writing, and is also the author of three books.

As the 2019-2020 Atkinson Fellow in Public Policy, John examined the politics and governance of smart city technology. He analyzed issues including data and privacy, mobility applications, predictive policing, sustainable smart cities, and smart city megaprojects. Through this series, John showed us the path to ensure these systems fit into accountable, progressive and democratic city-building efforts.

The Atkinson Fellowship in Public Policy awards a seasoned Canadian journalist the opportunity to pursue a yearlong investigation into a current policy issue. The fellowship is a collaborative project of the Atkinson Foundation, the Honderich family and the Toronto Star.

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INTRODUCTION

When John Lorinc proposed to study smart cities in 2019, Toronto was in the midst of excitement and controversy around Sidewalk Labs' plan to build a new tech-oriented neighbourhood. The issue of disruptive 'smart' technologies needed examination beyond simply their prospects and promise. John proposed a deep dive into what building a smart city could mean for personal privacy, urban planning, and democratic engagement and accountability.

Little did we know then that this issue would become even more urgent with the COVID-19 pandemic. Many of us now have smartphone apps that let us know if we've been near someone with COVID-19. There is a new push to use tech-based solutions in grocery stores and in deliveries to reduce transmission of the virus.

And while urgent, the complexity of smart technologies and systems can make it challenging to immediately understand the multitude of issues surrounding them. As a reporter who has covered politics, urban issues, the environment and business for over 30 years, John was the ideal journalist to untangle this complexity.

In *Building Smart Smart Cities*, John takes us to cities around the world to learn from their experiences. Based on these, he lays out clear policy priorities for all levels of government related to privacy legislation reform, data governance, and democratic accountability. He also reports on citizen organizing and democratic engagement, that have spurred critical questions to be asked about projects: who benefits? Have the people most affected been heard? Does this solve or perpetuate existing inequalities? Who is accountable?

These questions are guiding our work at the Atkinson Foundation. In the spirit of our favourite 20th century urbanist, Joseph Atkinson, we're interested in what makes communities work for everyone. We think this series is an important contribution and call to action. As John reminds us, cities are ultimately social spaces. They're built by us.

That's why it's so important that all of us share these articles widely. We need to hear many diverse voices and to have many more hands on deck in these city building projects. We look forward to seeing what John's reporting inspires, and to working with you to realize our highest and best visions.

Colette Murphy

Colette Murphy
ATKINSON FOUNDATION
FEBRUARY 2021

SMART CITIES WILL BE CLEANER, ACCESSIBLE, EVEN MORE DEMOCRATIC, PROPONENTS SAY

But governments adopting new tech must contend with risks, too

MONDAY JANUARY 4, 2021 | BARCELONA

On an overcast day in November 2019, thousands of people from all over the globe streamed in to Barcelona's cavernous suburban convention centre to partake in what's become an annual celebration of a utopian vision for 21st-century cities — a vision fuelled by the potent confection of cutting-edge digital technology, urbanist idealism and an enormous amount of money.

Sprawled across two giant trade halls, the Smart City Expo, founded in 2011, featured exhibits by tech companies of all sizes, as well as local, regional and national governments. Bureaucrats, investors, academics and journalists roamed aisles lined with screens, cafes and Sim City-type renderings. Smart city sales people, meanwhile, offered "seminars," handed out brochures and enticed attendees to try devices ranging from sophisticated surveillance and mapping gear to electric

The fast-growing world of smart city tech is redolent with upbeat narratives about technologies that claim to improve or at least help navigate the complexities of urban life.
ILLUSTRATION McKENNA DEIGHTON / TORONTO STAR

scooters. Signage throughout encouraged visitors to be inclusive and sustainable. Cisco, a network tech giant and major sponsor, had its logo everywhere.

The Government of Canada operated a single modest booth off in one corner, while Sidewalk Labs, Apple/Google's ambitious smart city disrupter, had no booth.

The location of the event was no accident: over the past decade, the picturesque Catalonian capital has established itself as an exponent of progressive smart city policy as well as a hub of smart-city investment and entrepreneurship. Barcelona's smart-city congress itself has become something of a lucrative export product, with well-attended spinoff trade-shows in Latin America, Asia and the Middle East.

Perched at a high table in the City of Tel Aviv-Yafo's bar-style booth, Liora Schecter, the harried-looking chief information officer, described what has become the region's smart city calling card — a seven-year-old service called Digi-Tel that showcases Tel Aviv's brand as a lively and fun-filled metropolis and a global centre for tech research and investment. In 2014, in fact, Tel-Aviv won the "world's smartest city" award for its Digi-Tel platform during the Barcelona expo that year.

Residents, she half-shouted over pulsing electronic dance music, can register by providing "just a bit little bit of information" — anything from addresses to interests, children's ages, and so on. The analytics behind Digi-Tel's smartphone app, in turn, push out personalized notifications ranging from the location of nearby schools and washrooms to discounts on tickets for musical events. "If you have a small child and we have an activity for children nearby, we'll proactively invite you," Schecter said. "It gives you information about things you actually expect a municipality to arrange for you."

The project, which coincided with the launch of public Wi-Fi, was conceived as an inexpensive means of improving citizen engagement and trust in local government, according to a 2016 case study by the Inter-American Development Bank, which noted that the city has also deployed security-focused smart systems such as hundreds of CCTVs coupled to an automatic image-analysis software used to combat property crime and other threats.

Digi-Tel allows users to register for city programs, pay bills, check beach conditions and express their views about neighbourhood planning matters. During the past five years, according to Schecter, Tel Aviv-Yafo has signed up 231,000 households, representing 70 per cent of the city's adult population. Privacy, she added, hasn't been a sticking point because the service is entirely voluntary. "You will deliver your data only if you believe it will get value."

The system conforms to Israel's privacy laws and the municipality only hands over information to authorities if there's a court order; none, Schecter added, is sold to third parties, in spite of its obvious commercial value. "I'm a resident myself," she shrugged. "I wouldn't want it to happen to me."

The fast-growing world of smart city tech is redolent with such upbeat narratives — stories, or "use cases," in industry parlance, about technologies that claim to improve or at least help navigate the complexities of urban life. Smart city technologies, proponents say, have the capacity to

make urban spaces cleaner, more accessible and even more democratic. Some industry leaders say these innovations can displace a sluggish and older generation of municipal technologies built around mainframe computers.

"There's billions of dollars flowing into this space," says University of Toronto urban geographer Matti Siemiatycki, a Canada Research chair in infrastructure and finance. "This activity is happening in a small number of cities and Toronto is one of them." The GTA, he adds, can become a leader in how cities leverage data and technology to support broad social goals, like sustainability and inclusion, while making municipal operations far more efficient and responsive.

Yet, as this series will explore, it's increasingly clear that the utopianism that burnishes smart city technology should prompt us to pose tough questions about ubiquitous surveillance, the risks of technocratic control, mission creep and the growing influence that profit-minded tech firms exert over city government clients who want to find savings in their budgets and show voters they're not dinosaurs.

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As urban historians know, earlier visions of utopian cities turned out to be markedly dystopian. "If the history of city building in the last century tells us anything," tech critic Anthony Townsend warned in his 2014 book *Smart Cities*, "it is that the unintended consequences of new technologies often dwarf their intended design." Others note how the seduction of a tidy and rational digital solution to complex urban challenges can foster a blinkered mindset — what Ben Green, a former City of Boston data scientist and author of *The Smart Enough City*, describes as "tech goggles." "They cause whoever wears them to perceive every ailment of urban life as a technology problem and to selectively diagnose only those issues that technology can solve."

In certain cases, the underlying systems have become so powerful, complex and, in many cases, opaque, that they compel us to imagine new forms of urban politics, civic engagement and approaches to regulation and governance that are every bit as innovative as the technologies themselves.

Some observers also argue that some of these technologies have failed to live up to marketing promises. "There's been 10 years of smart city hype about how smart cities will save the world," says New York University urban planning and informatics expert Constantine Kontokosta. "We haven't seen any systematic analysis that using these smart city models has actually helped."

Shannon Mattern, a professor of anthropology at New York's New School for Social Research, tracks the debates about smart city tech and its ethical implications. In a widely cited 2017 essay in the journal *Places*, she argued for more public scrutiny of digital systems that purport to

"optimize" urban regions. "We don't know how these experiments will fare," she cautioned. "A city is not a computer."

When I spoke to Mattern in 2020, she said the computational heft of artificial intelligence-fuelled technologies had become far more complex in just the two years since she had penned her essay. Watching the evolution of the technology, Mattern saw positive applications, in fields like health and transportation, but also alarming ones, like facial recognition. "It's very situational."

Mattern, however, stressed that technologies capable of processing and drawing inferences from vast pools of data can't be seen as a surrogate for other ways of understanding how urban communities function. Memory, sensory perception, experience — all of these forms of nondigital, nonquantifiable 'information' mustn't be elbowed aside in favour of technological solutions that draw on apparently objective data sources and algorithms.

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The city-as-computer metaphor, she warned in her essay, "give(s) rise to technical models, which inform design processes, which in turn shape knowledge and politics, not to mention material cities."

The question, then, is whether the wider social, political and even economic context in which these powerful technologies take root will determine whether they contribute to sustainable and progressive city-building, or produce its opposite.

It's likely that most Torontonians first encountered the expression "smart cities" in the fall of 2017, when Sidewalk Labs, then a little known New York startup, arrived with an intriguing buffet of futuristic plans for developing a swath of the eastern waterfront, dubbed Quayside, and the Port Lands.

Computer networks, analytics and data processing have been integral to urban development and management since military information systems began to take root in municipal government during the Cold War, according to Jennifer Light, who studies the impact of science and technology on urban planning at MIT.

However, the phrase "smart cities" can be traced back to the early 2000s and the "creative cities" movement — a term popularized by the University of Toronto urban geographer Richard Florida. He argued that cities able to attract creative and highly educated people will succeed in a world in which dynamic, innovation-fuelled urban regions increasingly serve as the command centres for the global economy.

For some analysts, creative cities were, axiomatically, smart cities. But with accelerating private investment in digital communications technology and a growing public policy emphasis on

innovation as a major driver of regional economic development, such places also began betting heavily on a range of "smart" systems — "smart" energy metres, "smart" traffic signals designed to adapt to congestion levels, even "smart" waste bins.

Developers started designing "smart" office buildings, where sensors automatically set heating and cooling levels. Tech giants like Cisco and IBM began marketing large-scale, back-end information systems for local governments. Other tech firms were creating urban-focused smartphone apps, such as ride-hailing services or Google's Waze, which could guide drivers along the path of least resistance. By the early 2010s, during the grim aftermath of the credit crisis, these technologies rapidly coalesced into a sprawling, global smart city industry that's now estimated to generate revenues worth hundreds of billions of dollars each year.

Sidewalk emerged in 2015, a corporate marriage of Silicon Valley tech types and New York City urban development insiders. Its pitch for Toronto's waterfront included everything from tall wood buildings outfitted with smart energy systems to programmable streets for autonomous vehicles, underground tunnels for self-guided delivery trolleys and public spaces that residents and merchants could reconfigure using apps designed by startups.

The precinct would be fitted out with thousands of sensors and a substrate of state-of-the-art network connectivity — a neighbourhood, as founder and CEO Dan Doctoroff liked to say, that was "built from the internet up." He balked at critics who accused Sidewalk of attempting to privatize a chunk of Toronto's waterfront. "We're not interested in creating a corporate campus or a gated community."

The concept of this "digital layer," observes Rutgers University law professor Ellen Goodman, was not unlike the business model used to great advantage by tech giants like Apple, Google and Facebook, which have provided other companies access to their platforms or their vast stores of data for a fee. As she wrote in the *Fordham Law Review*, "Sidewalk sells the digital layer as the engine for the edge innovation, the startups, and the tech businesses of the silicon idyll."

During the rocky two-and-a-half years between Sidewalk's splashy debut and the firm's decision, announced early in the pandemic, to pull the plug on its waterfront plans, many Torontonians came to the conclusion that a massive smart city real-estate play couldn't just drop out of the sky and expect to win public acceptance based on slick marketing and futuristic promises alone. Sidewalk's plans not only lacked technical specifics; it wasn't clear how this new neighbourhood would be regulated or governed; how it would function socially or commercially; what would become of privacy or surveillance concerns; and who, ultimately, would profit from what Sidewalk often described as a real-life "lab."

Mostly, neither the company nor Waterfront Toronto — the agency that has planning oversight for the area and had invited Sidewalk to submit its ideas — had provided a compelling answer to a baseline question: was Sidewalk's intricate smart city blueprint a solution in search of a problem?

For several years, as it happened, critics, activists and scholars have warned that intensively marketed smart city technology shouldn't get a pass. As early as 2013, Rob Kitchin, a geographer with Ireland's Maynooth University and a leading expert on smart city governance, cautioned about risks such as political conflicts over the use of big data (i.e., very large tranches of digital

information, such as cellphone location signals, social media feeds or credit card transaction records), "buggy and brittle" software, tech companies that negotiate "lock-ins" with naïve government agencies and a mounting use of surveillance, or what he calls the "panoptic city." As Townsend wrote, "We need to question the confidence of tech industry giants."

The pushback that greeted Sidewalk between 2017 and 2020 can be read as a recognition by a growing number of city-dwellers that smart city tech has the power to alter urban communities in ways that aren't well understood, and must therefore be assessed differently than more quotidian forms of urban development and infrastructure. Indeed, these technologies may necessitate a form of social licence that goes beyond the logic of either the marketplace or normal course policy-making.

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A choice example: Airbnb, which began as a convenient online booking service connecting travellers and people who wanted to rent their homes for short periods of time. By the onset of the pandemic this year, it was actively disrupting both the residential development sector and rental housing markets in many big cities, leading to tenant displacement, tense conflicts in apartment buildings and rent inflation. These side-effects have rippled through neighbourhoods, forcing municipal officials to devise regulatory workarounds or impose tough limits, as was the case in Barcelona.

With even more powerful technologies looming — e.g., the deployment in public spaces of autonomous vehicles, including delivery robots, or the unregulated dissemination of image recognition algorithms—the question of how cities govern these systems will only become more urgent.

How the pandemic factors into the smart city picture remains to be seen. On one hand, the enormous overhang of COVID-19-related deficit spending may force heavily indebted local and regional governments to shelve "nice-to-have" technology investments. At the same time, social distancing public health policies have created a huge demand for online/remote services in both the public and private spheres.

For instance, technology supporting contact tracing apps, which have been deployed to help track the spread of the coronavirus, will almost surely find applications in other domains, predicts Goodman, the Rutgers law professor. Another example involves systematic testing of sewage for viral loading. A global network of "wastewater surveillance" epidemiologists and public health units, among them the City of Ottawa's, have sprung up to examine of the data culled from this testing to predict and locate outbreaks.

What's more, the pandemic has radically altered the way people move around urban spaces and how they connect with one another; the entrepreneurs who capitalize on these shifting patterns will almost certainly construct their business models around emerging digital technologies, with the spoils accruing to whomever secures first mover advantage.

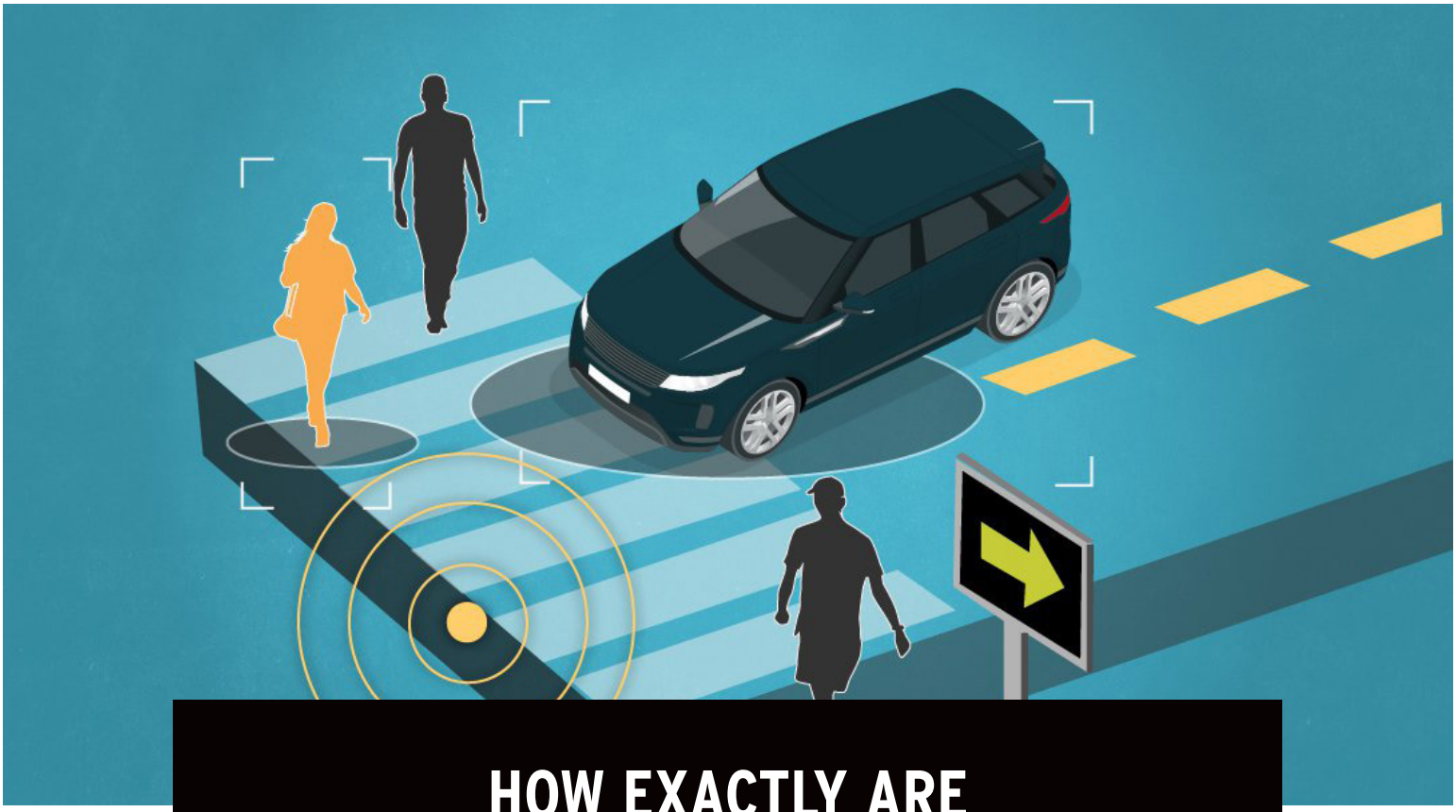
None of this is to say that all smart city technology is dangerous or necessarily creates a slippery slope toward an Orwellian future. There are demonstrably benign and progressive applications, especially in fields such as sustainability and energy conservation. And smart city systems can assist in making municipal services operate more effectively, provided their uses are focused, with well-understood, and democratically approved, constraints on their consumption of various forms of urban and individual data.

Yet, as Rob Kitchin, the geographer at Maynooth University, has noted, their use encourages a "technocratic" approach to urban management that "[fails] to take account of the wider effects of culture, politics, policy, governance and capital that shape city life and how it unfolds."

University of Toronto philosopher Mark Kingwell, who has written frequently about cities, has pondered the implications of the ubiquity of privately developed, AI-driven software systems that generate complicated statistical predictions about human behaviour. Governments and businesses, he observes, use these predictions to manage infrastructure, regulate how people move through public space and produce new forms of commerce.

"I always find myself thinking again and again about 'the right to the city,'" he says, citing the French sociologist Henri Lefebvre, who coined the phrase in 1968 as a counterpoint, Kingwell notes, "to all the invisible gates" that divide urban communities. In the face of the sheer size and transactional momentum of the tech industry, as well as its keen interest in targeting urban regions and local governments, Kingwell argues that we can't forget that cities are, at their essence, infinitely varied social spaces that can never been completely known, observed or measured, even with the most sophisticated networks of digital sensors.

"I want to have spontaneous interactions with my fellow residents," he muses. "That's part of what it means to be a citizen. You obviously can't program for that. You have to leave a huge amount of room for that spontaneity, otherwise it's not a city; it's just a system."



HOW EXACTLY ARE SMART CITIES BUILT?

From facial recognition and 5G networks to cheap sensors — these are the essential components

TUESDAY JANUARY 5, 2021 | BARCELONA

Far from the disorderly world of big city streets, Mart Suurkask, the CEO and founder of Bercman Technologies, demonstrates a working prototype of the firm's "smart pedestrian crosswalk" to a small crowd of onlookers gathered at a trade show booth hosted by the government of Estonia.

The device looks exactly like crosswalk signs throughout Europe — a post supporting a square sign with the universal symbol of a pedestrian crossing a street. What makes it "smart," as he explains, is an assembly of digital devices stowed inside the sign: high-tech motion detectors aimed in all directions that are programmed to calculate the velocity of vehicles approaching the crosswalk to determine if vehicles are slowing safely when someone is crossing.

Smart city systems are built with a diverse and ever-growing range of technological building blocks: hardware, software, cloud-based data warehouses and cellular networks, artificial intelligence algorithms, etc. The components run the gamut from smart phone apps and cheap sensors to multimillion-dollar control hubs. Some have used the term "everyware" to describe their ubiquity. ILLUSTRATION McKENNA DEIGHTON / TORONTO STAR

The software includes a "machine-learning" algorithm that allows the detector to learn and then anticipate traffic patterns so it can "optimize" for cars moving through a particular location. Bercman's smart crosswalk is also fitted with wireless transmission capabilities that will someday automatically send notifications to fast-moving, connected vehicles, alerting them to brake right away. When the crosswalk signal detects danger, it flashes and beeps.

The four-year-old startup, which is based in Tartu, Estonia's second largest city and a hub of tech development, wanted to find solutions to rising pedestrian fatality rates, as well as the eventual advent of self-driving cars. "We thought these vehicles might need some help from smart infrastructure," he says.

Bercman's smart crosswalk is still in development. Suurkask concedes that in real-world testing, about a third of the warning signals turn out to be false alarms. As it happens, it is also fitted with sensors measuring air quality, traffic flow and pedestrian volumes, as well as digital cameras designed to identify licence plates but not faces. The sign, as he says, "is just one part" of a smart city "ecosystem."

Smart-city systems are built with a diverse and ever-growing range of technological building blocks: hardware, software, cloud-based data warehouses and cellular networks, artificial intelligence algorithms, etc. The components run the gamut from smartphone apps and cheap sensors to multimillion-dollar control hubs. Some have used the term "everyware" to describe their ubiquity.

While a lot of smart-city tech is designed for and purchased by local or regional governments, these systems can also be found in health-care settings and utilities, as well as private sector environments, such as 'smart' office buildings.

Many are focused on security and urban mobility applications, while others — e.g., mapping, short-term rental or recommender apps — aren't geared at the municipalities per se but turn out to have far-ranging implications for the ways in which cities actually function. Still others are built using various forms of information released by municipalities through open data portals — everything from zoning bylaws and property lines to the GPS signals on transit vehicles.

Here is an overview of some of the core components:

SENSORS

These are the building blocks of smart-city systems — inexpensive, compact (fist-sized or smaller) devices that can be installed on all manner of objects ranging from utility poles and buses to water mains and bridges. They can gather readings on air quality, vibrations, passenger loads, traffic volumes, leaking pipes and even the chemical composition of sewage water, where they can detect trace amounts of drugs or explosives that find their way into local drains.

Sensors are fitted with small radio transmitters to send readings wirelessly, with the signals ultimately shunted to control centres that monitor water systems or local utilities and use this real-time data to manage problems.

In Philadelphia, for example, the city a decade ago installed "Big Belly" waste bins equipped with GPS-enabled sensors that detect when the bins need to be emptied. Carlton Williams, Philadelphia's streets commissioner, says the devices allow the municipality to route garbage trucks more efficiently — i.e., they pick up only from full bins — and the number of crews have

been slashed on some routes, with a $600,000 a year savings. The reduction of trucks has also reduced congestion. "We think it's a huge success," he says.

What's evident is that an inexpensive gadget that lives inside municipal trash bins can alter local employment levels and downtown traffic speeds.

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DIGITAL VIDEO AND FACIAL RECOGNITION

The presence of tens of thousands of close-circuit television (CCTV) cameras on city streets and on all sorts of buildings or in public spaces is nothing new, but these devices have become smaller, cheaper, less static and more prevalent in a range of settings. For example, digital doorbells with fish-eye camera lenses, some made by Google and Amazon, allow homeowners to use smartphones to watch for porch pirates.

Facial recognition has become increasingly prevalent in some regions. In China, ubiquitous CCTV surveillance and advanced facial recognition software have been deployed as part of the Communist government's security and intelligence operations. Some systems are developed by private firms such as Clearview, a smartphone-based facial recognition system, and Sense Time, a Chinese AI company whose investors include Alibaba Group and Qualcomm, a U.S. Chipmaker.

In some jurisdictions, police are equipped with body-worn cameras and police vehicles with dashcams that record interactions and upload video. Drones, increasingly inexpensive and deregulated, are fitted out with high-res video. They can be used for everything from real-estate listings and monitoring cracks or energy losses on the outsides of high buildings to missing person searches. In the U.K., police drones use facial recognition software to assist with the latter.

Specialized cameras are affixed to vehicles for use in mapping applications that go well beyond Google's Street View. For example, Mobileye, a publicly traded Israeli firm owned by Intel, works with vehicle manufacturers to install specialized cameras on the windshields of trucks or buses. The cameras record whatever is on the street, and the streaming video is continuously uploaded to a cloud-based mapping database. These maps can be accessed wirelessly by autonomous vehicles that need real-time information.

THE INTERNET OF THINGS

The objects that have wireless connections to the internet, and constitute the so-called "internet of things" (IoT), include devices that have nothing to do with smart cities: Bluetooth-connected electric toothbrushes with accompanying app, glucose monitors for diabetes patients, smart fridges, etc.

In recent years, tech giants like Cisco and IBM have sought to estimate the number of such devices, which include cellphones. The tallies, according to Barcelona-based IoT privacy and information policy researcher Gilad Rosner, are wild: 20 billion to 50 billion globally, as of 2020, although the numbers vary widely depending on what's included. The actual figure, he says, "is difficult to pinpoint."

Smart city systems increasingly rely on the combination of an extensive deployment of sensors connected to the IoT. These networks allow officials to remotely monitor vibrations on bridges or property managers to track mechanical systems in smart office buildings.

According to an August 2020 survey of 50 global cities by IoT Analytics, the most prevalent urban applications include connected public transit, traffic, flood and weather monitoring, video surveillance, street lighting and air quality sensors.

Yet IoT in public space raises critical issues about security — are these tiny and inexpensive devices linked wirelessly to extensive digital networks vulnerable to hacking? — as well as privacy, or what Rosner describes as the "right to obscurity." "The issue is surveillance. The more sensors, the more surveillance."

ENTERPRISEWIDE PLATFORMS

Global network and software platform firms, such as Cisco, IBM and SAS, were among the first to use the "smart city" branding as a sales pitch, notably to local and regional governments (there are almost 600,000 municipalities worldwide).

While these large firms promised customers more cost effective operations or outsourced technical services like payments processing, their come-on is inflected with the rhetoric of progressive urbanism.

Critics have warned that so-called "vendor lock-in" provisions in service agreements have made the companies' proprietary systems difficult to remove or, in some cases, to augment with software from other companies.

In some cases, the pitch to municipal IT managers is that it if they have invested heavily in the backbone system, it then makes good sense to get the most out of it by adding functions that cut across a range of city divisions. The return on investment improves if customers invest in multiple applications, such as a smart lighting network and a street parking app, Del White, formerly Cisco's global director for smart and connected communities, tells a small audience at the firm's Smart City Expo booth in Barcelona. "Every time you add a use case, your (return on investment) gets better."

Other firms go even further, telling municipalities how these enterprise systems will enable core urban functions, from traffic control and transit to energy consumption and air quality, to operate at peak efficiency. "There are ways we can optimize a city going forward," says Roland Busch, deputy CEO of Siemens AG, the German engineering giant which promotes the creation of a centralized city "operating system" capable of integrating all sorts of urban infrastructure into a single "ecosystem."

Some cities have made this leap. The northern English municipality of Hull invested in a AI-driven "smart city platform" that includes parking space detectors, air quality sensors, smart trash bins, traffic counters, and digital video to track road quality, with the data travelling over a 5G network. Furqan Alamgir, CEO of Connexin, which was contracted to install and operate all this technology, describes the firm as an "enabler." "We're not data owners. The data belongs to the people and the city."

HIGH-SPEED FIBRE OPTIC CABLE AND 5G WIRELESS NETWORKS

In big cities around the world, the utility tunnels beneath streets are filled with the kind of broadband fibre-optic cable that enables data heavy applications, from multi-player online gaming to real-time streaming video.

As well, telecommunications giants are installing so-called 5G wireless networks in a growing number of large urban regions. The 5G technology — which has produced both geopolitical tensions (over Huawei) and pandemic-fuelled conspiracy theories — uses lower radio frequencies, allowing networks to accommodate far higher data volumes than currently possible. The tradeoff is that 5G networks need a much denser concentration of cell towers and transmitters.

For many smart city applications, 5G could be a game-changer because these networks allow huge volumes of data to move rapidly across wireless networks with what's called "low latency," meaning very little time elapses between the detection of a signal and the response to it generated in a remote computer system.

A case in point: Verizon and TomTom, the digital mapping and navigation giant, are testing 5G for busy intersections. The idea is for traffic cameras and connected autonomous vehicles to be in constant communication, via 5G, as a means of reducing the risk of collisions. "If each vehicle passing through an intersection is able to relay and receive information from other vehicles and streetlight-mounted cameras, that information can be used to notify connected devices when lights turn red or vehicles ahead come to a sudden stop," explained Traffic Technology Today, a trade magazine, in Oct. 2019.

SMART ENERGY SYSTEMS

Smart cities advocates have long argued that one of the key benefits of these technologies involves improving urban sustainability and reducing and shifting energy consumption from carbon-intensive sources to renewables. A growing number of utilities use technologies, such as smart meters, peak-period pricing and load management system, that allow large consumers, such as office buildings, to automatically make slight adjustments to heating and air-conditioning levels as a means of reducing overall energy consumption.

Many municipalities, in turn, are investing in centrally controlled smart street lights. These devices, mounted on utility poles, use low-energy LED instead of conventional bulbs. They have lower maintenance costs because they last longer, and some systems are programmed to adjust automatically to ambient light, which also reduces energy consumption. Some commercial models have other sensors and even video built in, transforming them from static emitters of nighttime illumination to disbursed data gathering tools.

In regions that promote the use of photovoltaic solar panels, two-way meters allow energy generated on a rooftop to flow into the grid. Growing numbers of homeowners are installing smart thermostats that use sensors to continually readjust heating or cooling levels. These devices are Wi-Fi enabled so can be managed from a smart phone app. Smart thermostat firms like Ecobee also allow users to wirelessly "donate" their energy use data to scientists studying building performance.

SMART TRANSPORTATION TECHNOLOGIES

Some of the earliest smart city systems were traffic control centres developed by IBM and other firms for municipal customers. These computer systems combine video, traffic flow readings from weight detection "loops" built into the pavement, and, more recently, GPS information about public transit vehicles to generate a real-time view of road conditions and congestion. These so-called "intelligent transportation systems" — i.e., the "Sydney Coordinated Adaptive Traffic System," which was developed in New South Wales, Australia, in the early 1990s and has since been deployed in gridlocked cities around the world — automatically control traffic signals in a dynamic way that responds to conditions on the road.

"A 2018 analysis by McKinsey Global Institute concluded that transportation-related smart systems yielded the greatest gains for cities. 'We found that these tools could reduce fatalities by 8 to 10 per cent, accelerate emergency response times by 20 to 35 per cent, (and) shave the average commute by 15 to 20 per cent.'"

Many startups have entered this market. In 2016, Miovision, a Waterloo, Ont., firm, raised $30 million to develop and market automated traffic counters, which are installed in boxes near signalized intersections to measure vehicle movements. Using digital cameras that can interpret road conditions, the devices have AI algorithms designed to automatically adjust signal intervals and co-ordinate with adjacent traffic lights, based on a municipality's road policies. Founder Kurtis McBride says improved efficiency in traffic flow can cut travel times and reduce idling emissions.

Other transportation themed technologies have proliferated and include transit smart cards (e.g., London's Oyster travel card) to licence-plate readers, apps showing transit routes and real-time schedules, parking and navigation apps and a range of vehicle-sharing systems for cars, bikes and scooters, all accessible via smartphones.

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VISUALIZATION

While architects have long used sophisticated modelling software to design buildings and public spaces, urban planners are turning to related applications that use data visualization tools developed by smart-city startups. Some firms have created software that aggregate big data sets gathered by sensors and other sources to generate so-called "digital twins" — highly detailed 3-D representations of an urban region that allows users to zoom in and out, pivot images and drill down to find even more detailed data, for example about the zoning rules that apply to a given location.

The simulation tools permit planners, politicians, businesses and residents to visualize various future planning scenarios. For example, Augment City, a 15-year-old Norwegian firm, has created a simulator that look at how Alesund, a city of about 70,000 in the country's north, can reduce emissions using a range of strategies, from introducing more electric vehicles to altering the mooring practices of the cruise ships in the harbour. The simulator is designed to graphically depict how different planning decisions impact the city's carbon emissions overall. "Humans understand data in visual formats," says CEO Joel Alexander Mills. "We need humans to interact with technology to make decisions."

While some smart technologies solve practical problems, others are still in development or promise tidy solutions that don't quite fit the untidy reality of cities.

Shoshanna Saxe, an assistant professor of civil engineering at the University of Toronto, points to an infrastructure monitoring system developed jointly by NASA and the University of Bath. The idea is to use remote wireless sensing devices on satellite radar to detect subtle structural vibrations on bridges that could indicate worsening weaknesses. Officials and control systems are to monitor the sensors for signs of trouble. But, as she notes, the problem with this idea is its reliance on digital devices, wireless networks and the electrical grid. What could happen, she

Augment City, a Norwegian firm, has created a simulator that look at how Alesund, seen in this file photo, can reduce emissions using a range of strategies, from introducing more electric vehicles to altering the mooring practices of the cruise ships in the harbour. PHOTOGRAPH SANDRA NOWLAN / SPECIAL TO THE HAMILTON SPECTATOR

asks, if the power goes out or the sensors fail to pick up the vibrations created by a potentially catastrophic crack? Other smart city watchers have also warned about the risks of what Anthony Townsend describes as "buggy and brittle" technologies.

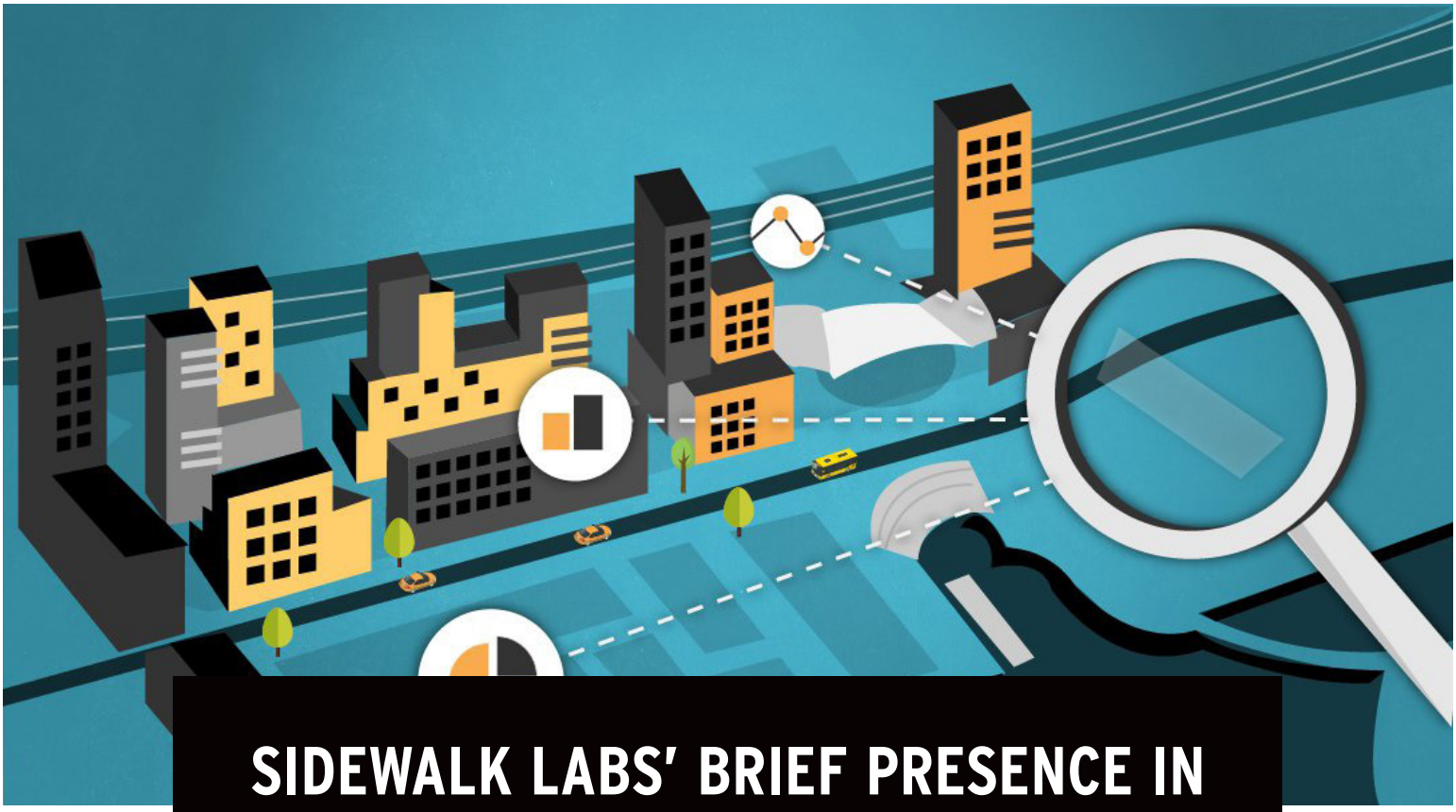
Smart cities, Saxe wrote last year in a New York Times column "will be exceedingly complex to manage, with all sorts of unpredictable vulnerabilities. There will always be a place for new technology in our urban infrastructure, but we may find that often, 'dumb' cities will do better than smart ones."

She says that ordinary consumer electronics — i.e., cellphones or kitchen appliances kitted out with some kind of digital functions — become obsolete rapidly, and smart city tech will be no different.

"Rather than chasing the newest shiny smart-city technology," Saxe warned, "we should redirect some of that energy toward building excellent dumb cities — cities planned and built with best-in-class, durable approaches to infrastructure and the public realm ... Tech has a place in cities, but that place is not everywhere."

"There will always be a place for new technology in our urban infrastructure, but we may find that often, 'dumb' cities will do better than smart ones."

— SHOSHANNA SAXE



SIDEWALK LABS' BRIEF PRESENCE IN TORONTO TAUGHT US MUCH ABOUT PRIVACY AND DIGITAL GOVERNANCE

Two of the thorniest dilemmas facing smart cities

WEDNESDAY JANUARY 6, 2021 | TORONTO

In January 2019, the Toronto Region Board of Trade floated a trial balloon in an attempt to defuse the controversy that had swirled around Sidewalk Labs' closely watched waterfront plans for almost a year-and-a-half.

The New York-based Google/Alphabet subsidiary had pitched an ambitious plan to develop Quayside, a brownfield portion of the eastern waterfront that would be fitted out with a wide array of new and existing smart city technologies. Among them, hundreds of sensors were deployed in public and private spaces to gather massive quantities of data from the neighbourhood. That information could then be sliced and diced for use in all sorts of ways, from

Under Sidewalk Labs' plan, hundreds of sensors would be deployed in public and private spaces to gather massive quantities of data from the Quayside neighbourhood. Activists and pundits attacked Sidewalk's proposal, zeroing in on a few fundamental questions: Who would own all that data? How was it to be used? ILLUSTRATION McKENNA DEIGHTON / TORONTO STAR

"Activists and pundits attacked Sidewalk's proposal, zeroing in on a few fundamental questions: Who would own all that data? How was it to be used? Could Sidewalk's sensors somehow identify individuals and target them for ads ... or worse? And who profited?"

specific energy and infrastructure operations to more open-ended applications, such as the management of public spaces.

While Sidewalk abandoned the Quayside project early in the 2019 pandemic, the lessons about the enormous complexities and risks associated with smart city data pools represent an important, albeit unintended, legacy of the company's brief presence in Toronto. Chief among them is that the existence of smart city data pools demands oversight from robust regulatory institutions.

The company had promised that independent firms, including startups, could have open access to the raw data and use it to manage services and develop apps that could, presumably, eventually be scaled up and used in other cities. Sidewalk Labs called this approach to digital city-building its "platform" strategy — a business model not unlike Apple's app store.

Activists and pundits attacked Sidewalk's proposal, zeroing in on a few fundamental questions: Who would own all that data? How was it to be used? Could Sidewalk's sensors somehow identify individuals and target them for ads ... or worse? And who profited? Others, like Andy Best, CEO of Civic Digital Network, formerly Open City Network, a Canadian non-profit that builds publicly governed data infrastructure, pointed to the apparent gaps in Canadian law and the absence of a national data strategy.

During a period when the manipulation or outright misuse of individuals' data by giants like Google and Facebook had provoked a "tech-lash," it seemed increasingly clear that Sidewalk's pitch would live or die based on how the company's planners addressed these core issues.

The board of trade's solution, dubbed "BiblioTech," seemed beguilingly elegant and simple: put all that data into the hands of the Toronto Public Library, a highly trusted institution that happens to specialize in managing information. This "data hub," according to the board's recommendations, would be overseen by the Information and Privacy Commissioner of Ontario, with the library in charge of developing policies for data collection and use.

Similar but subtly different "data governance" proposals had also surfaced — among them a pitch from the provincially owned tech incubator MaRS for a "civic digital trust," which it defined as "a trust that is established to manage the digital layer of a smart city." According to MaRS, this trust's assets "may include the physical infrastructure (sensors and data warehouses), code base (database, standards, processing structures and interface) and data that make up the digital layer. The civic digital trust may also manage financial assets to ensure the sustainable operation of the trust."

With Sidewalk's plans under intense scrutiny from critics who were deeply skeptical about the company's data strategy, it was not surprising that the company's local supporters were talking about libraries and trusts.

Data is both the opportunity and the flashpoint in most conversations about smart city technology. Smart city hardware, software and systems effectively soak up all sorts of data and transform it into intelligence that can improve civic infrastructure, create services or add efficiencies to existing ones. There's nothing new about using online portals to pay property tax bills or to access statistics to support planning. But the promise of smart cities involves combining very large batches of data and then applying sophisticated analytics to find patterns or to generate predictions. These findings can then be used to make cities more livable or sustainable. That, in any event, is the vision.

As the global tech sector well knows, data has enormous monetary value, especially in large batches. As importantly, data is the raw material that fuels the development of lucrative artificial intelligence-based technologies. These run the gamut from voice-recognition algorithms and online language translation software to much more ambitious systems that can generate fine-grain decisions about urban transportation networks or the deployment of police officers. The development of algorithms that feed off urban data figured prominently in Sidewalk Labs' plans. "The algorithm is where the value is," observes Natasha Tusikov, an assistant professor at York University who studies smart cities and data governance.

According to Kurtis McBride, CEO of Miovision, a smart traffic signal firm in Waterloo, Canadian policy-makers have yet to wake up to an economic reality that global tech giants such as Google understand. In a decade or so, he says, most urban infrastructure will be equipped with technology that generates data with significant commercial value. Either private firms will own and profit from it or the value in those pools of urban data can be applied to the public good, he says. "You have a decision about what kind of future you want." Government officials, McBride continues, "aren't thinking about this."

What further complicates the discourse about data is that the term itself is exceptionally broad — akin to talking about mammals or transportation — and ever expanding. Data covers everything from databases of building inspection records, recreation program registrations and census tract statistics to signals generated continuously by traffic monitors or GPS devices on buses.

With its Quayside project, Sidewalk Labs had promised that independent firms, including startups, could have open access to the raw data and use it to manage services and develop apps that could, presumably, eventually be scaled up and used in other cities. Sidewalk Labs called this approach to digital city-building its "platform" strategy — a business model not unlike Apple's app store. ILLUSTRATION / PICTURE PLANE LTD

Smart city scholar Rob Kitchin notes that the volume and speed of these latter categories far exceed the information that turns up in statistical tables or even on social networks. "Whilst directed and volunteered data can provide useful insights into urban systems and city lives, it is automated forms of data generation that have most caught the imagination of those concerned with understanding and managing cities," he wrote in a 2013 paper.

In some cities (including Toronto), data streams have been marshaled to create "dashboards" that provide metrics — i.e., air quality readings, transit ridership, daily shelter use, etc. — which can be used by policy-makers, businesses and residents.

"Whilst directed and volunteered data can provide useful insights into urban systems and city lives, it is automated forms of data generation that have most caught the imagination of those concerned with understanding and managing cities."

— ROB KITCHIN

The installation of smart city sensors, in turn, can create information that didn't exist in the (unmonitored) past. "The whole idea of the smart city is that every interface is a data collection space," says Anna Artyushina, a York University PhD candidate who specializes in data governance for smart cities.

Case in point: sensors designed to detect if a parking spot is occupied or empty at any particular point in time. If there's no monitoring device, the spot's status — taken/vacant — is knowable only to someone who happens to be passing. But what if there's a connected digital system that registers the spot's status in real time and makes this information available to transportation officials or anyone with an app? The resulting data could be used to alter parking rules — maybe the spot is always vacant and could be used for some other purpose? — or generate revenue: after all, if you need to park, you may be willing to pay to find a location.

We already live in a world that's programmed to track our movements, our consumer habits, our online behaviour and our digital interactions thanks to smart phones, apps, Google searches, social media platforms and security devices in private spaces like malls and office buildings. Personal data is harvested, aggregated, analyzed and then sold or shared, often without our knowledge or explicit consent — what Harvard business professor Shoshana Zuboff has called "surveillance capitalism."

For those reasons, the management of personal and operational data gathered in public spaces (streets, parks, etc.) by public agencies that have invested in smart city technologies, has become a hot-button topic, and rightly so.

Here are four policy domains associated with smart cities.

PRIVACY

Many critics of the Sidewalk plan expressed grave concerns about privacy. Could sensors identify individuals who just happened to be on the street or in a park, for example? There were also

privacy questions about other types of systems, such as smart condo buildings that continuously collect energy consumption readings from individual apartments. Could that data be used to make inferences about the occupants' habits? While Sidewalk initially retained former Ontario privacy commissioner Ann Cavoukian to evaluate its plans using a "privacy by design" approach, she eventually resigned, citing concerns that Sidewalk would not live up to its pledges.

In most big cities and especially in high-traffic core areas, public spaces have long been monitored by public and private closed-circuit TVs. In China, the government has deployed surveillance networks that extend from smart phones to the widespread use of facial recognition systems and, with the pandemic, location-based tracking apps. As the New York Times noted, "officials in some places are loading their apps with new features, hoping the software will live on as more than just an emergency measure."

At the other end of the spectrum is the European Union's General Data Protection Regulation, which is considered to be the world's "strictest" privacy legislation, according to Artyushina, data governance scholar at York University. (California legislated a comparably strict consumer privacy framework that went into effect in early 2020.) While the GDPR has broad applications in the private sphere (for example, the law regulates the use of cookies and establishes the legal right for individuals to "be forgotten"), its core principles are also highly relevant for smart city applications.

Artyushina points, in particular, to provisions in the GDPR relating to the "purpose specification principle" and "data minimization." The former means that personal data can only be collected for a "specific, explicit and legitimate use" and can't be used for any other purposes. Data minimization "means keeping data collection to the bare minimum required for data collectors' operations," Artyushina wrote in a recent study. (Outside the EU, some cities have adopted similar principles. The City of Boston, for example, says it "collect(s) as little data as possible to solve a particular problem" and has solicited privacy advice from the American Civil Liberties Union.)

Aspects of the GDPR can be found in Canada's privacy legislation, including some proposed amendments to national privacy laws (provincial governments also enact privacy laws that apply to municipalities). "However," Artyushina adds, "the Facebook/Cambridge Analytica scandal demonstrated that the country's privacy protection laws may be ill-equipped to deal with technology companies." York University's Tusikov agrees and points out that Sidewalk Labs' plans for collecting "urban data" — meaning the information gathered by sensors installed in public spaces and the buildings which would then be used to operate infrastructure or services — exposed a gap in Canada's privacy laws.

FUNCTION CREEP

In July 2019, the Washington Post revealed that agents for the FBI and Immigration and Customs Enforcement (ICE) were using facial recognition software to scan digital databases of state-level driver's licence records, which always include photos, to identify immigrants in the country illegally and suspects in criminal cases. Thousands of freedom of information requests made by Georgetown Law's Centre on Privacy and Technology produced documents revealing that these databases had been transformed into an "unprecedented surveillance infrastructure." The law enforcement officials, moreover, were accessing the images without having obtained the consent of the licence

holders. The Post reported that neither the U.S. Congress nor state legislatures had authorized such uses.

The reporting exposed not only a giant privacy breach but presented a salient example of "function creep" — a technology, in this case the digital databases, originally intended for one purpose that ended up being used for something quite different. Function creep should be on the radar of cities that make significant investments in smart city systems which have been designed to perform a range of tasks or collect data.

"These technologies can have different features turned on," says Gilad Rosner, founder of the Barcelona-based IoT Privacy Forum and an advocate for the use of the "precautionary principle" in the deployment of new technology. He cites the free public internet terminals installed around New York that were revealed to contain digital cameras. The Intercept, an online investigative news outlet, reported that civil liberties groups feared the LinkNYC kiosks, as they were known, could also track the locations of people who used the terminals.

Privacy laws that respect the principle that there must be explicit limits on the use of personal data should, in theory, rule out the risk of function creep. Yet the jurisdictions with the most progressive smart city policies also embed those principles into the design of their data systems. Estonia is one of the best-known examples of widespread adoption of e-government technologies that don't fall prey to function creep. In 2001, the tiny Baltic state (1.3 million residents) began building what came to be known as "X-Roads," a national software network that knit together the information systems and databases of dozens of public agencies, state banks and utilities.

Residents can access the entire network — from tax filings to medical records — with a single password. Changes input by citizens or public servants are automatically updated in the appropriate databases. But security and access safeguards prevent data breaches and unauthorized or unspecified uses, such as police surveillance of drivers' licences. "Critically," observed public sector IT analysts David Eaves and Ben McGuire in Policy Options last year, "there is a mechanism for citizens to see who has accessed their data to ensure no one is doing so without proper authority."

OPEN DATA

Over the past decade, most city governments began releasing certain types of municipal information through open data portals — websites that allowed users to download, for free, "machine readable" databases (i.e., formatted so they can be queried with readily available software) that municipal officials have made public. The information ranged from registered pet names to air quality readings, overnight shelter usage and the locations of urban objects, such as signals and crosswalks or park benches. New York City's huge open data portal includes a Central Park squirrel census. These data sets are updated regularly and are subject to privacy laws to ensure that no personally identifiable information is released.

Early on, the open data movement became a *cause célèbre* among digital open government advocates, who saw it as a way of unlocking public information tucked away in municipal servers. Cities hosted hack-a-thons for coders and app developers who would figure out how to use of

this treasure trove of data and create digital services for city dwellers. Some local governments made it a practice to aggressively release new data sets (New York City passed a law in 2012 mandating the disclosure of all municipal data from all departments by 2018) while others did it grudgingly or with little enthusiasm.

Some applications bobbed to the surface — i.e., Rocketman, an app that maps the real-time movement of transit vehicles and is available in cities across Canada. In other cases, the municipal data became the foundation of business ventures. In Toronto, for example, Ratio City has developed software that combines municipal geographic information system data on zoning rules, property lines and built forms with visualization features that produce detailed 3-D maps of what can be developed where. Activists have marshaled large sets of data, often presented in visualizations, to advocate for non-commercial goals ranging from public space improvements to changes in police check practices.

"Activists have marshaled large sets of data, often presented in visualizations, to advocate for non-commercial goals ranging from public space improvements to changes in police check practices."

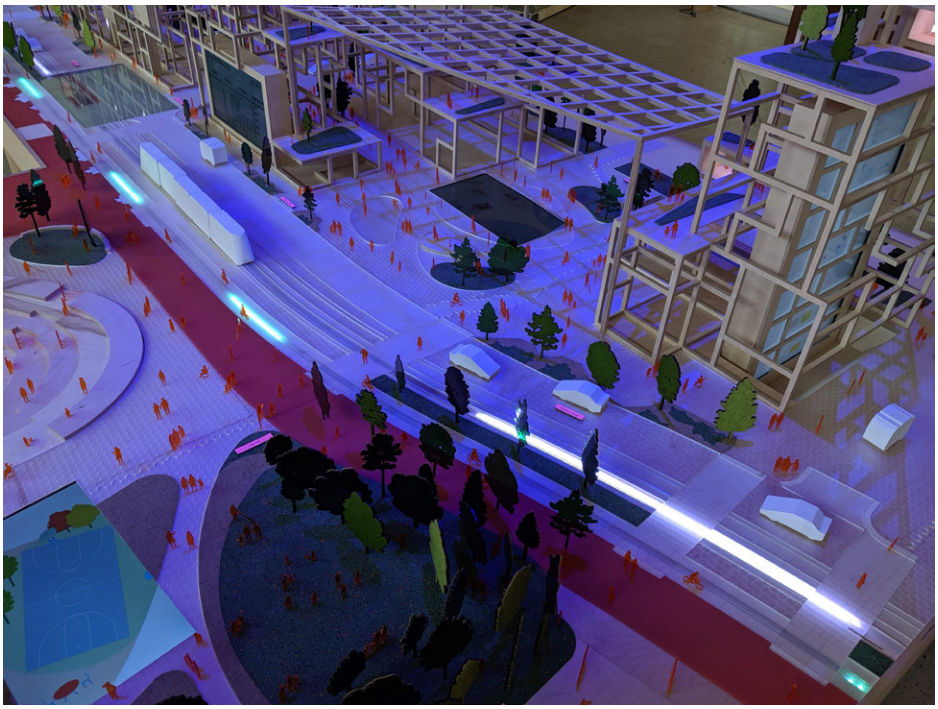
Among the early users of open data portals, in fact, were municipal officials, who could finally gain access to operationally relevant information from other departments. For instance, databases of citizen complaints to 311 call centres have been used to make service improvements while data on taxi movements is used to assist in transportation planning.

In recent years, cities like London and New York have begun retooling their open data strategies to respond more quickly to requests and allow for the release of streams of live data.

Some players, in turn, have begun to ponder the monetary value of all this publicly generated information and if municipalities should be giving it away. McBride, the founder of Miovision in Waterloo, says that companies like his use public data streams — such as traffic counts — and transform them into a profitable business model. "The more data I have, the more the data is worth," he said last year during a public consultation session titled Realizing the Value of Data. "The public sector needs to think about whether open data is a lost opportunity."

DIGITAL GOVERNANCE

When Sidewalk Labs released its digital governance plan for Toronto in June 2019, the company proposed a radical, though subtle, approach to the ownership, control and monetization of data. In contrast to municipal open data portals, Sidewalk pitched the idea of an "urban data trust" — a self-regulating entity, ostensibly independent, that would own and sell all the data generated by its sensors and other systems deployed around Quayside. The trust would be subject to private contracts between Sidewalk, Quayside residents and businesses and other firms that operate technology used in the area.



Sidewalk Labs pledged that this trust would respect Canadian privacy laws, but critics had a laundry list of questions about how the trust would work, its legal obligations and its ability to meaningfully guarantee privacy while ensuring that people living, working and visiting Quayside consented to sharing their information.

"Promises to self-regulate must be viewed with skepticism especially because of the way technology companies have expanded their data collection and use practices," wrote Rutgers University law professor Ellen Goodman in a 2019 review of Sidewalk's plan, commissioned by the Canadian Civil Liberties Association and part of a lawsuit seeking to block approval.

Goodman co-founded Rutgers Institute for Information Policy and Law and studies such issues as the ethics of artificial intelligence in smart cities. Goodman states in her brief that Sidewalk Labs' digital governance plans contained promises about privacy and responsible use but the gaps in its proposal, coupled with Alphabet/Google's history of misusing personal information, raised warning flags.

She cited some of the digital technologies planned for Quayside — apartment-level energy schedulers, a system for tracking each apartment's waste to generate 'pay-as-you-throw' bills and the self-driving parcel delivery robots operating in tunnels beneath the buildings. All three gather personal information (i.e., name, address) and connect it to fine grain data about when someone was home, what might be in their waste and their consumption habits. The systems rely on algorithms fed by data generated by users to determine the services accordingly. "These

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particular algorithmic regulatory systems are likely to be at the core of the Quayside infrastructure, influencing how the built environment is arranged and functions," Goodman cautioned. "Once they are in place, it may be difficult to unwind the data flows."

Sidewalk's proposed digital governance leaned heavily on anonymizing personal data before it was shared. But Goodman noted that growing research shows how privacy violations — "reidentification" — can occur despite such steps. Transportation information — tap-on/tap-off transit cards or trip data from ride hailing services — can be mined and cross-referenced with other public sources of information to generate inferences based on a user's behaviour (i.e., regular trips to a health clinic). Citing privacy violations by Apple, Amazon and YouTube (Google), Goodman concluded: "There are too many examples of technology companies promising to anonymize personal information, but then compromising that anonymity, to rely on assurances of de-identification."

> "It seems that after all these scandals with tech companies, people have reached a point where there's a role for government … We need a professional civil service that has digital governance capability and can push back against the technology companies."
>
> — NATASHA TUSIKOV

Smart city technologies are complex, but technical difficulty isn't necessarily an impediment. Tusikov, of York University, cites earlier examples of public governance of highly technical systems, such as the Canadian Radio-television and Telecommunications Commission or the Atomic Energy Control Board. "It seems that after all these scandals with tech companies, people have reached a point where there's a role for government," she says. "We need a professional civil service that has digital governance capability and can push back against the technology companies."

ROTTERDAM IS USING SMART CITY TECH TO SOLVE PRESSING URBAN PROBLEMS

Here's what Canadian cities can learn from the Dutch model

THURSDAY JANUARY 7, 2021 | ROTTERDAM

During the past decade, thousands of Rotterdam building owners installed green roofs on their dwellings — about 330,000 square metres in total, almost two per cent of the city's 18.5 square kilometres of flat roof space. But where some cities have promoted such projects to improve energy efficiency and absorb carbon dioxide, Rotterdam's green roof infrastructure is all about water, and keeping as much rainwater run-off as possible out of aging, overtaxed sewers in order to prevent flooding.

About four-fifths of the Dutch port is below sea level. As Paul van Roosmalen, the city official overseeing sustainable public real estate, puts it: "The water comes from all sides" — the sea, the sky, the river and ground water. "It's always been a threat." But he also sees an opportunity to use

The blue-green roof campaign is just one element of a wider set of Dutch policies that are meant to confront the potentially ruinous impact of climate change. The technology "is a means, and not a goal in and of itself," says Rob Schmidt, the City of Rotterdam's project manager for smart cities and the digital economy

ILLUSTRATION McKENNA DEIGHTON / TORONTO STAR

a marriage of technology and green design to elevate the role of rooftops in managing Rotterdam's water pressures.

While typical green roofs function like sponges and look like gardens, Rotterdam is working with public and private landlords to develop a "green-blue grid." Instead of simply fitting out roof areas with plantings, these spaces can also be equipped with reservoirs or tanks to retain excess flow — blue roofs. The tanks, in turn, are equipped with electronic drain valves that can be opened and closed remotely, in some cases via a smart phone app.

"The problem," says van Roosmalen, "is that when they're full, they're full." The city's vision, he explains, is to develop a system for co-ordinating the water levels in these tanks to help manage sewer capacity. The idea is to link the valve control devices into a grid of blue roofs that function, in effect, like a dispersed network of storm water reservoirs. When there's rain in the forecast, the reservoirs can be drained automatically. Then, during heavy weather, they can store rainwater, reducing pressure and flooding in the sewer system.

While Rotterdam's green-blue grid is still far from completion, it may be seen as a compelling example of how a set of technologies can be harnessed to produce what can be described as a smart city solution to a pressing urban problem.

The technological linchpin in Rotterdam's strategy has been the installation of a highly sensitive weather radar on the roof of the city's tallest building. The device is capable of detecting rainfall 16 to 20 kilometres away. Remotely operated blue-green roof control systems can be programmed to dynamically respond to those forecasts and release water that sits in the reservoirs. (A similar project, the Resilience Network of Smart and Innovative Climate-Adaptive Rooftops, or Resilio, is underway at several Amsterdam social housing complexes.)

The Netherlands' outlook can also serve as a model for Canadian cities and policy-makers. Dutch governments are by no means indifferent to a potential economic windfall from the urban tech sector and have backed hundreds of smart city or digitization ventures.
PHOTOGRAPH SUPPLIED

To date, Rotterdam officials are testing a pilot version of this grid, and not just to confirm that the technology works. To scale it up, the city needs to co-ordinate with Rotterdam's water board, which manages the sewer infrastructure, as well as property owners. The strategy complements other water management planning moves, among them retrofitting public squares with "rain gardens" — i.e., clusters of water-absorbing shrubs and perennials planted in a small depression in the ground. "Instead of making bigger sewer pipes, we made a choice to invest in redesigning public space in a way that contributes to a nicer, better, more attractive district," Arnoud Molenaar, Rotterdam's chief resilience officer, told Thomson Reuters last year.

Van Roosmalen adds that a green roof can absorb about 15 millimetres of rain per square metre, whereas a roof with a reservoir can retain 10 times as much. The city's goal is to convert one million square metres of flat roofs to include water retention systems and solar panels. Aggregated across even a portion of the city's flat roofs, he says, "it's a tremendous amount of water."

The blue-green roof campaign is just one element of a wider set of Dutch policies that are meant to confront the potentially ruinous impact of climate change. The technology "is a means, and not a goal in and of itself," says Rob Schmidt, the City of Rotterdam's project manager for smart cities and the digital economy.

The Netherlands' outlook can also serve as a model for Canadian cities and policy-makers. Dutch governments are by no means indifferent to a potential economic windfall from the urban tech sector and have backed hundreds of smart city or digitization ventures.

But the country situates its smart city technology projects in a broader sustainability agenda. It features extensive public engagement, applied research ventures and public-private partnerships. The Netherlands has set out to promote the circular economy (i.e., ambitious policies to reusing waste and castoffs) and alternatives to private, gas-powered cars. The national government, moreover, works closely with the country's nine major cities to implement these plans. In Holland, smart city policy isn't about the tech tail wagging the urban dog.

Some of the earliest applications of smart city technology involved sustainability, and specifically the growing interest in distributed, renewable electricity that began in the 2000s. Conventional electricity grids were linked to large, and often dirty, power sources — coal or gas-fired generators. But as wind power and solar became more economically viable and politically popular, utilities had to figure out how to allow these smaller sources of power generation access to supply the grid. These included homes or flat-roofed commercial buildings fitted out with rooftop photovoltaic solar panels that could generate energy.

In Ontario, the Liberal government's 2007 pledge to phase out coal forced a push for renewable alternatives. Queen's Park sought to attract clean energy investors, large and small, with attractive subsidies. The transition turned on the deployment of smart grid technology, including smart meters. These allowed utilities to manage energy drawn from a decentralized set of producers, among them private property owners with solar panels that could feed power into the grid.

Those investments, in turn, paved the way for other conservation-oriented policy shifts, such as time-of-use pricing, which provides ratepayers with a financial incentive to reduce consumption during peak periods. Smart grids also laid the foundation for more electricity-related consumer innovations, such as the wide deployment of electric vehicle charging stations or the

installation of backup energy storage devices, such as Tesla's Powerwall. From a sustainability perspective, smart grid systems only cut overall emissions if utilities phase out or reduce carbon-emitting generation, as Ontario did.

While Canada continues to emit far more carbon than the Netherlands, Holland's climate policies reflect a great sense of urgency, given its exposure to sea level rise and flooding on rivers that flow into the country from the east. For that reason, adaptation and mitigation are central to plans to future-proof its cities.

Schmidt points out that the Netherlands' nine largest city-regions collaborate to develop and test approaches and technologies. "We learn from each other how to cope with these so-called smart city projects." Each city has adopted a policy area: Rotterdam is focused on climate adaptation; Amsterdam, circular economy; Eindhoven, low-carbon mobility and energy transition, and so on.

The national government, has launched an Urban Agenda that involves negotiating "city deals" many involving smart city projects that typically include multiple partners, including research institutions. "Our approach is focused on the opportunity and finding everyone you need to get to a solution," says Urban Agenda program manager Frank Reniers. "You put them in a room and try to innovate your way out of the problem."

The Netherlands wasn't always so collaborative. According to Frank Kresin, dean of the Faculty of Digital Media and Creative Industries at the Amsterdam University of Applied Sciences, Amsterdam in the late 2000s and early 2010s "was doing everything in its power to become 'smart.' " The city's appetite for tech drove a great deal of investment in automation and digitization.

But the infatuation with these corporate solutions, Kresin wrote in a 2016 study, "had some flaws," including the risk of excessive surveillance and an unquestioning embrace of the idea that the smart city was "a machine that needs to be optimized, with no consideration or understanding

The City of Amsterdam has many smart technologies in place: from smart devices that measure things (i.e., sensors) to smart devices that steer processes in the city (i.e., actuators) such as traffic lights, charging stations, adaptable street lights, barriers that go up and down and adaptive digital signs.
PHOTOGRAPH SUPPLIED

of the organic reality. It wants to maximize efficiency and avoid friction, so it simply and non-negotiably imposes top-down, nontransparent technological solutions."

Kresin wasn't the only one concerned about this drift. In the last five or six years, citizens groups, entrepreneurs and academic institutions have pushed Dutch policy-makers and companies to swap out the top-down approach in favour of a more grassroots philosophy that features extensive public engagement, citizen-science projects and applied research.

"The big threat is loss of autonomy," says Jan-Willem Wesselink of Future City Foundation, a Dutch network of municipal agencies, civil society organizations, universities and technology companies seeking to promote a more democratic approach to smart urbanism that aligns with one of the United Nations' 17 sustainable development goals (number 11) about resilient, sustainable and inclusive cities. "Does Google or some other company decide how you use the city?"

Kresin describes one early effort at broadening the conversation. In 2014, Amsterdam Smart City, a tech incubator, distributed several hundred "smart citizen kits," which provided rudimentary sensors to allow people to perform environmental indicator tests on water and air quality around the city. Their findings were fed to the city. While the readings fell short of research-grade data, this experiment in citizen science attracted many participants, generated upbeat media coverage and, in a few cases, led the city to clean up local beach areas. Its popularity also inspired Kresin and some colleagues to establish the Amsterdam Smart Citizens Lab, where civil society groups, academics and government officials work together to find solutions to other urban problems.

The distribution of the kits "was a surprisingly successful project," says soil chemist Gerben Mol, a resilient cities researcher at Amsterdam's Advanced Metropolitan Solutions Institute (AMS), a university-municipal government joint venture established to conduct more formal applied urban research.

In recent years, a growing number of Dutch city-dwellers are finding venues to engage in local conversations or projects about how to put urban data and technology to work in addressing the problems they see in their communities — in effect, a cultural, as opposed to corporate or bureaucratic, response.

In 2014, Amsterdam Smart City, a tech incubator, distributed several hundred "smart citizen kits," which provided rudimentary sensors to allow people to perform environmental indicator tests on water and air quality around the city. Their findings were fed to the city.
PHOTOGRAPH SUPPLIED

> "Most of the companies we're working with really do see the value of incorporating citizens and using the wisdom of the crowd."
>
> — NANCY ZIKKEN

All this grassroots work has had a bearing on AMS' work. While some of its research falls under the heading of smart city tech — i.e., data visualization projects — other research initiatives are focused on parallel policy themes, such as the circular economy. One intriguing example: an AMS project that created a composite out of a glue-like bacterial residue and decontaminated wood fibre culled from septic waste (i.e., used toilet paper). A potential application is being tested to use this composite as a binding agent in road asphalt.

There are other more traditional tech ventures, such as Amsterdam Smart City, an incubator with numerous public and private partners, all working collaboratively to benefit the city. The incubator's community manager Nancy Zikken says the City of Amsterdam has "embraced" TADA.city, a network of European organizations that have pledged to adhere to six core principles for digital city initiatives (inclusive, locally focused, controlled by residents, monitored, transparent and broadly accessible).

She also says that Amsterdam Smart City screens applicants, such as startups, to ensure their proposals align with broader policy goals and have what Zikken calls "social value." As an example, she cites a firm that recently pitched a parking app that was rejected because it would likely encourage car use in a congested city that wants the opposite. "Most of the companies we're working with really do see the value of incorporating citizens and using the wisdom of the crowd."

In Rotterdam, city officials, who are driving the green-blue grid initiative, are also using public education, open houses and other engagement tools to promote these projects, many of which will be installed on privately-owned dwellings, using private capital, if the strategy is to attain sufficient scale to make an impact.

Rotterdam, interestingly, hasn't created financial incentives. Rather, in discussions with private property owners, city official van Roosmalen says his team stresses the benefits and explains the options for what's possible, for example combining a rooftop reservoir with solar. "They can pick what they think would add to the quality of their specific land," he says. But there's also a more urgent appeal, too. "You can save your city from drowning."

CIVIC LEADERS HAVE MORE DATA THAN EVER TO GUIDE THEIR DECISIONS, BUT THE TECH IS NOT IN CHARGE

SATURDAY JANUARY 9, 2021 | EINDHOVEN

Most big cities have bar and club zones that get rowdy when drunk patrons spill out at closing time. But the party strip in Eindhoven, a tech hub of 230,000 people in southeastern Netherlands near the Belgian and German borders, is such a compressed space that the crowding can become dangerous. On some nights, as many as 15,000 people will stream into the "Stratumseind," a downtown pedestrian zone about 300 metres long and just 15 metres wide that's lined with pubs and discos. Fights break out and rising violence became a significant public safety issue.

In 2015, Tinus Kanter, a municipal official who looks like a roadie, began working on a smart-city approach to public safety. In partnership with Stratumseind businesses, local police and tech firms, as well as the lighting giant Philips, which is headquartered in Eindhoven, the municipality transformed the stretch into a "living lab" with a range of technologies designed to drain some of the negative energy out of Saturday night revelries.

Data from phones, Wi-Fi and more create new sources of information for city planners, but the resulting decisions aren't necessarily revolutionary. ILLUSTRATION McKENNA DEIGHTON / TORONTO STAR

Video cameras were situated at each end of the strip to tally how many were entering or leaving (without capturing faces). Audio sensors are programmed to detect aggressive sounds while an off-site AI algorithm scans and interprets social media for posts mentioning Stratumseind or have geo-tagged images of the strip. Software, devised by the city and its tech partners, combines these data streams and sends red flags when trouble is detected, including to the police. Depending on the signals about the crowd's behaviour, lighting provided by Philips, would shift to softer hues when things got ugly.

Kanter comes by his interest in crowd control honestly: before joining the civil service, he ran a heavy metal music festival. He stresses that the city insisted on "privacy by design," so the systems do not capture personal information. The municipality also took more conventional steps, adding planters, terraces and seating to break up the space. "What I see now is that the street is becoming nicer and more open," says Kanter, who adds that Eindhoven has been diligently tracking data. "We think that gathering numbers is a good thing because (they) provide scientific proof."

However, what the data shows in terms of safety isn't clear. Kanter insists there has been less fighting, although he can't prove the lighting and the sensors were the reason. Albert Meijer, a University of Utrecht professor of public innovation who has studied Stratumseind, says the technology alone didn't markedly improve safety. What did change, he says, is that media coverage of the area shifted from the brawling to the devices, which, in turn, has attracted municipal delegations from abroad, which may have been the point all along. "Philips," he says, "wanted to showing its new street lighting to sell around the world."

Meijer describes Stratumseind as a "quantified street" and the label speaks to the complex, and long-running, triangular relationship between planning, urban data and the diverse array of technologies deployed to gather it. One of the core promises of smart-city technology is that by collecting and interpreting granular, real-time data drawn from a wide range of sources, such as sensors, municipalities will be able to make more responsive and more efficient planning and operational decisions. It is, fundamentally, a technocratic idea that suggests that evidence and facts gathered from the city itself will guide the best course of action.

There is truth in this thinking. For example, when city officials can track cycling activity using apps installed on cyclists' phones, they can "see" where bike lanes are used and needed. Similarly, if transportation or transit planners can track daily traffic or ridership volumes over an extended period, using data from cellphone signals or tap-on-tap-off fare cards, they can add service, or identify areas experiencing increases in work-related car trips. Such insights could lead to planning that informs infrastructure and private investment, as well as choices about programming public spaces.

The planning profession, which dates back to the beginning of the 20th century, didn't originally rely on data. Rather, growth was driven by the construction of new civic infrastructure (streetcar lines, bridges, etc.) and prevailing planning ideologies — for example, the importance of creating garden-city suburbs or physically separating residential, commercial and industrial areas.

By the 1920s and 1930s, municipal officials were collecting more information, such as the condition of housing stock or infectious-disease outbreaks, and using it to plan. In the postwar era, systematically gathered and synthesized data took on a much more prominent role. According to MIT science and technology historian Jennifer Light, planners learned how to map growth, housing conditions and urban "blight" by combining census and household survey data with aerial photography and military satellites.

By the mid-1970s, Light wrote in her 2003 book,"From Warfare to Welfare," analysts working for the City of Los Angeles were developing mathematical models that combined information from databases of digitized aerial images, census statistics and building-inspection reports to make predictions about future housing-development scenarios — a precursor of today's smart city analytics.

Also since the 1960s, local governments (and many others) have used "geographic information systems" to support their analyses and planning. Originally conceptualized by an Ottawa geographer, GIS are densely layered digital maps that contain a range of information associated with a particular place — natural features, buildings, boundaries, infrastructure, businesses, land use and zoning rules, census data, aerial photos, pollution sources, etc.

Transportation planners also use extensive annual travel surveys, the results of which were combined with census data to produce so-called travel demand forecasts — information that municipalities could use to estimate transit usage and traffic around regions such as Greater Toronto.

Land-use planners, both in government and the private sector, also draw on diverse information sources, including traffic, cycling and pedestrian counts, visualizations of zoning policies, interactive simulation software, consultation session feedback and surveys of residents. Numerous planning apps have also emerged, such as "Walk Score," which rates neighbourhood walkability in cities around the world.

In recent years, the extensive deployment of sensors, as well as large-scale smart phone and social media usage, and newly digitized municipal records have combined to change the playing field, yielding torrents of raw data instead of the more processed statistics that planners had relied on in the past.

What's more, remarkable advances in computing power and coding tools, as well as the long-anticipated maturation of artificial intelligence software engineering, have created entirely new ways of leveraging data and observing what's happening in a city. For example, the City of Stockholm, through a partnership with MIT and Sweden's KTH Royal Institute of Technology, has

Tinus Kanter, a municipal official began working on a smart city approach to public safety. In partnership with Stratumseind businesses, local police and tech firms, as well as the lighting giant Philips, which is headquartered in Eindhoven, the municipality transformed the stretch into a "living lab" with a range of technologies designed to drain some of the negative energy out of Saturday night revelries. PHOTOGRAPH / TINUS KANTER

a project to install solar-powered sensors on city vehicles — buses, garbage trucks, taxis — to gather data on noise, air and road quality that can provide planners with granular information about "hyperlocal" environmental conditions.

Other sources of planning data are coming from outside municipalities. InsideAirbnb is a website that "scrapes" address, rate and other host details from Airbnb's main site. It cross-references this information with housing and rental market data, and then maps it all. The site was created by a handful of New York City affordable housing activists. Through it, visitors can see the density and locations of Airbnb units in any neighbourhood in any city. The site, in effect, is a data visualization tool that gives planners and residents valuable housing market information (and policy insights) into phenomena such as condo towers that have become overrun by short-term rental investors and ghost-hotel operators.

The coronavirus pandemic has created more public-health applications for big data culled from cellphone signals. Researchers, governments and data firms, including Google, Apple and Environics Analytics, have been publishing analyses on mobility patterns, both nationally and locally, as a means of assessing how physical distancing measures have impacted travel. For example, Google and Apple aggregated cellphone mobility data by location type in Toronto in the fall. The data, published in charts in the Toronto Star, showed a sharp increase in park usage compared to pre-pandemic levels. Such evidence helped city officials make decisions about extending park-focused programs and services into the cold-weather months.

However, not all of the emerging applications are convincing or useful.

In 2017, for instance, a Harvard-MIT research team published a study about an experiment using Google Street View, itself a vast trove of urban data. Using 1.6 million images of street scenes in five U.S. cities, taken first in 2007 and again in 2014, the researchers amassed a database of paired photos of the same places, from the same perspectives, at two points in time. The investigators then developed an algorithm to assess "perceptions of safety" based on a "crowd-sourced study" of street scenes in New York and Boston, and used this formula to rate the perceived safety of the images they had gathered.

Finally, they crossed referenced the street-level safety scores with census and other socio-economic data. Not surprisingly, it concluded that denser areas populated by more affluent residents were less likely to experience physical decline — "tipping," as the authors put it — over time. The upshot is that a forbiddingly complex technical process yielded an obvious and well-understood conclusion.

Less experimentally, an Israeli company called Zen City has been selling a software-based service using AI that gathers and assesses citizen feedback on local planning — a process it calls "sentiment analysis." The feedback comes from online surveys, but also scans social-media chatter, tourist ratings, complaints to municipal 311 lines, etc. The company presents its system as a decision-making tool for municipal politicians and officials — "it's representing the voices of the silent majority," says Zen City solutions architect Nir Zernyak.

Zernyak cites an example from Oregon. Beaverton, a suburb of Portland, has attempted to ban so-called "car camping" by setting up two "safe parking" locations for homeless people who live

in their cars. The city or partner agencies assist the users to access social services. In its marketing materials, Zen City claims its "actionable, data-based insights" revealed that Beaverton may have to change its zoning rules to allow for these sites, and that not all neighbourhoods wanted one — conclusions that may not have required this kind of outsourced data-crunching. (Beaverton officials did not return calls for comment.)

The push to mobilize new sources of "smart" urban data often comes from private firms that stand to benefit. In New South Wales, Street Furniture Australia, an industry group, recruited academic planners and landscape architects to evaluate street furniture equipped with wirelessly connected sensors that perform tasks such as monitoring when a trash can needs to be emptied or how park benches are used. Other applications include park-based work stations, with Wi-Fi and USB ports, as well as tables that can be booked via a phone app.

"Information that flows from park bench or picnic table sensors could prompt municipal planners to add amenities if heavy traffic is indicated. But it's not difficult to imagine less positive applications."

The data generated from these "smart social spaces" is aggregated on a "smart asset management dashboard" which municipal officials use to monitor how these hubs are used. The idea behind the pilot, explains Nancy Marshall, a University of Sydney planning professor who is part of the evaluation team, is to find ways to encourage people to use public spaces, but the group also wants to conduct "behaviour mapping." She says none of the sensors gather personal information. (The team met with Sidewalk Labs officials in Toronto last year.)

How this intel gets used is an open question. Information that flows from park bench or picnic table sensors could prompt municipal planners to add amenities if heavy traffic is indicated. But it's not difficult to imagine less positive applications. For example, if the data shows a lot of late-night traffic, local residents worried about crime might use the information as extra fodder for municipal officials to remove benches or tips for police to increase patrols. Marshall stresses the data from the pilot projects isn't shared with law enforcement but such assurances is no guarantee that other municipalities that purchase these systems will be as restrained.

New York University planning and urban analytics expert Constantine Kontokosta offers another caution. Trash bin sensors designed to monitor when a container needs emptying could, in theory, provide data that lets city officials apply algorithms to optimize collection routes by using GPS mapping tools to direct trucks only to full bins, thus saving money on fuel and labour. However, in a 2018 paper, Kontokosta writes that such analysis might conflict with other municipal policies, such as the need to abide by collective agreements. "The computing challenges are solvable," he notes. "(T)he real uncertainty lies with how to integrate data-driven processes into public sector management."

The broader point is that existing and new forms of urban data, some of it automated, can inform a city's policy-making machinery and deliver fresh insights, but they don't supplant

institutional or political judgment, as well as human experience. "Planning is a social science, which balances these pieces with an artistic element as well," says Toronto planner Blair Scorgie, an associate at SvN, a planning and design firm. "It's what I love about it."

Some of the most compelling examples of smart, data-driven planning pre-date the rise of the smart-city tech industry. In the early 1960s, Danish architect and planner Jan Gehl began meticulously documenting pedestrian activity in a newly created car-free zone in central Copenhagen to prove to area merchants that they weren't going to lose business. Carried out by volunteers, Gehl's "public life surveys" tracked pedestrian and cyclist activity, bench usage, sidewalk café seating and so on, with the results painting a picture of how and when people use their streets; it's not a tech-driven exercise involving sensors, but rather one based on much more nuanced observations about the human rhythms of city life.

In the late 2000s, New York City hired Gehl to conduct similar surveys and analysis on Times Square and several of Broadway's intersections. The surveys revealed a conspicuous dearth of younger and older pedestrians — a detail non-video sensors wouldn't pick up — while an analysis of the chronically congested intersection showed the road allowance occupied almost 90 per cent of all the open space in the Square. NYC's transportation czar in 2008 used Gehl's findings to order a radical remake of Times Square, closing large segments of the street and creating public spaces fitted with tables and chairs. The model has been replicated elsewhere in Manhattan, reclaiming 400,000 square metres from traffic.

In Toronto, the King Street Pilot Project, which launched in 2017, offers a compelling example of how city officials succeeded in integrating technology and planning judgment to improve public

People sit at tables in New York's revamped Times Square in 2009.
PHOTOGRAPH DANIEL ACKER / BLOOMBERG VIA GETTY IMAGES

services and public space. In 2015, the city set up a "big data innovation team" to tease out insights from information generated by electronic traffic counters, cycling apps, vehicle detectors and other sources that produced continuous flows of digitized transportation information.

The plan envisioned significantly restricted private-vehicle use on King Street in order to improve streetcar service. Data analysts used low-resolution cameras installed in traffic signal controllers to monitor pedestrian and vehicles volumes, and then drew on anonymized Bluetooth signals from phones to calculate how much time riders spent on streetcars traversing the area. Project officials also tracked daily revenues through point-of-sale payment devices to assess how declines in vehicle traffic impacted King Street businesses.

The city published a monthly dashboard of key metrics to demonstrate changes in travel times, cyclist and pedestrian activity and commerce. Restaurants, in turn, were allowed to build partially enclosed patios extending into the street — a move that laid the ground work for the city's Cafe-TO pandemic program, which let scores of eateries expand into cordoned off parking spaces.

The metrics affirmed the experiences of commuters, residents and local businesses: that streetcars were moving faster, pedestrian and cycling activity was up and merchants hadn't seen a drop in business, as some had feared. In 2019, council voted to make the King Street corridor permanent.

As with downtown Copenhagen and Times Square, the King Street project illustrated how planners and analytics experts can make innovative uses of granular urban data in order to deliver city-building goals, and that it was possible to do so without compromising privacy or directing scarce funds to smart city tech firms.

A TTC streetcar makes its way along the King Street Pilot Project (near Bathurst) past some empty chairs and tables in 2018. The city used data gleaned via Bluetooth and other sources to confirm that the project worked as hoped. PHOTOGRAPH / TORONTO STAR

GETTING THE REAL NUMBERS OUT OF 311

When municipalities across North America began setting up 311 call centres to handle requests and complaints, the centres weren't positioned as "smart city" systems. Rather, proponents saw 311 as a means of improving citizen engagement and bureaucratic accountability. Over the years, 311 services, including Toronto's, have become increasingly tech-enabled, with social-media accounts, apps and the release of machine-readable complaint-tracking records through open data portals.

Municipalities now sit on vast troves of data from 311 calls — hundreds of thousands or even millions per year — that can be mined and analyzed, and then used to inform municipal planning and budgeting. A proliferation of calls about basement floods, missed garbage pickups or dubious odours from factories can provide important clues, both about what's happening in a neighbourhood as well as the performance of city departments. If scanned carefully for longer-term patterns, 311 calls can also offer predictions about future problems.

These digital mountains of call records certainly qualify as "big data." But the ways in which this information is or can be used also offers important lessons, both positive and negative, about applications for other large urban data sets that might be generated by smart-city technologies.

The most obvious application is how municipal agencies respond to residents' requests for service. New York University urban analytics expert Constantine Kontokosta observes that many municipalities tend to be make such decisions in a "black box," with little transparency as to whose needs take first priority (first-come-first-serve, a triage system, etc.). He and other 311 researchers say that these data sets also contain important signals that could assist in making service delivery either more efficient or more equitable (which aren't necessarily the same thing).

One pattern, noted by a New York state Health Foundation/Harvard research team in a 2020 study, found that spikes in calls about a particular problem may be orchestrated community

The City of Toronto 311 operations centre in Metro Hall. PHOTOGRAPH RICK MADONIK / TORONTO STAR

campaigns. The study described the practice as a "misuse" that could lead city officials to "erroneously" conclude that an area was experiencing some kind of decline.

Another evaluation, published by Kontokosta in 2017, looked at New Yorkers' complaints about hot-water problems in their buildings. Drawing on 311 data, inspection reports, census tract information and other records, the study found that neighbourhoods with high rents and incomes, better educated residents and larger non-Hispanic white populations "tend to over-report": "Based on these results, we find that socioeconomic status, householder characteristics and language proficiency have a non-trivial effect on the propensity to use 311 across the city."

Still other analysts have mined 311 data sets to show how they correlate to broader trends, such as the spread of urban "blight." Those patterns, according to a 2016 analysis by NYU and the Center for Urban Science and Progress, could theoretically be used to predict future real-estate prices.

In 2017, a team of geographers and artificial intelligence scholars at the University of Illinois Urbana used six years of Chicago 311 sanitation service requests (e.g., overflowing garbage cans) to develop what they said was the first algorithm capable of generating predictions to help guide decisions about scheduling and routes.

> "Neighbourhoods with high rents and incomes, better educated residents and larger non-Hispanic white populations 'tend to over-report': 'Based on these results, we find that socio-economic status, householder characteristics and language proficiency have a non-trivial effect on the propensity to use 311 across [New York City].'"
>
> — CONSTANTINE KONTOKOSTA

Kontokosta, whose work focuses more on fairness and equity than efficient management, contends that such algorithms will eventually be available commercially, but notes that one limiting factor is that many local governments still use older mainframe computers that don't have the chops to process so much data.

The other is a dearth of data scientists and mathematicians on municipal payrolls. "People with these skills," he says, "aren't working for cities."

TECH CAN HELP CITIES IMPROVE SERVICES

But first leaders have to ask hard questions about privacy, equity and more

SUNDAY JANUARY 10 2021 | SAN DIEGO

On a Zoom call earlier in the year, Jim Benson, a senior marketing executive for GE Current, is walking through a slick but intriguing PowerPoint presentation, extolling the diverse virtues of the company's smart lighting "nodes."

General Electric, he begins, has been in the lighting business for well over a century. In recent years, the firm's "intelligent environment" group began thinking about street lighting — an "under-utilized asset" with vast potential. The commercialization of long-lasting, low-energy LED lights opened that door, as municipalities looking to cut emissions began replacing their sodium street lamps with these new products. LED street lights could even be adjusted remotely.

GE Current (now spun off) wanted to go further and look at street lighting completely differently. The company designed a node that sits at the top of a power pole, next to the LED fixture. This white plastic box contains digital sensors, computing power and Wi-Fi connections to a cloud-based

Municipal scandals, like San Diego's case with GE Current's smart lighting system, reveal what can happen when smart-city technology and salesmanship confound well-established municipal procurement rules. ILLUSTRATION McKENNA DEIGHTON / TORONTO STAR

database called CITY IQ, operated by GE Current. GE Current tells potential customers the nodes can be financed using $2.4 million in energy savings from the LED lights, so it's essentially a wash for taxpayers. "It allows the city to do lots of things," Benson says.

The devices come with air quality monitors and fish-eye cameras that can monitor bike or vehicle volumes, unsafe driving and parking infractions. There's even an audio device linked to a third-party software system called "ShotSpotter," which detects gunfire, estimates the location and notifies 911.

GE Current has sold its smart lighting systems to the cities of Portland, Atlanta and San Diego. Benson insists the sensors have been fitted with data privacy protections — the shot detector, for example, can't make out voices. But, he acknowledges, not all customers wanted the video capabilities. "There's a lot of sensitivity around this."

That would be putting it mildly. In San Diego — which paid $30 million to purchase 4,200 nodes in 2016, becoming GE Current's largest customer — revelations about police using the video cameras set off a fight about two years ago, pitting the mayor and the police chief against racialized communities and civil-liberties activists. San Diego council scrambled to contain the fallout, and last summer ordered city officials to pause data collection and disable the cameras — unsuccessfully, as it turned out — until they had addressed the privacy and surveillance concerns.

"The city has been trying to cover up what they knew about the technology," charges Geneviéve Jones-Wright, a San Diego lawyer and Democratic candidate who speaks for TRUST SD, a coalition that fought the use of cameras.

While this story, on one level, seems to be about the introduction of covert surveillance devices into the public realm, it is about something else as well. San Diego's struggles reveal what can happen when smart-city technology and salesmanship confound well-established municipal procurement rules — the latter being an unsexy administrative task that normally generates few headlines and even less political attention.

In an effort to combat gun violence, in 2018 Toronto brought in as a pilot project the so-called ShotSpotter microphone technology that provides police real-time information about shooting locations. The technology has provoked controversy, however, both here and in San Diego. ILLUSTRATION / SHOTSPOTTER.COM

Through their procurement divisions, municipal governments buy all sorts of goods and services, from road salt and engineering services to buses and laptops. Typically, these departments draw up requests for proposals (RFP) and award contracts to low bidders. The procurement system is highly structured and constrained by legal precedent to ensure fairness for contractors and protection for taxpayers against bid-rigging, price-fixing, collusion, kickbacks and other forms of corruption. Governments are mostly bound by law to award contracts to low-cost bidders and ensure an objective evaluation process. Other factors also come into play, such as policies favouring minority-owned businesses, climate-friendly suppliers or compliance with international trade agreements.

When procurement works well, it lets municipalities deliver services to residents. But when procurement goes sideways — as happened in Toronto in 2000 with a smelly computer leasing deal — it can come under intense scrutiny. A flawed procurement lay at the heart of the controversy over Waterfront Toronto's arrangement with Sidewalk Labs, which began with a problematically open-ended RFP that some alleged had been written specifically for Sidewalk Labs, although no evidence to prove this suspicion surfaced.

In San Diego, the glitch occurred at the very outset, when the city bruited the notion of buying smart lights from GE. As it turns out, municipal officials had a lot to say about what these devices *would* do (reduce energy consumption and identify areas with lots of cyclists in order to expand the bike lane network).

What the city didn't explain, however, is what they *could* do.
In mid-December 2016, San Diego finalized a contract to gradually replace 14,000 of its 60,000 street lamps with GE Current's intelligent lighting devices. According to city procurement reports cited in a police policy document obtained by a local newspaper, the installation of the first 4,000 nodes would allow the city to transform the equipment "into a connected digital network to optimize parking and traffic, enhance public safety and track air quality."

What did officials mean by "enhance public safety?" They insisted — after the fact — that the embedded street-oriented cameras weren't meant to be surveillance devices and were equipped with software that obscures details such as faces, private property and licence plates.

"It really started as an energy project," says the city's deputy chief operating officer Erik Caldwell, who adds that San Diego, which got the equipment on "favourable terms," was seen by the company as a showcase. Informed observers question this account. "It was clear from those contracts that they weren't just street lights," says Rutgers University privacy law expert Ellen Goodman.

In 2018, San Diego Police Department officials realized they could use the video footage, which is stored for five days, in investigations and began asking the city to release it. City council wasn't informed about the SDPD's interest. "In our conversations with GE and council, we made it clear we didn't want to use the system for law enforcement," Caldwell insists. "That was not our intention." Still, he adds, the city had "a legal and moral" obligation to hand over the footage when the police asked for it.

Jones-Wright has a far more skeptical account of the city's conduct. She says officials and the mayor's office made little effort to explain the system's capabilities early on and mostly played up the environmental benefits. "There was never even a public discussion," she says. "The city has been trying to cover up what they knew about the technology."

Many of the remaining 10,000 units, Jones-Wright adds, are destined for low-income communities. "No one had a chance to weigh in on this."

As revelations about the police use of the nodes surfaced in documents obtained through access-to-information requests made by reporters, the SDPD noted how the cameras had not only assisted with investigations but, in one incident, disproved assault charges that had been laid against a bystander.

"We had no idea what the quality of video would be, or what it would capture," Jeffrey Jordon, who leads special projects and legislative affairs for the police department, told Bloomberg/CityLab last year. "The first time we saw it we were like, 'Holy cow, that's really good video.'"

As the controversy widened, it became increasingly obvious that the city was operating in a policy vacuum. There were unanswered questions about the ownership of the data and metadata generated by the nodes, and whether the information could be mined or sold. There were no rules around how the police would access the video and under what circumstances. And the city had done nothing to consult the community about privacy issues. "They're collecting data about how I move (around) in the city without acknowledging that we should have a say in that," says Jones-Wright.

The politics shifted in 2019. The SDPD issued a procedure document outlining the use of the video but critics pointed out that such policies were designed by and for law enforcement. The city published a directive that sought to clarify the ownership status of the data — not just from the cameras but in the other sensors — and also who has access. Yet Jones-Wright and the

Geneviéve Jones-Wright, a San Diego lawyer and Democratic candidate, speaks for TRUST SD, a coalition that fought the use of cameras in streetlights. PHOTOGRAPH / JONESWRIGHTFORDA.COM

TRUST SD coalition pushed for a complete moratorium on further deployment until San Diego council had produced a legally enforceable privacy policy with public oversight.

After a year of bitter fighting, and more troubling revelations about how police used the footage — e.g., during protests in the wake of the George Floyd murder — council cut off funding for the street lights in July and in mid-November approved stricter controls and better governance processes, including the establishment of a privacy advisory board that reports to council.

"Let us never underestimate the power of concerned community members coming together and making change," Jones-Wright said. "The work started because our government and public officials failed us."

A growing number of cities are either buying or considering smart lighting, and some like Oakland have opted to disable video to head off concerns about surveillance. San Diego's Caldwell, for his part, points to the broader issue of unintended consequences. "It's a kind of lesson for cities thinking about smart-city technology."

For policy makers, one problem has to do with intention. When municipalities buy buses, playground equipment or road salt, it's pretty clear how they will be used. Data-generating digital technologies, by contrast, are packed with latent capabilities: they can do many things, not all of which are known ahead of time. The smart phone is a perfect example. Did Steve Jobs envision that someday, Bluetooth-enabled electric toothbrushes would have digital features that deliver brushing effectiveness metrics to an app on your smart phone? Probably not.

Another has to do with evaluation. Many smart-city systems, especially those that use artificial intelligence, involve complex technologies — e.g., autonomous mini-buses — that may be difficult for municipal officials to assess in terms of reliability, value for money and compliance with other crucial policies, particularly privacy and data rules. (The World Economic Forum, together with the U.K. government, Salesforce and Deloitte, this year published a guide to public-sector procurement of AI systems, and it sets out high-level principles around risk, scrutiny, and the involvement of humans in automated decision-making systems.)

Finally, for all the hype about smart city solutions and the presence of major tech firms in the market, the industry is far from mature, which means that procurement managers may find themselves recommending sole-source contracts because only a single firm responded to an RFP.

Toronto council earlier this year narrowly avoided just such a quagmire. City technology officials recommended entering into a $13.6-million, three-year contract with PayIt, a Kansas City firm that provides smartphone-based payment apps for government services in exchange for transaction fees. The company had made an unsolicited proposal to the city's partnerships office, despite warnings from the city's auditor-general about the risks of such deals. "Under no circumstances, even in a pandemic, should a deal for a core part of the City's digital infrastructure be sole sourced," commented Bianca Wylie, an open-government activist and outspoken critic of the Sidewalk Labs plan. Council voted to ask for more bidders before proceeding.

Barbara Swartzentruber, executive director of Guelph's smart city office, says that the difficulty for municipalities is that these technologies have become intensely polarizing. "Either you're for innovation and risk, or you're a Luddite."

Guelph was one of three Canadian municipalities in 2019 to win the federal government's "smart city challenge." But beyond that venture, officials in Guelph, as well as London and Barrie, have been working with a group at Toronto tech incubator MaRS to design an innovation-driven procurement process that includes, but isn't driven by, technology — and is also designed to anticipate problems instead of react to crises.

"It has to be an eyes-wide-open conversation," says Swartzentruber, who adds that she regularly gets sales calls from firms pitching the latest and greatest smart-city solutions.

The challenge for municipalities, obviously, is to not get taken in by a sales pitch and end up locking in to a complex contract that effectively gives the supplier all sorts of advantages, such as unanticipated data-ownership rights or provisions that effectively make it impossible for a different firm to add to a system.

In other cases, the problem is that the market remains underdeveloped — either there are only a few firms delivering a service or the ones that bid for contracts haven't worked out the kinks in their technology.

Sue Talusan, a design manager at MaRS, says the Municipal Innovation Exchange program aims to provide cities with a procurement "toolkit" designed to help officials figure out what they might need and then to assess the market, before putting out calls for bids. These measures include pitch days, "market soundings" (i.e. getting a sense of what's available) and the use of accelerators. She also reminds municipal officials that they need to engage the public early.

In Guelph, transportation officials participated in a "problem discovery" exercise and came up with an idea to affix digital cameras to city vehicles that could capture images and locations of potholes, cracks and other signs of wear on the 581 kilometres of roadway within city limits. The data would be uploaded to a spreadsheet to assist the city in prioritizing 311 calls and allocating capital budgets.

Guelph officials, Talusan notes, realized early the need for technology that blurs identifying details, such as licence plates or faces, to ensure privacy. The municipality also asked Guelph Lab, a small civic accelerator run jointly by the city and the University of Guelph, to research the proposal. Sam Laban, the lab's facilitator, served up some important insights: U.S. research, he found, has shown that municipal works departments that rely on digital feedback to drive maintenance decisions don't treat all neighbourhoods equally.

Some studies showed, for example, that predominantly Black communities log plenty of requests for service, but tend to be underserved. Meanwhile, neighbourhoods with many new-comers generate fewer complaints and may get even less attention. "Equity isn't implicit in these technologies," Laban says.

As they contemplated their project, Guelph officials knew they would have to look at equity inclusion when vetting potential vendors to avoid investing in technology that amplifies, rather than reduces, underlying social problems.

As Barbara Swartzentruber considers the various innovation proposals that have landed on her desk, she has come around to the view that it's best to be cautious and start small — for example, with pilot projects that can easily be iced. She is acutely aware of the pressure imposed by vendors that want municipalities to be more daring. "We have to go a bit faster and the tech people have to go a bit slower, and we'll meet in the middle."

> "Some studies showed, for example, that predominantly Black communities log plenty of requests for service, but tend to be under-served. Meanwhile, neighbourhoods with many newcomers generate fewer complaints and may get even less attention."

'EDGE COMPUTING' THE LATEST INNOVATION FOR CITIES — FOR WHEN THE DECISIONS HAVE TO BE QUICK

London, Ont. parks and recreation officials had a public-space dilemma: some sports fields, which organizations have to reserve, were being used by non-booked groups, while others were languishing empty. Typically, parks supervisors manage bookings, but they can't be everywhere at once. So London officials decided to work with the MaRS Municipal Innovation Exchange to find a way to ensure compliance and make better use of underused recreational spaces.

The result is a pilot project with Numina, a Brooklyn-based startup that makes "computer vision sensors" that look like tall-boy beer cans and are strapped to hydro poles. The devices map pedestrian activity without capturing human images — an approach Numina describes as "intelligence without surveillance."

The firm, which last year partnered with Sidewalk Labs, says it runs the data through its software to provide cities with insights about how people are using public space. London officials say they'll use the technology to assess how many people are using recreational amenities and for what purposes.

Numina's technology is an example of "edge computing," a phrase that describes dispersed digital networks that bundle powerful analytics with the sensors, rather than in a central computer system. In some business applications, edge computing is about reducing what software engineers describe as "latency" — the time lag when large volumes of data travels between devices and mainframes.

One of many potential applications, according to a 2019 study by the Institute of Electrical and Electronics Engineers (IEEE), involves "smart" traffic lights that may someday communicate with autonomous vehicles, sending signals that they need to slow down or stop. In such scenarios, the system will have to rapidly detect vehicle activity, make calculations and send out notifications to approaching AVs as quickly as possible, which means the software has to be situated in "road side units" — traffic-signal controllers located near intersections.

Others see edge computing as a potential solution to privacy and surveillance concerns. If sensors deployed in urban settings are engineered to block or obscure identifying details *before* transmitting data to municipal control centres — an approach known as "privacy by obscurity" — they might head off the kind of controversy that engulfed San Diego's smart lighting project. But the authors of the IEEE study warn that edge computing infrastructure also "exhibits novel security risks" that make these devices potentially more susceptible to malware attacks than carefully protected centralized or cloud-based computers and databases.

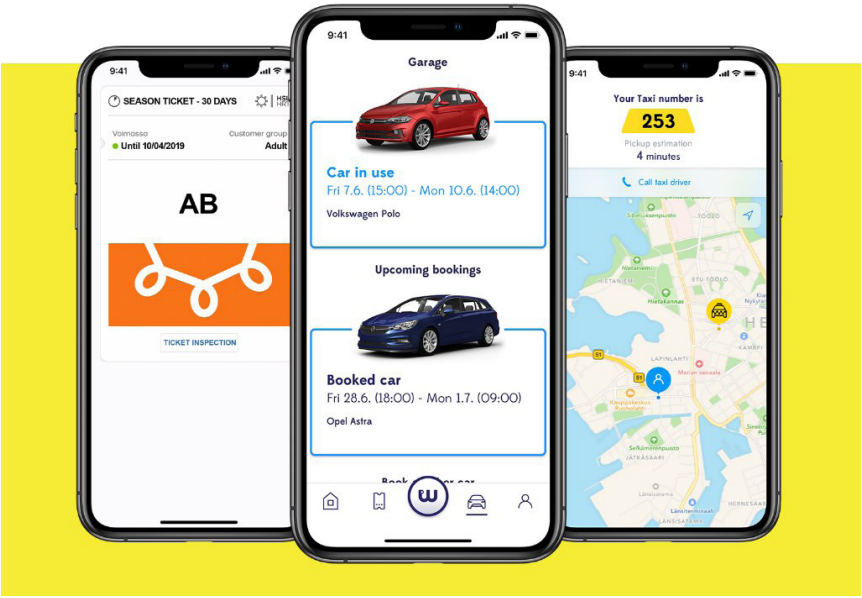
MOBILITY TECH OFFERS CITIES ENORMOUS OPPORTUNITIES FOR HELPING RESIDENTS GET AROUND — IF THEY CAN AVOID THE QUAGMIRE

MONDAY JANUARY 11, 2021

It was an idea that seemed to have all the right ingredients for the tech-saturated world of 21st century urban mobility. In 2015, a Helsinki start-up unveiled a plan for something it called "mobility-as-a-service," or MaaS. The company, MasS Global, had an app that provides city-dwellers with a digital one-stop shop for all sorts of travel options – transit, taxis, ride hailing, bike sharing, and so on.

With Google's online mapping function, commuters can plot the best way to get from A to B and then, through the app, procure or book the transportation modes that fit the route and the users' preferences. MaaS Global sells monthly subscriptions, not unlike cellphone packages, that provided various combinations — up to a given number of transit trips, a certain number of ride-hailing journeys and so on; the bookings are made through smart phones. The company's mission

Urban mobility is arguably the single most sought-after prize in the sprawling smart city industry.
ILLUSTRATION McKENNA DEIGHTON / TORONTO STAR



is, quite simply, to provide a "true" alternative to private vehicle ownership. "MaaS," according to the firm's website, "could be the single most powerful tool to decarbonize transport for future generations."

The idea rapidly caught the imagination of other mobility entrepreneurs, as well as venture capital firms and transportation giants like Siemens. "We need to make end-to-end trip planning easier," says Roland Busch, Siemens' deputy CEO.

As of late 2019, MaaS Global had raised almost $54 million ($84 million Canadian) from investors, including BP and Mitsubishi. Its app, known as Whim, was available in Helsinki, Vienna, Antwerp, and a handful of other cities. Montreal, which won a $50-million federal smart city challenge, is in the process of developing its own version (the city's pitch included technology solutions to community mobility and local food security issues).

Even in progressive jurisdictions, municipal transit agencies have not welcomed this innovation — most don't want to relinquish the pricing and distribution of fares to third parties — and consumers have been slow to sign on. According to a recent report by *Bloomberg/CityLab*, some MaaS firms are also facing financial difficulties because the business model isn't especially profitable, yet. "If you're going to disrupt automobiles, one of the biggest industries in the world, it will take a bit of time," said Global MaaS founder Sampo Hietanen.

Notwithstanding its current commercial prospects, the MaaS sector reveals much about the promise, risk and peril of digital urban mobility, which is, arguably, the single most sought-after prize in the sprawling smart city industry. Smart mobility encompasses a wide range of digital technologies and applications, from those already in wide usage (car and bike sharing services, ride-hailing, transit smart cards, parking apps, electric vehicles) to those that are very much under development (autonomous cars, buses and trucks, "smart" traffic signals, curb-mapping, drone delivery vehicles, and even streets where illuminated lane pavers adjust automatically based on traffic levels detected by sensors, an idea bruited by Sidewalk Labs for its now-cancelled Quayside project).

The Whim app by MaaS is available in Helsinki, Vienna, Antwerp, and a handful of other cities. GRAPHIC / MAAS

Many of these technologies will rely heavily on artificial intelligence algorithms and densely layered digital mapping applications (Google Maps and Waze, as well as proprietary systems being developed by car manufacturers) that mesh GPS, satellite images and cellphone signals along with a rapidly expanding collection of real-time data streams, from dynamic bike-sharing or transit maps to parking spot addresses and eventually, perhaps, even the location of unfilled potholes. Some of the granular information that drives these services will come from people moving through cities, while other tranches will be harvested from municipal agencies' open data portals.

In some fields, there are enormous opportunities presented by the technologies that fall under the broad heading of smart mobility: more responsive traffic and transit planning; improved accessibility for groups that face impediments in moving around cities (disabled residents, seniors, children); and better low-carbon alternatives to privately owned fossil-fuel burning vehicles.

What's more, transportation planners now need even more precise real-time travel data in order to find ways of responding to the profound and often unpredictable pandemic-related disruptions in how people move around cities.

A case in point: over the past few years, the TTC has installed sensors on the doors of all its buses that record how many passengers are boarding and how many are exiting and send this information to the agency's control centre. Initially intended to create periodic ridership reports to allow the TTC to adjust service levels, agency officials during the pandemic figured out how to tweak the system so it could detect, in real time, when more than 25 people are on a bus, meaning it's too full to permit adequate social distancing. The system generates "heat maps" showing which routes are experiencing overcrowding. TTC managers use that intelligence to dispatch buses that have been put on stand-by for this specific purpose.

Yet the disruptive arrival of ride hailing services like Uber and Lyft — which, pre-pandemic, fueled congestion and eroded transit usage — serves as a warning that future market-driven mobility innovations will require scrutiny, careful policy planning and clear-eyed assessments of the costs and the benefits.

University of Toronto geographer Shauna Brail studies the ride-hailing sector. Some of the big players, she notes, have slowed or closed their autonomous vehicle research and development operations. PHOTOGRAPH JOHNNY GUATTO / UNIVERSITY OF TORONTO

Over the past two years, new car buyers have been able to choose vehicles with safety features that hint at the dawn of a new era. Automated anti-collision systems developed by manufacturers like Toyota process information from dash-cams, GPS devices, tiny radars, on-board sensors with recognition capabilities and systems that track and adjust the vehicle's position in a lane. The automotive industry, as well as tech giants like Google, have invested billions in these kinds of innovations, and they can be seen as some of the earliest advances that may lead to fully autonomous vehicles (AVs) — so-called "level five," for their ability to guide themselves without a driver.

During much of the decade before the pandemic, the investment hype around AVs reflected a feverishness informed by futuristic visions of vast fleets of driverless cars, operated by ride-hailing companies. Instead of private vehicle ownership, city-dwellers could travel simply by summoning shared AVs, which would cost far less to use because there were no drivers to pay.

Some critics, however, found this image of urban mobility to be troubling and rife with questions: Where would AVs go when they didn't have passengers? Would these services accelerate sprawl or further erode transit ridership, which has already seen drops due to the popularity of ride-hailing? What about safety? Despite all the talk about AVs being immune to distracted driving, who is responsible if a cyclist or a pedestrian is hit, as has happened in trials? And finally, are such vehicles, with their wireless connectivity, vulnerable to hacking, satellite signal disruptions or even power-outages?

Other experts point out that the pandemic has fundamentally altered the presumed uses for fleets of AVs operated by companies such as Uber or Lyft. "There are huge challenges right now with sharing anything," says University of Toronto geographer Shauna Brail, who studies the ride-hailing sector. Some of the big players, she notes, have slowed or closed their AV research and development operations.

Transportation technologies, moreover, can bring unintended consequences; one need only think about the earth-changing impact of the internal combustion engine to see that technical innovations have triggered profound social and ecological upheaval. But with fully automated AVs still at least a decade — and more likely two decades — away, it's by no means clear how local and regional governments should proceed. Clearly, there will be implications to the advent of AVs, but no one really knows what a proactive policy response should look like.

But the messy, and mostly unregulated, arrival of ride-hailing offers important insights. In the early- to mid-2010s, tech upstarts like Uber wielded the triumphant rhetoric of disruption: innovators could topple lumbering incumbents that had grown complacent, but such was the way of capitalism. After all, does anyone today fret that a very young Microsoft kneecapped IBM in the 1980s, or that Steve Jobs ruthlessly dethroned Blackberry with the iPhone in 2007?

Yet mobility, and specifically urban mobility, isn't just another consumer good or service; cities are defined, in fundamental ways, by their transportation networks, which create urban spaces, enable commerce, support labour markets, activate street life but also require extensive planning and public investment. The notion that mobility is a "market" isn't wrong, but it doesn't tell the whole tale.

Some cities welcomed Uber *et al* and ignored the complaints of taxi companies; others imposed regulations, banned Uber outright or sought to give home-grown ride-hailing firms a leg-up. Over time, however, the policy environment in many places has shifted, including in Toronto. According to a 2018 study conducted by researchers with the University of Waterloo's School of Public Health and Health Systems, safety concerns relating to driver training, background checks and insurance drove regulatory action in many jurisdictions.

What's missing from that study's list, however, is the non-negligible impact that ride-hailing has had on transit, transportation and land-use planning. For example, a 2018 analysis published by three University of Kentucky civil engineers found that in U.S. cities, each year after the arrival of ride-hailing companies saw rail ridership fall by 1.3 per cent and bus ridership drop by 1.8 per cent. "The effect builds with each passing year and may be an important driver of recent ridership declines," the authors conclude. Those losses translate into increased traffic and emissions, as well as accelerating operating shortfalls for transit agencies. Put another way, the profits earned by ride-hailing firms come directly at the expense of the public purse.

"In U.S. cities, each year after the arrival of ride-hailing companies saw rail ridership fall by 1.3 per cent and bus ridership drop by 1.8 per cent. The effect builds with each passing year and may be an important driver of recent ridership declines."

The Town of Innisfil, north of Greater Toronto, sought to square this circle by offering subsidized or flat-fee Uber rides as a substitute for bus service — an experiment that garnered international media attention when it launched in May 2017. The problem, as it turns out, was that residents enthusiastically embraced the offer, so much so that the town has ended up spending far more than it would have on a conventional bus service and had to impose a cap on how many subsidized trips an individual could take. What's more, Innisfil, which plans to develop a walkable urban core over the next few decades, has seen an increase in vehicular traffic, according to some reports.

More recently, e-scooter firms like Lime and Bird borrowed from Uber's playbook, rapidly launching their services, in some cases without seeking municipal approval. Like ride-hailing, e-scooters can be booked and paid for via a smartphone app; in some cities, they can be left anywhere, cluttering sidewalks and sowing confusion about where they can travel. Because e-scooters can move so rapidly, cities that have allowed these devices have also seen a spike in collision-related injuries, in some cases even exceeding those involving pedestrians and cyclists. (In Ontario, Queen's Park last year announced a five-year pilot to "examine their ability to safely integrate with other vehicle types and determine whether existing rules of the road are adequate." It's up to municipalities to choose to participate.)

Then there's the data piece. University of Ottawa professor Teresa Scassa, Canada research chair on information law and policy, notes that Los Angeles County planners wanted to understand if dockless scooters made a dent in the so-called "last mile" problem — the final stretch between home, shopping and work where there are few transportation options other than private vehicles. As a quid pro quo, she says, county officials offered to allow the e-scooter companies to operate on city streets, on the proviso that they provide anonymized usage data for planning purposes. But the firms' balked and appealed to state legislators for protection.

Cities' experiences with both ride-hailing and e-scooters should sound a "warning shot" for municipal officials. "The disruption from AVs is likely to be much more substantial," Kirsten Rulf, an analyst with the Harvard Kennedy School Autonomous Vehicles Policy Initiative, cautioned on Medium in 2018. "Cities and states need to move into the driver seat now to set the right course for their constituents. That is why learning from both the scooter wars and the rapid and irrevocable [ride hailing] implementation is essential for city and state policy-makers. They can avoid being on the defensive once again by acting now on AVs."

While AVs will likely be several orders of magnitude more disruptive than either e-scooters or ride-hailing, the prospect of developing AV policy proactively serves up a classic chicken-and-egg dilemma. With the technology still under development, many governments are reluctant to act, beyond enabling AV test projects, such as pilots of automated mini-buses. At the same time, AVs, once commercially viable, shouldn't be allowed to use public rights of way in the absence of standards and regulations that govern traditional vehicles.

Which is not to suggest policy-makers aren't thinking about AVs; many are. For example, Transport Canada, earlier this year, released a detailed "guidance" on cyber-security for "connected and autonomous vehicles" — an acknowledgment that hackers or terrorists could corrupt these computer systems on wheels, either during the manufacturing process or while they're on the road and operating. The guidance points out that Canada is heavily involved in international standards-setting working groups focused on harmonizing AV regulations.

Katelyn Truong test rides a Bird Scooter. Electric scooter company Bird launched a pilot program in the Distillery District in Toronto in 2019. PHOTOGRAPH STEVE RUSSELL / TORONTO STAR

At the local level, however, it's a different story. A detailed study published last year in the *Journal of the American Planning Association* concluded that most cities haven't attempted to get out ahead of the eventual arrival of AVs on local streets and highways.

MIT mobility planning scholars Yonah Freemark, Anne Hudson and Jinhua Zhao reviewed the transportation plans for 25 large U.S. cities and surveyed another 120. Few, they concluded, had begun planning for AVs. Nevertheless, many transportation officials had formed opinions about the potential consequences. "Although local officials are optimistic about the technology and its potential to increase safety while reducing congestion, costs and pollution," the authors found, "more than a third of respondents worried about AVs increasing vehicle miles travelled and sprawl while reducing transit ridership and local revenues."

The City of Toronto, interestingly, is an exception — one of the few large municipalities to date to have leaned into the problem of creating a local policy framework for a global technology that has yet to ripen. Approved last fall by council, the 176-page Automated Vehicles Tactical Plan aims to bridge the gap between the emerging technology and the city's other priorities. The document is nothing if not encyclopedic in scope. It scans the state of the technology circa 2019, the commercial eco-system in which AVs are being developed, the weave of federal, provincial and municipal regulations that apply to vehicles, potential use cases, and even the findings of surveys detailing GTA residents' expectations about AVs.

"We're very proactive in thinking about [AV policy]," says Shauna Brail, the University of Toronto geographer. "But it's unclear how to regulate something that's changing so rapidly."

The plan's main focus, explains its author Ryan Lanyon, was to force a conversation about how AVs should advance, as opposed to undermine, Toronto's other civic priorities. These include equity and health, sustainability, privacy, integrated mobility and prosperity. "We need the technology to move us to those objectives," says Lanyon, a senior transportation manager with the City. "The bigger question is, how does the technology get us there?" "The vision," he continues, "has to accommodate what we want the technology to do."

The tactical plan lays out a highly detailed menu of small preliminary steps over the next two years as a means of embarking on a much longer journey. These include measures from ensuring wheelchair accessibility on an automated shuttle bus pilot project (it is set to begin service in

Olli 2.0 is a driverless shuttle that will be used by the city of Toronto and Metrolinx for a pilot project in the Scarborough neighbourhood West Rouge. ILLUSTRATION LOCAL MOTORS / CITY OF TORONTO

the spring and will be overseen by the City, the TTC and Metrolinx) to establishing a testing "sandbox" for AV prototypes. Much of the work calls for continuing research on the development of AVs, from their impact on surface transit to the way they might circulate when unoccupied. Unstated but evident is the city's intention not to get sandbagged again by a technology that it didn't see coming.

Lanyon's report was informed by a close reading of how early car adoption influenced urban histories. In cities like Los Angeles, critical decision-points — e.g., the post-war move to tear up its extensive streetcar network — played a determinative role in the city's fraught relationship with the automobile and the related problems with sprawl and air quality.

The tactical plan draws heavily on an influential 2005 analysis of the evolution of the urban transportation technology between 1860 and 1930, by University of Manchester innovation scholar Frank Geels. He set out to explore the technical and societal "transition pathway" between the horse-drawn carriage and the automobile. Lanyon says the most important lesson from Geels' work is that there was "no critical path" that led to the dominance of the automobile; it was never some kind of foregone conclusion. Lanyon also takes the view that we're in a similar period of transition right now. "As a society, we won't just jump forward" to the adoption of AVs as they are currently imagined.

Geels' narrative — which is well worth reading — illustrates just how complex that transportation revolution was. The push to rely less on horses was informed by public health concerns — too much manure on city streets — and gave way to the advent of horse-drawn taxis and then trolleys. The inventors of early private cars experimented with batteries and steam as fuel sources, and combustion engines initially didn't catch on because they required a crank. At the same time, the late 19th-century bicycle craze gave rise to manufacturing techniques while stoking public interest in individual mobility and the use of bikes for touring. Meanwhile, cities were beginning to pave streets and replace cobblestones with asphalt as the expansion of electricity fueled the public's appetite for electric trams.

A Dearborn, Mich., inventor named Henry Ford borrowed from the new bike manufacturing techniques as he developed what would become the first mass-produced car. But, Geels argues, the application that really drove the popularity of private cars was that city-dwellers could take them out into the countryside to explore. It was a recreational, as opposed to practical, application that produced the demand that allowed the gas-powered private vehicle to dominate. "The success of the automobile," Geels concludes, "was enabled by the previous transformations."

The learning, Lanyon reflects, is that AVs will have to compete with other transportation technologies; the winner is not pre-determined just because the auto sector is sinking so much money into these systems.

Smart city watcher Anthony Townsend argues that the car industry's much-hyped investments in AVs have diverted attention from what he feels will become more impactful applications, such as smaller, nimble autonomous transit vehicles or a range of specialized mobility devices that rely on AV navigation systems, such as bikes capable of re-balancing themselves and next-gen motorized wheelchairs. "There are so many scenarios for other kinds of vehicles," he says. "But that's not part of the main narrative because that's not part of the auto industry's messaging."

For policy makers, the takeaway is that it will be extremely important to keep close tabs on how transportation markets unfold in order to assess whether AVs are likely to increase congestion or exacerbate sprawl in urban regions. As Shauna Brail adds, all three orders of government need to be engaged in order to prevent or at least mitigate unintended consequences. "I think that's really huge."

It may be that the smart mobility revolution is actually playing out off to one side, somewhere other than on the streets and in the auto sector's R&D labs. Case in point: over the past few years, a Google subsidiary called Coord has been busy mapping the *curbs* of big cities. "Curb analytics," as the company describes this venture, involves building digital maps packed with geographical data on the locations and dimensions of "assets" like parking spaces, loading zones, use regulations, taxi stops, wheelchair accessible curb ramps, fire hydrants and so on.

"A new way to see your city's curbs," announces a Coord blog post, which itemizes commercial applications for this kind of data — visualizations for municipal planners to assist in figuring out the allocation of curb space, for loading, bike lanes, or pick-up/drop-off zones. In a related venture that Sidewalk Labs planned to test in Toronto, the company would install sensors along the edges of streets to detect if a parking spot is vacant at any given moment. Such devices come with a cost, which suggests a business model and a strategy for generating revenue from them.

Even further away from the road right-of-way, Amazon is testing delivery "robots" — they resemble tall, enclosed children's wagons and are decked out with the company's smile logo. These vehicles are designed to make use of sidewalk space as they drop off parcels in neighbourhooods. The trials, reports Mashable, are taking place in Georgia and Tennessee. No doubt the pilots of these compact autonomous vehicles are being closely watched, given the dramatic surge in e-commerce since the beginning of the pandemic. (A home-grown version, known as Geoffrey and produced by Tiny Mile Robots, is being tested in Toronto.)

In recent months, the veteran Toronto mobility consultant Bern Grush has been working on developing international standards to be adopted by the International Standards Organization that

This undated photo provided by Amazon shows a self-driving delivery robot that Amazon is calling Scout.
PHOTOGRAPH / COVER IMAGES VIA AP IMAGES

would lay out rules for how such robots must function on strips of concrete that have long been the exclusive preserve of pedestrians.

This fast-growing family of smart mobility technologies is transforming the unhurried world of curbs and sidewalks into contested, and possibly financially valuable, spaces that are of intense interest to e-commerce, delivery and tech giants and, perhaps eventually, fleets of shared AVs, which will have wireless access to curb maps that identify parking spots where they can stop until the next ride. "We've never managed the sidewalk before with that complexity," Grush says. "They all compete for space."

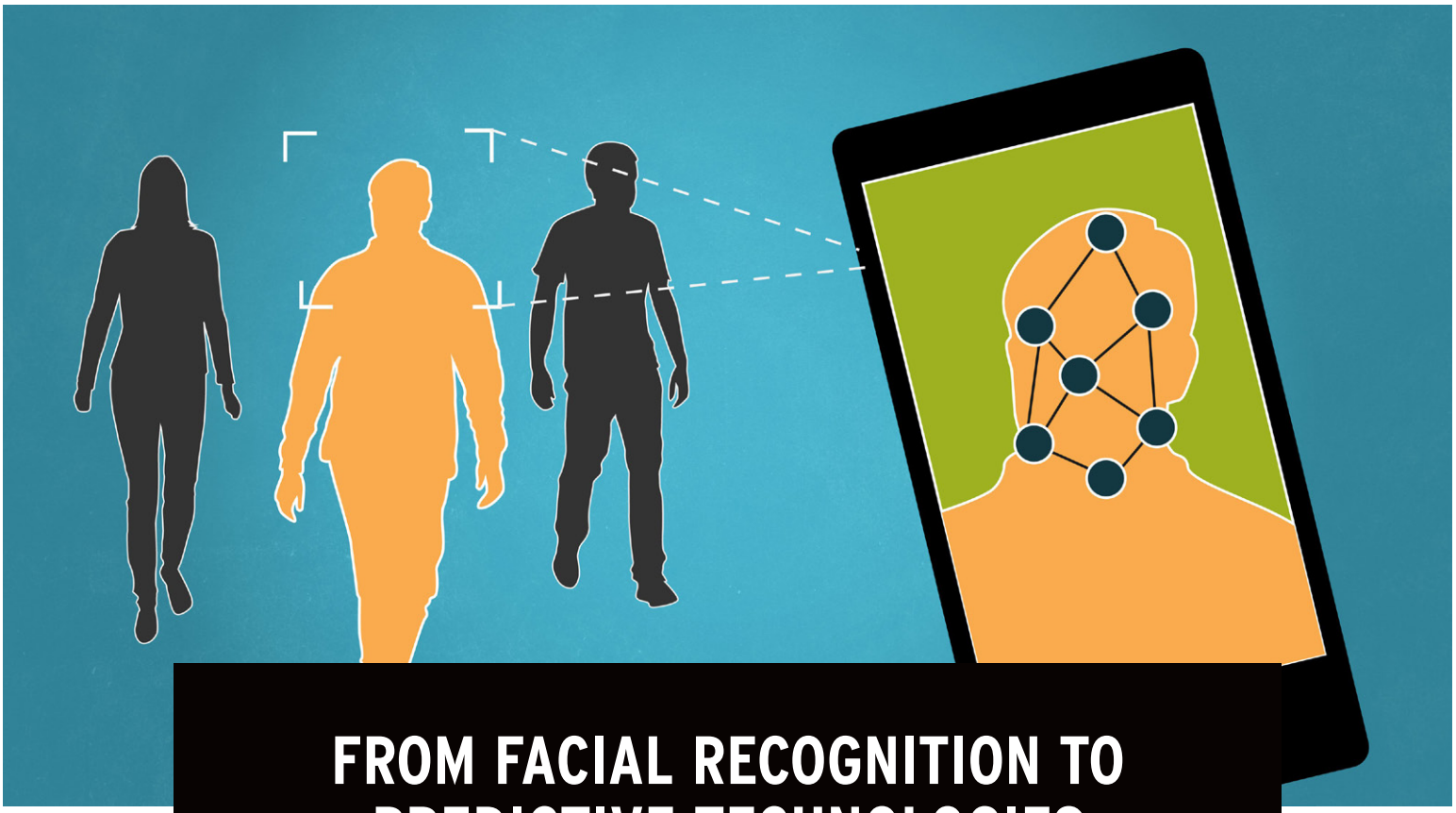
Standards development, Grush observes, has raised some complex philosophical questions. "The rules apply to the machines," he says. "I'm not contemplating anything in the standard to regulate human behaviour." The prospect of AVs navigating sidewalks means they will interact with humans, dogs, people pushing strollers, and motorized wheelchairs, not to mention recycling bins, sidewalk detritus, snow, even dog poop. "What I am saying is that if we're going to allow a robot on the sidewalk, that robot has to grant the right of way, it has to stick to one side. But will the robots change our sidewalk behaviour?"

"In a world where urban mobility becomes ever more digitally determined and eventually autonomous, the role of the city as the regulator of public space seems destined to become far more complicated — an exercise in weighing interests that could easily rank the desires of residents well below the demands of big tech."

It's an interesting question. Of course, private enterprises use — and make money from — public spaces in cities all the time, from restaurant sidewalk patios to street vendors, billboards and food trucks. Their presence does alter human behaviour — where we go and what we do, whom we meet and so on.

Yet the combination of powerful digital mapping tools and different species of AVs raises the prospect of the financialization of public spaces in order to serve the interests in of very large corporations. After all, if Uber or Lyft someday operates a fleet of AVs that will need places to park between rides, access to real-time data about the location and availability of nearby parking spaces suddenly becomes a desirable commodity. Likewise, if parcel delivery companies become reliant on the use of sidewalks, it's not difficult to imagine that they'll eventually demand that municipalities provide more and better access, perhaps even citing data collected from those routes where they encounter obstacles, like a group of pre-teens ambling home from school and blocking the sidewalk, as kids do.

In a world where urban mobility becomes ever more digitally determined and eventually autonomous, the role of the city as the regulator of public space seems destined to become far more complicated — an exercise in weighing interests that could easily rank the desires of residents well below the demands of big tech.



FROM FACIAL RECOGNITION TO PREDICTIVE TECHNOLOGIES

Big data policing is rife with technical, ethical and political landmines

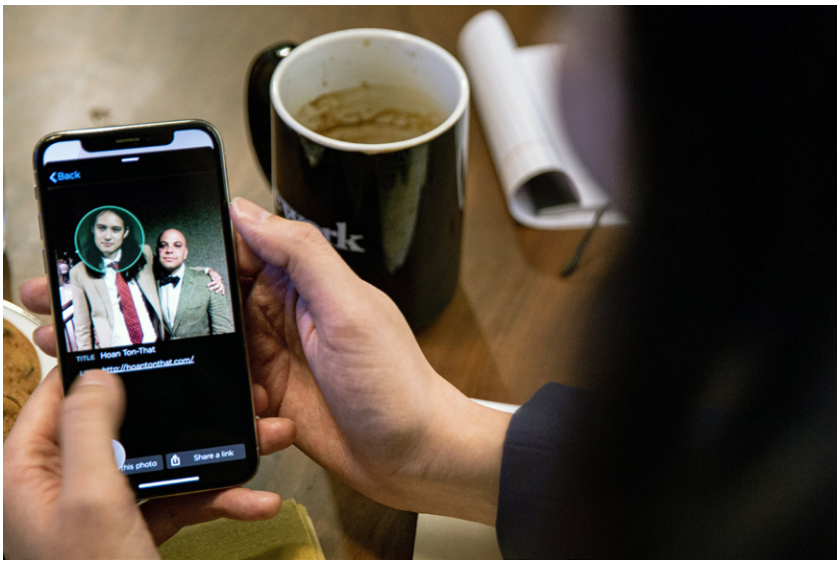
TUESDAY JANUARY 12, 2021

In mid-2019, an investigative journalism/tech non-profit called MuckRock and Open the Government (OTG), a non-partisan advocacy group, began submitting freedom of information (FOI) requests to law enforcement agencies across the United States. The goal: to smoke out details about the use of an app rumoured to offer unprecedented facial recognition capabilities to anyone with a smartphone.

Co-founded by Michael Morisy, a former Boston Globe editor, MuckRock specializes in FOIs and its site has grown into a publicly accessible repository of government documents obtained under access to information laws.

As responses trickled in, it became clear that the MuckRock/OTG team had made a discovery about a tech company called Clearview AI. Based on documents obtained from Atlanta, OTG researcher Freddy Martinez began filing more requests, and discovered that as many as 200

Over the past decade or so, dramatic advances in big data analytics, biometrics and AI, stoked by venture capital and law enforcement agencies eager to invest in new technology, have given rise to a fast-growing data policing industry. ILLUSTRATION McKENNA DEIGHTON / TORONTO STAR



police departments across the U.S. were using Clearview's app, which compares images taken by smartphone cameras to a sprawling database of 3 billion open-source photographs of faces linked to various forms of personal information (e.g., Facebook profiles). It was, in effect, a point-click-and-identify system that radically transformed the work of police officers.

The documents soon found their way to a *New York Times* reporter named Kashmir Hill, who, in January 2020, published a deeply investigated feature about Clearview, a tiny and secretive start-up with backing from Peter Thiel, the Silicon Valley billionaire behind Paypal and Palantir Technologies. Among the story's revelations, Hill disclosed that tech giants like Google and Apple were well aware that such an app could be developed using artificial intelligence algorithms feeding off the vast storehouse of facial images uploaded to social media platforms and other publicly accessible databases. But they had opted against designing such a disruptive and easily disseminated surveillance tool.

The *Times* story set off what could best be described as an international chain reaction, with widespread media coverage about the use of Clearview's app, followed by a wave of announcements from various governments and police agencies about how Clearview's app would be banned. The reaction played out against a backdrop of news reports about China's nearly ubiquitous facial recognition-based surveillance networks.

Canada was not exempt. *To Surveil and Predict*, a detailed examination of "algorithmic policing" published this past fall by the University of Toronto's Citizen Lab, noted that officers with law enforcement agencies in Calgary, Edmonton and across Greater Toronto had tested Clearview's app, sometimes without the knowledge of their superiors. Investigative reporting by the Toronto Star and Buzzfeed News found numerous examples of municipal law enforcement agencies, including the Toronto Police Service, using the app in crime investigations. The RCMP denied using Clearview even after it had entered into a contract with the company — a detail exposed by Vancouver's The Tyee.

Hoan Ton-That, the founder of Clearview AI, tests the company's app in New York on Jan. 10, 2020. Law enforcement agencies across the United States and Canada are using Clearview AI — a secretive facial recognition start-up with a database of three billion images — to identify children who are victims of sexual abuse. PHOTOGRAPH AMR ALFIKY / NEW YORK TIMES / REDUX

With federal and provincial privacy commissioners ordering investigations, Clearview and the RCMP subsequently severed ties, although Citizen Lab noted that many other tech companies still sell facial recognition systems in Canada. "I think it is very questionable whether [Clearview] would conform with Canadian law," Michael McEvoy, British Columbia's privacy commissioner, told the Star in February.

There was fallout elsewhere. Four U.S. cities banned police use of facial recognition outright, the Citizen Lab report noted. The European Union in February proposed a ban on facial recognition in public spaces but later hedged. A U.K. court in April ruled that police facial recognition systems were "unlawful," marking a significant reversal in surveillance-minded Britain. And the European Data Protection Board, an EU agency, informed Commission members in June that Clearview's technology violates Pan-European law enforcement policies. As Rutgers University law professor and smart city scholar Ellen Goodman notes "there's been a huge blowback" against the use of data-intensive policing technologies.

There's nothing new about surveillance or police investigative practices that draw on highly diverse forms of electronic information, from wire taps to bank records and images captured by private security cameras. Yet during the past decade or so, dramatic advances in big data analytics, biometrics and AI, stoked by venture capital and law enforcement agencies eager to invest in new technology, have given rise to a fast-growing data policing industry. As the Clearview story showed, regulation and democratic oversight have lagged far behind the technology.

U.S. startups like PredPol and HunchLab, now owned by ShotSpotter, have designed so-called "predictive policing" algorithms that use law enforcement records and other geographical data (e.g. locations of schools) to make statistical guesses about the times and locations of future property crimes. Palantir's law-enforcement service aggregates and then mines huge data sets consisting of emails, court documents, evidence repositories, gang member databases, automated licence plate readers, social media, etc., to find correlations or patterns that police can use to investigate suspects.

Yet as the Clearview fallout indicated, big data policing is rife with technical, ethical and political landmines, according to Andrew Ferguson, a University of the District of Columbia law professor. As he explains in his 2017 book, *The Rise of Big Data Policing*, analysts have identified an impressive list: biased, incomplete or inaccurate data, opaque technology, erroneous predictions, lack of governance, public suspicions about surveillance and over-policing, conflicts over access to proprietary algorithms, unauthorized use of data and the muddied incentives of private firms selling law enforcement software.

At least one major study found that some police officers were highly skeptical of predictive policing algorithms. Other critics point out that by deploying smart city sensors or other data-enabled systems, like transit smart cards, local governments may be inadvertently providing the police with new intelligence sources. Metrolinx, for example, has released Presto card user information to police while London's Metropolitan Police has made thousands of requests for Oyster card data to track criminals, according to The Guardian. "Any time you have a microphone, camera or a live-feed, these [become] surveillance devices with the simple addition of a court order," says New York civil rights lawyer Albert Cahn, executive director of the Surveillance Technology Oversight Project (STOP).

The authors of the Citizen Lab study, lawyers Kate Robertson, Cynthia Khoo and Yolanda Song, argue that Canadian governments need to impose a moratorium on the deployment of algorithmic policing technology until the public policy and legal frameworks can catch up.

Data policing was born in New York City in the early 1990s when then-police Commissioner William Bratton launched "Compstat," a computer system that compiled up-to-date crime information then visualized the findings in heat maps. These allowed unit commanders to deploy officers to neighbourhoods most likely to be experiencing crime problems.

Originally conceived as a management tool that would push a demoralized police force to make better use of limited resources, Compstat is credited by some as contributing to the marked reduction in crime rates in the Big Apple, although many other big cities experienced similar drops through the 1990s and early 2000s.

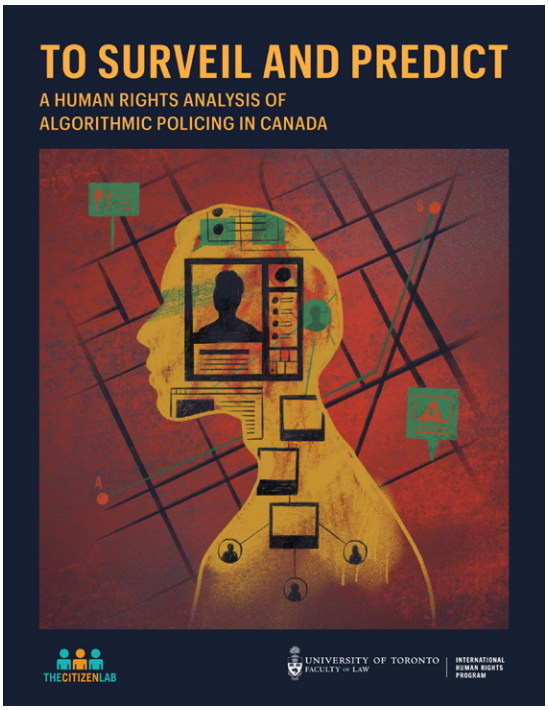
"The authors of the Citizen Lab study, lawyers Kate Robertson, Cynthia Khoo and Yolanda Song, argue that Canadian governments need to impose a moratorium on the deployment of algorithmic policing technology until the public policy and legal frameworks can catch up."

The 9/11 terrorist attacks sparked enormous investments in security technology. The past two decades have seen the emergence of a multi-billion-dollar industry dedicated to civilian security technology, everything from large-scale deployments of CCTVs and cybersecurity to the development of highly sensitive biometric devices — fingerprint readers, iris scanners, etc. — designed to bulk up the security around factories, infrastructure and government buildings.

Predictive policing and facial recognition technologies evolved on parallel tracks, both relying on increasingly sophisticated analytics techniques, artificial intelligence algorithms and ever deeper pools of digital data.

The core idea is that the algorithms — essentially formulas, such as decision-trees, that generate predictions — are "trained" on large tranches of data so they become increasingly accurate, for example at anticipating the likely locations of future property crimes or matching a face captured in a digital image from a CCTV to one in a large database of headshots. Some algorithms are designed to use a set of rules with variables (akin to following a recipe). Others, known as machine learning, are programmed to learn on their own (trial and error).

The risk lies in the quality of the data used to train the algorithms — what was dubbed the "garbage-in-garbage-out" problem in a study by the Georgetown Law Center on Privacy and Technology. If there are hidden biases in the training data — e.g., it contains mostly Caucasian faces — the algorithm may misread Asian or Black faces and generate "false positives," a well-documented shortcoming if the application involves a identifying a suspect in a crime.



Similarly, if a poor or racialized area is subject to over-policing, there will likely be more crime reports, meaning the data from that neighbourhood is likely to reveal higher-than-average rates of certain types of criminal activity, a data point that would justify more over-policing and racial profiling. Some crimes are under-reported, and don't influence these algorithms.

Other predictive and AI-based law enforcement technologies, such as "social network analysis" — an individual's web of personal relationships, gleaned, for example, from social media platforms or examined by cross-referencing of lists of gang members — promised to generate predictions that individuals known to police were at risk of becoming embroiled in violent crimes.

This type of sleuthing seemed to hold out some promise. In one study, criminologists at Cardiff University found that "disorder-related" posts on Twitter reflected crime incidents in metropolitan London — a finding that suggests how big data can help map and anticipate criminal activity. In practice, however, such surveillance tactics can prove explosive. This happened in 2016, when U.S. civil liberties groups revealed documents showing that Geofeedia, a location-based data company, had contracts with numerous police departments to provide analytics based on social media posts to Twitter, Facebook, Instagram, etc. Among the individuals targeted by the company's data: protestors and activists. Chastened, the social media firms rapidly blocked Geofeedia's access.

In 2013, the Chicago Police Department began experimenting with predictive models that assigned risk scores for individuals based on criminal records or their connections to people involved in violent crime. By 2019, the CPD had assigned risk scores to almost 400,000 people, and claimed to be using the information to surveil and target "at-risk" individuals (including potential victims) or connect them to social services, according to a January 2020 report by Chicago's inspector general.

These tools can draw incorrect or biased inferences in the same way that overreliance on police checks in racialized neighbourhoods results in what could be described as guilt by address. The Citizen Lab study noted that the Ontario Human Rights Commission identified social network analysis as a potential cause of racial profiling. In the case of the CPD's predictive risk model, the system was discontinued in 2020 after media reports and internal investigations showed that people were added to the list based solely on arrest records, meaning they might not even have been charged, much less convicted of a crime.

Early applications of facial recognition software included passport security systems or searches of mug shot databases. But in 2011, the Insurance Corporation of B.C. offered Vancouver police

To Surveil and Predict, a detailed examination of "algorithmic policing" published this past fall by the University of Toronto's Citizen Lab, noted that officers with law enforcement agencies in Calgary, Edmonton and across Greater Toronto had tested Clearview's app, sometimes without the knowledge of their superiors. REPORT COVER / CITIZEN LAB

the use of facial recognition software to match photos of Stanley Cup rioters with driver's licence images — a move that prompted a stern warning from the province's privacy commissioner. In 2019, the Washington Post revealed that FBI and Immigration and Customs Enforcement (ICE) investigators regarded state databases of digitized driver's licences as a "gold mine for facial recognition photos" which had been scanned without consent.

In 2013, Canada's federal privacy commissioner released a report on police use of facial recognition that anticipated the issues raised by Clearview app earlier in 2020. "[S]trict controls and increased transparency are needed to ensure that the use of facial recognition conforms with our privacy laws and our common sense of what is socially acceptable." (Canada's data privacy laws are only now being considered for an update.)

The technology, meanwhile, continues to gallop ahead. New York civil rights lawyer Albert Cahn points to the emergence of "gait recognition" systems, which use visual analysis to identify individuals by their walk; these systems are reportedly in use in China. "You're trying to teach machines how to identify people who walk with the same gait," he says. "Of course, a lot of this is completely untested."

The predictive policing story evolved somewhat differently. The methodology grew out of analysis commissioned by the Los Angeles Police Department in the early 2010s. Two data scientists, Jeff Brantingham and George Mohler, used mathematical modelling to forecast copycat crimes based on data about the location and frequency of previous burglaries in three L.A. neighbourhoods. They published their results and soon set up PredPol to commercialize the technology. Media attention soon followed, as news stories played up the seemingly miraculous power of a *Minority Report*-like system that could do a decent job anticipating incidents of property crime.

Operationally, police forces used PredPol's system by dividing up precincts in 150-square-metre "cells" that police officers were instructed to patrol more intensively during periods when

In this June 15, 2011 file photo, a Vancouver Canucks fan jumps from a police car that was overturned by rioters following the Vancouver Canucks defeat by the Boston Bruins in the NHL Stanley Cup Final in Vancouver, Canada. That year the Insurance Corporation of B.C. offered Vancouver police the use of facial recognition software to match photos of Stanley Cup rioters with driver's licence images a move that prompted a stern warning from the province's privacy commissioner. PHOTOGRAPH DARRYL DYCK

PredPol's algorithm forecast criminal activity. In the post-2009 credit crisis period, the technology seemed to promise that cash-strapped American municipalities would get more bang for their policing buck.

Other firms, from startups to multinationals like IBM, entered the market with innovations, for example, incorporating other types of data, such as socio-economic data or geographical features, from parks and picnic tables to schools and bars, that may be correlated to elevated incidents of certain types of crime. The reported crime data is routinely updated so the algorithm remains current.

Police departments across the U.S. and Europe have invested in various predictive policing tools, as have several in Canada, including Vancouver, Edmonton and Saskatoon. Whether they have made a difference is an open question. As with several other studies, a 2017 review by analysts with the Institute for International Research on Criminal Policy, at Ghent University in Belgium, found inconclusive results: some places showed improved results compared to more conventional policing, while in other cities, the use of predictive algorithms led to reduced policing costs, but little measurable difference in outcomes.

"I think it's crucial that we understand that there are lives at stake. This language of location-based policing is by itself a proxy for racism. They're not there to police potholes and trees. They are there to police people in the location. So location gets criminalized, people get criminalized, and it's only a few seconds away before the gun comes out and somebody gets shot and killed."

— HAMID KHAN

Revealingly, the city where predictive policing really took hold, Los Angeles, has rolled back police use on these techniques. Last spring, the LAPD tore up its contract with PredPol in the wake of mounting community and legal pressure from the Stop LAPD Spying Coalition, which found that individuals who posed no real threat, mostly Black or Latino, were ending up on police watch lists because of flaws in the way the system assigned risk scores.

"Algorithms have no place in policing," Coalition founder Hamid Khan said in an interview this summer with *MIT Technology Review*. "I think it's crucial that we understand that there are lives at stake. This language of location-based policing is by itself a proxy for racism. They're not there to police potholes and trees. They are there to police people in the location. So location gets criminalized, people get criminalized, and it's only a few seconds away before the gun comes out and somebody gets shot and killed." (Similar advocacy campaigns, including proposed legislation governing surveillance technology and gang databases, have been proposed for New York City.)

There has been one other interesting consequence: police resistance. B.C.-born sociologist Sarah Brayne, an assistant professor at the University of Texas (Austin), spent two-and-a-half

years embedded with the LAPD, exploring the reaction of law enforcement officials to algorithmic policing techniques by conducting ride-alongs as well as interviews with dozens of veteran cops and data analysts. In results published last year, Brayne and collaborator Angèle Christin observed "strong processes of resistance fuelled by fear of professional devaluation and threats of performance tracking."

Before shifts, officers were told which grids to drive through, when and how frequently, and the locations of their vehicles were tracked by an on-board GPS devices to ensure compliance. But Brayne found that some would turn off the tracking device, which they regarded with suspicion. Others just didn't buy what the technology was selling. "Patrol officers frequently asserted that they did not need an algorithm to tell them where crime occurs," she noted.

In an interview, Brayne said that police departments increasingly see predictive technology as part of the tool kit, despite questions about effectiveness or other concerns, like racial profiling. "Once a particular technology is created," she observed, "there's a tendency to use it." But Brayne added one other prediction, which has to do with the future of algorithmic policing in the post-George Floyd era — "an intersection," as she says, "between squeezed budgets and this movement around defunding the police."

The widening use of big data policing and digital surveillance poses, according to Citizen Lab's analysis as well as critiques from U.S. and U.K. legal scholars, a range of civil rights questions, from privacy and freedom from discrimination to due process. Yet governments have been slow to acknowledge these consequences. Big Brother Watch, a British civil liberties group, notes that in the U.K., the national government's stance has been that police decisions about the deployment of facial recognition systems are "operational."

At the core of the debate is a basic public policy principle: transparency. Do individuals have the tools to understand and debate the workings of a suite of technologies that can have tremendous influence over their lives and freedoms? It's what Andrew Ferguson and others refer to as the "black box" problem. The algorithms, designed by software engineers, rely on certain assumptions,

Big Brother Watch at a February 2020 protest over London police's use of facial recognition surveillance cameras. PHOTOGRAPH KELVIN CHAN

methodologies and variables, none of which are visible, much less legible to anyone without advanced technical know-how. Many, moreover, are proprietary because they are sold to local governments by private companies. The upshot is that these kinds of algorithms have not been regulated by governments despite their use by public agencies.

New York City Council moved to tackle this question in May 2018 by establishing an "automated decision systems" task force to examine how municipal agencies and departments use AI and machine learning algorithms. The task force was to devise procedures for identifying hidden biases and to disclose how the algorithms generate choices so the public can assess their impact. The group included officials from the administration of Mayor Bill de Blasio, tech experts and civil liberties advocates. It held public meetings throughout 2019 and released a report that November. NYC was, by most accounts, the first city to have tackled this question, and the initiative was, initially, well received.

Going in, Cahn, the New York City civil rights lawyer, saw the task force as "a unique opportunity to examine how AI was operating in city government." But he describes the outcome as "disheartening." "There was an unwillingness to challenge the NYPD on its use of (automated decision systems)." Some other participants agreed, describing the effort as a waste.

If institutional obstacles thwarted an effort in a government the size of the City of New York, what does better and more effective oversight look like? A couple of answers have emerged.

In his book on big data policing, Andrew Ferguson writes that local governments should start at first principles, and urges police forces and civilian oversight bodies to address five fundamental questions, ideally in a public forum:

- Can you identify the risks that your big data technology is trying to address?
- Can you defend the inputs into the system (accuracy of data, soundness of methodology)?
- Can you defend the outputs of the system (how they will impact policing practice and community relationships)?
- Can you test the technology (offering accountability and some measure of transparency)?
- Is police use of the technology respectful of the autonomy of the people it will impact?

These "foundational" questions, he writes, "must be satisfactorily answered before green-lighting any purchase or adopting a big data policing strategy."

In addition to calling for a moratorium and a judicial inquiry into the uses of predictive policing and facial recognition systems, the authors of the Citizen Lab report made several other recommendations, including: the need for full transparency; provincial policies governing the procurement of such systems; limits on the use of ADS in public spaces; and the establishment of oversight bodies that include members of historically marginalized or victimized groups.

Interestingly, the federal government has made advances in this arena, which University of Ottawa law professor and privacy expert Teresa Scassa describes as "really interesting."

The Treasury Board Secretariat in 2019 issued the "Directive on Automated Decision-Making," which came into effect in April 2020, requires federal departments and agencies, except those

involved in national security, to conduct "algorithmic impact assessments" (AIA) to evaluate unintended bias before procuring or approving the use of technologies that rely on AI or machine learning. The policy requires the government to publish AIAs, release software codes developed internally and continually monitor the performance of these systems. In the case of proprietary algorithms developed by private suppliers, federal officials have extensive rights to access and test the software.

In a forthcoming paper, Scassa points out that the directive includes due process rules and looks for evidence of whether systemic bias has become embedded in these technologies, which can happen if the algorithms are trained on skewed data. She also observes that not all algorithm-driven systems generate life-altering decisions, e.g., chatbots that are now commonly used in online application processes. But where they are deployed in "high impact" contexts such as policing, e.g., with algorithms that aim to identify individuals caught on surveillance videos, the policy requires "a human in the loop."

The directive, says Scassa, "is getting interest elsewhere," including the U.S. Ellen Goodman, at Rutgers, is hopeful this approach will gain traction with the Biden administration. In Canada, where provincial governments oversee law enforcement, Ottawa's low-key but seemingly thorough regulation points to a way for citizens to shine a flashlight into the black box that is big data policing.

SMART CITY MEGAPROJECTS GET A LOT OF HYPE

So why do so many turn out to be expensive disappointments?

WEDNESDAY JANUARY 13, 2021

A languishing brownfield site. A developer's visions of castles in the sky. Corporate partnerships to build cutting-edge smart city infrastructure. And the promise of luring tech giants prepared to invest billions.

The hype could have easily described Sidewalk Labs' now aborted Toronto venture, but this story actually played out near Boston, on a decommissioned airbase in Weymouth, about half an hour southwest of a city known for its Ivy League colleges and the booming tech industry spawned by MIT.

When LStar, a North Carolina developer, began building Union Point in the mid-2010s on that base, it looked a lot like many generic master-planned edge city projects. But a partnership LStar established with General Electric in 2017 promised much more: not just a fully wired community, but intelligent lighting (LED street lamps that can be remotely monitored), autonomous vehicles,

It starts with a developer's visions of castles in the sky. But too many smart city projects turn into expensive disappointments. ILLUSTRATION McKENNA DEIGHTON / TORONTO STAR

"Smart city rhetoric seduced local officials who were dazzled by the possibility of having an instantly lucrative, tech-focused 'smart' city. What they missed ... was the fact that so many of these smart city megaprojects had turned into expensive disappointments."

green energy "micro-grids" and streets equipped with sensors that would gauge traffic, locate parking spots and even alert police if gunshots were detected.

As the New York Times noted: "General Electric will use Union Point as a laboratory for testing new products and as a showroom for working systems." It could have been describing Sidewalk.

LStar and Weymouth officials were so bullish they believed Union Point was a shoo-in to be chosen as Amazon's second headquarters, a strange urban beauty contest that drew bids from cities across North America, including Toronto. As Kyle Corkum, LStar's managing partner, told the Boston Business Journal, "I feel sorry for the rest of the competition in the United States, because, honest to God, I have a hard time imagining another site that can score the way we're going to score."

Amazon, of course, ended up choosing New York (which promptly changed its mind), and the rest of LStar's Union Point vision soon collapsed in a cloud of recriminations, lawsuits and complaints from residents who couldn't even buy a cup of coffee in their cutting edge techno-burb. "The Smart City That Wasn't" is the cutting verdict handed down by the Journal of American Institute of Architects.

In a bid to contain the damage, Weymouth authorities took desperate measures to push out LStar, even blocking sewer hookups. In January of this year, Toronto developer Brookfield was chosen to take over the languishing project and develop it in a more conventional way.

A McGill University study published in 2019 in the journal *Cities* concluded, "Union Point represents an example of how smart city rhetoric seduced local officials who were dazzled by the possibility of having an instantly lucrative, tech-focused 'smart' city." What they missed, the authors noted, was the fact that so many of these smart city megaprojects had turned into expensive disappointments.

While smart city critics often focus on data and privacy, the Union Point saga hints at a larger story about the proliferation of large-scale *tabula rasa* smart city schemes promoted by regional governments and tech giants. They tend to be heavily monitored and privately managed. Sidewalk Labs, Union Point and a Bill Gates-backed venture in Arizona are North American examples, but many more have sprung up in the developing world. "These are private cities being developed for a million people," says Sarah Moser, an associate professor of geography at McGill, who is an expert in the emergence of these megaprojects.

Such ventures have appeared in Ecuador, Nigeria, the United Arab Emirates and Saudi Arabia. Many share key traits: state-of-the-art security, municipal and digital infrastructure management contracts with private firms and intensive government sales efforts meant to woo property investors and tech firms.

In some cases, the technology was designed in Silicon Valley but found more uptake in the global south, where privacy laws are less developed, says University of North Carolina management professor Nir Ksherti, who has studied the cybersecurity issues associated with this kind of digital infrastructure. "People in the west are always opposed to these technologies. In Asia there are different attitudes."

At least one developing world smart city — King Abdullah Economic City, in Saudi Arabia — operates as a publicly traded company. Some, especially in Asia and Africa, are tied to China's "new silk road" strategy for securing international trade networks. Others are being promoted by international consulting firms like McKinsey and Deloitte. "We're seeing it all over the Global South," says Moser, noting that government officials often fall for the glitzy sales presentations because their digital literacy is "shockingly low."

A number of factors are contributing to this global real-estate development trend, including investors' search for profits, accelerating urbanization and the tech sector's drive to secure new markets. But as Moser's research has found, many, like Union Point, fall short of the hype, take longer to build than anticipated and sometimes need to be scaled back. Still, she adds, this development-plus-technology-plus data model has raised tough questions about the emergence of quasi-privatized new cities in the 21st century.

The prototype of the master-planned smart city has been rising from a former tidal flat just off the Yellow Sea port of Incheon, South Korea, for the past decade-and-a-half. This new-build metropolis known as Songdo, now home to over 90,000 people and hundreds of businesses, is a multibillion dollar joint venture whose partners include a South Korean economic development region, Gale International, a Boston developer, and Cisco, the Silicon Valley network equipment behemoth which began promoting itself as a builder of "smart and connected communities" in 2009.

From the beginning, Songdo was envisioned as a state-of-the-art city that with high-speed digital networks and sustainability features, including LEED-certified green buildings, bike paths,

King Abdullah Economic City, in Saudi Arabia, operates as a publicly traded company. PHOTOGRAPH / KAEC

rapid transit access and a pneumatic waste-disposal system linked to a high-tech incinerator and recycling facility that eliminates the need for garbage trucks. As the developer boasted, it's an approach to "future proofing Asian cities the smart way."

Today, satellite campuses of four international universities are located in Songdo. But the streets have a generic corporate feel one finds in many rapidly developing highrise districts, like Mississauga City Centre and Toronto's South Town. The buzz around Songdo has also abated, as media reports have surfaced in recent years quoting residents who complain about the area's seeming emptiness.

Esthetics and investment aside, perhaps the most notable element of the Songdo experiment involves its governance. The area's services are managed through a public-private partnership that includes Cisco, various Korean municipal agencies and other firms, with residents and businesses purchasing services on a pay-as-you-go model. "Cisco hopes that this will make for both a more profitable and a more effective way of developing new technology around its smart and connected communities projects," noted a 2013 Public Culture study. The municipality, they add, sees this business model as a way of financing services.

Sarah Moser, at McGill, notes that the Korean government has positioned Songdo as a kind of integrated export product for regions thinking about building smart cities from scratch. Government officials from the Middle East, Africa and Latin America regularly arrive for "policy tours," she says. "Korea is selling their model of smart cities to places that can't do it on their own."

South Korea, of course, doesn't have the field to itself. Some 4,500 kilometres to the south, Forest City, a strikingly similar enclave is rising on four man-made islands just off the coast of Singapore and is nominally Malaysian. But this venture is backed entirely by the Chinese government and Chinese developers and is intended as a high-tech gated community, says Moser who characterizes it as a "neocolonial outpost" situated on a strategically critical shipping route.

From the beginning, Songdo was envisioned as a state-of-the-art city that with high-speed digital networks and sustainability features, including LEED-certified green buildings, bike paths, rapid transit access and a pneumatic waste-disposal system linked to a high-tech incinerator and recycling facility that eliminates the need for garbage trucks. PHOTOGRAPH / GALE INTERNATIONAL

Her research shows that the national government has "granted extraordinary and unprecedented concessions of sovereignty" to the developer. "[It] is a completely private city with no publicly provided services," Moser concluded in a 2018 research paper. "Education, health care, securities, utilities, management and so on, are all privatized and cater to Chinese nationals."

The bookend project to Forest City can be found on the west side of midtown Manhattan, the gleaming and recently opened Hudson Yards. Constructed during the past decade on top of an 11.3-hectare rail yard in a long neglected industrial zone, the $20-billion (U.S.) megaproject has been characterized as America's first fully "quantified community," where extensive networks of digital sensors and infrastructure systems, including pneumatic waste chutes and a co-generation plant, produce torrents of data that can be analyzed, for example, to improve energy efficiency or develop apps.

Architectural giant Kohn Pederson Fox created the project's master plan; the firm, not coincidentally, drew up the Songdo blueprint. The complex serves as the head office for Sidewalk Labs, whose founder, Dan Doctoroff, was heavily involved in the development approvals for Hudson Yards when he served as New York City's deputy mayor.

Initially pitched as self-financing, Hudson Yards' developers, Related Companies and Oxford Properties, benefited greatly from direct and indirect subsidies from New York City under former mayor Mike Bloomberg, concluded a 2015 evaluation by Bridget Fisher, an economist with The New School for Social Research. The project also reaped hundreds of millions from the proceeds of a federal visa program intended to direct offshore investment to low-income areas, according to investigative reporting published by *Bloomberg City Lab*.

Smart city scholar Shannon Mattern has scrutinized Hudson Yards and notes the project's "embedded" data infrastructure meshed well with Bloomberg's outlook. "[His] belief in the power of data shaped his initiatives," she commented in *Places Journal*, adding that the mayor's

Forest City, just off the coast of Singapore, is backed entirely by the Chinese government and Chinese developers and is intended as a high-tech gated community. ILLUSTRATION / COUNTRY GARDEN PACIFICVIEW SDN BHD

signature moves included building a science and engineering campus and establishing the Center for Urban Science and Progress, a Brooklyn-based think tank dedicated to exploring city data. The centre, Mattern notes, forged a partnership with Related/Oxford to allow its researchers to slice and dice Hudson Yard's voluminous data as a way of testing "new physical and informatics technologies and analytics capabilities."

As with many other smart city megaprojects, the quality-of-life benefits from all the heavily promoted investment in data gathering have yet to be realized. "We're thinking about that digital infrastructure, then data and sensors as a way to collect information about how the neighbourhood functions and the environmental surroundings," Constantine Kontokosta, the New York University planning and engineering expert leading the centre's work with Hudson Yards, told *Metropolis Magazine*. "There's a lot of work that needs to be done to connect the two .... The reality is, nobody has demonstrated on the ground that they've used technology in such a way that the average person has actually benefited."

The reason behind these shortcomings has everything to do with the commercial motives that drive these investments, and the ways in which cities choose to govern the smart city technologies that have promised so much.

The official opening of Hudson Yards in New York City in 2009. The $20-billion (U.S.) megaproject has been characterized as America's first fully "quantified community." PHOTOGRAPH DIA DIPASUPIL / GETTY IMAGES

HOW CAN WE BE ASSURED SMART CITY TECH WILL DO MORE GOOD THAN HARM?

It all comes down to governance

THURSDAY JANUARY 14, 2021

After a Green/Social Democrat coalition won control of the Hamburg state parliament in a February 2020 election, the new government, under Mayor Peter Tschentscher, moved quickly to launch an ambitious transportation strategy for a fast-growing urban region of five million people. "We need to change the way mobility is organized in our city," says Dennis Heinert, a government spokesperson. (The Free and Hanseatic City of Hamburg has long enjoyed state status in Germany.)

The coalition's goal is striking: 80 per cent of trips within the city will be via transit, walking, cycling or other shared modes by 2030 in order to cut private vehicle use and carbon emissions. The plan calls for better transit service without fare hikes, a major expansion of the cycling network, and a strategy to load up transit hubs (known as "switch points") with a range of mobility options, such as e-bike rentals, that cover the last mile between transit stations and home or work.

To get to the point where smart city technology is subject to the type of robust governance that applies to buildings and bridges, all orders of governments, but especially provincial, need to move forward with a range of policy, legal and regulatory reforms that will allow cities to make these investments safely. ILLUSTRATION McKENNA DEIGHTON / TORONTO STAR

A central feature of the strategy is the concept of an intelligent transportation system (ITS), which uses various smart city technologies to knit all the pieces together. The elements include self-piloted subway trains and autonomous minibuses, and, eventually, a mobility-as-a-service system that allows travellers to book bike or scooter rentals, carpooling trips or ride-shares from a single app.

How will city officials evaluate the components of the system? "Very easy," replies Heinert. "Will it help our political goal of the transition of mobility?" State officials, he continues, will vet the portfolio of mobility technologies in terms of how they promote safer, greener and more efficient movement within the region. "There is no project within this whole ITS which is not working towards those goals."

The oversight of Hamburg's mobility-technology game plan isn't difficult to discern: an election brought in a sustainability-minded coalition that wants to advance a program that includes a range of technologies, as well a bureaucratic framework for evaluating those systems. The governance, in other words, is highly transparent, and voters will be able to judge the coalition's success.

"Governance" is a somewhat nebulous term that orbits around the politics of smart city technology, frequently cited but rarely defined with any degree of precision. At the most abstract level, governance is about accountability. How can ordinary people — and the public institutions that act on their behalf — be assured that these emergent technologies deployed in and around cities will do more good than harm? With the dramatic acceleration of pandemic-related service digitization, as well as the continued rapid growth of so-called platform companies like Lime, Airbnb and Uber, that question has taken on even more saliency.

A central feature of Hamburg's transit strategy is the concept of an intelligent transportation system, which uses various smart city technologies to knit all the pieces together. The elements include self-piloted subway trains and autonomous minibuses, and, eventually, a mobility-as-a-service system that allows travellers to book bike or scooter rentals, carpooling trips or ride-shares from a single app. PHOTOGRAPH CHRISTIAN HINKELMANN

Sometimes, the contours of smart city governance come into sharper focus by their absence. When Sidewalk Labs' revealed its master innovation and development plan for a derelict piece of Toronto's waterfront in June 2019, the hefty four-volume document included a range of governance proposals for how this new smart neighbourhood would be managed.

They included several specially created entities — "Open Space Alliance," "Waterfront Transportation Management Association," "Urban Data Trust" — with real regulatory power, nebulous financing arrangements and ties to Sidewalk Labs, but unclear relationships to the municipal agencies (i.e., the public) that perform core tasks like waste or transportation management. The proposals drew sharp criticism, with the city and Waterfront Toronto swiftly shooting down any notion that Sidewalk's experimental community would march to its own drummer.

So what are we talking about when we talk about smart city governance?

One way to think about this problem is to unpack the layers of governance baked into two very common categories of objects in the public realm: bridges and buildings. Like many of the data or digital devices discussed in this series, both can be seen as systems of engineered technologies, reflecting generations of innovation.

Bridges and buildings are designed and constructed by architects, planners, engineers, and contractors who are professionally trained and accredited, as well as legally accountable for the projects they construct. Both are subject to a range of municipal and provincial policies and regulations, from procurement processes to development approvals, zoning bylaws, design codes, budget expenditures, and transportation plans.

These structures typically involve public consultation and political approval. The decision-making processes, in turn, are mostly transparent thanks to routine disclosure policies and access to information laws. Provincial and federal building codes regulate materials and the minimum standards for their assembly. Inspectors monitor construction prior to completion, and then upkeep and structural integrity afterwards. The fact that a building is privately controlled doesn't exempt owners from most of these governance systems, nor from their obligation to pay taxes and adhere to laws and regulations.

It's also worth noting that with both bridges and buildings, the interface to the public realm isn't left to chance. Local bridges, needless to say, are never off-limits to general traffic. As for buildings, municipal regulations dictate their esthetic and logistical relationships to the outside world, even if those connections may be limited by practical necessities such as fences, secured perimeters, and so on. Governance, in other words, is about the wider context as well as accountability.

Smart city technology, clearly, poses very different questions about the nature and form of urban governance. The devices, software and data, in many cases, are neither tangible nor easily understood. One system may have the potential to do many tasks, some of which have yet to be determined. Data, in turn, is amorphous, fast-moving and malleable. It may be stored not only outside the city but beyond national borders.

Yet some common themes emerge: an expectation of technical robustness and reliability; the existence of professional standards; and the role of policy and regulation in determining how these systems function, including those that have nothing to do with local government but impact public spaces. Finally, adequate governance entails some measure of public engagement and approval, which confer on such technologies and their creators the social licence to operate.

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>
> — ELLEN GOODMAN

As Rutgers University law professor and smart city expert Ellen Goodman trenchantly observes in a recent essay, cities face a crossroads in their "embrace of the 'internet of things' and 'smart city' agendas. Will they do it in ways that give control over city functions and citizen information to private companies and impenetrable algorithms or will there be public control and accountability?"

Many experts point to Barcelona as a model for progressive smart city governance that balances the Catalonian capital's desire to attract tech investment with other goals, like citizen engagement, privacy and sustainable development. Barcelona officials began talking about smart city tech in 2011, and the municipal council in 2016 adopted a sweeping "Digital City Plan" designed to ensure that all public services are provided through digital channels. The strategy established a specialized smart city directorate within the municipal government, funding schemes, citizen engagement processes, and a range of technical policies aimed at procurement, data standards and network architecture.

But Barcelona's outlook is grounded in values, according to Josep-Ramon Ferrer, the former deputy chief information officer and director of the program. Chief among these is preparing the city for rapid 21st-century urbanization while recognizing technology "as a facilitator, not a goal in itself."

Other cities, of course, have adopted these kind of high-level governance visions, and a growing number have also signed on to even broader pan-urban efforts to ground rapid technology deployment in ethical or humanitarian principals. The Cities Coalition for Digital Rights, launched in 2018 by Barcelona, Amsterdam and New York, includes metropolitan areas around the world that have signed on to a declaration calling for improved privacy policies, more accessible internet access, and measures to ensure that residents have the ability to question artificial intelligence or automated decision-making-based systems to ensure they don't discriminate or perpetuate hidden data biases.

The City of Toronto belongs to this coalition (as of June 2019), and has begun advancing its own smart/digital city governance policies, largely in response to the controversy generated by Sidewalk Labs. Municipal officials have been hammering out a Digital Infrastructure Plan (which includes a citizen working group whose meetings I've attended). It lays out five core guiding principles, including equity and inclusion; effective local government; social, economic and environmental benefits; privacy and security; and democracy and transparency.

Other GTA municipalities have been working on their own strategies. Mississauga's smart city master plan, developed in response to a federally sponsored "smart city challenge" competition,

includes elements such as "living labs" for showcasing new technologies, parks with free Wi-Fi, smart LED street lights, air quality sensors, and the deployment of an AI-powered chatbot on the city's 311 website. "It's my job to make them stick," says Anthea Foyer, a sculptor and former digital curator who is now Mississauga's smart city program lead.

She cites one proposed initiative that's bobbed to the surface: the deployment of outdoor digital touch-screens with parks and recreation listings or other municipal information. The devices, however, come with an additional feature: a built-in facial recognition camera that scans eye movement to determine if users appear to understand the content and how the screens function. Foyer has found herself talking to plenty of vendors. "It feels like such a game-changer for me," she says, noting that the inner-workings of such technologies are "esoteric and hard to understand." "I would want to make sure residents feel comfortable with it."

The crux of the smart-city governance riddle, in fact, has to do with what happens between the lofty vision statements adopted by municipal councils like Barcelona's and the day-to-day choices made by civil servants like Anthea Foyer.

To get to the point where smart city technology is subject to the type of robust governance that applies to buildings and bridges, all orders of governments, but especially provincial, need to move forward with a range of policy, legal and regulatory reforms that will allow cities to make these investments safely. Such changes, moreover, should also apply to technology vendors and platform companies that provide systems or digital services that impact urban regions.

Here's a partial list of what's required.

PRIVACY LEGISLATION REFORM

Canada's privacy laws, as many critics of the Sidewalk Labs proposal observed, aren't equipped to respond to many of the data-gathering and surveillance technologies that fall under the smart city rubric. Some have been deployed in quasi-public spaces, like malls. Earlier this year, for instance, Canada's privacy commissioner slammed Cadillac Fairview, which owns shopping centres across the country, for installing concealed video analytics and mobile device tracking systems, and then collecting personal information on patrons without notifying them or seeking their consent.

The federal Liberals recently tabled reforms to national privacy laws that provide individuals with more rights over personal information gathered by private firms and is pressing ahead with implementing a "Digital Charter," which is, in large measure, a framework for enabling growth in Canada's information tech sector.

But information technologies such as artificial intelligence tend to advance far faster than public policy, observes Markus Dubber, a University of Toronto law professor and director of the Centre For Ethics.

Case in point: even though the European Union's General Data Protection Regulation is seen as the world's most expansive privacy law, revelations from earlier this year about facial recognition apps prompted calls for additional regulations governing these technologies. In fact, even before

the Clearview controversy broke, a 2019 analysis by Orla Lynskey, a London School of Economics law professor, warned that "the protection offered by [the EU] legal framework to those impacted by predictive policing technologies is, at best, precarious."

REGULATORY PROCEDURES

Just as significant public sector projects, from transit lines to new gas distribution networks, are subject to environmental assessments that include public hearings, it seems reasonable to expect that significant smart city technology undertakings be subjected to similar scrutiny. These could include requirements that municipalities undertake privacy impact assessments, which are evaluation procedures used in other parts of government, as well as versions of the new federal directive on automated decision-making systems if the smart city system uses AI or machine learning software.

A critical element of this kind of oversight involves testing the durability of so-called "data anonymization" measures. Municipalities release ever-larger tranches of digital information through open data portals, and it is standard practice that any personally identifying information is stripped away.

But a study published last year in Nature Communications itemized many examples of successful de-anonymizing efforts that cross-reference multiple data sets in order to identify individuals in databases considered to be shorn of personally identifying information. (An April 2019, *New York Times* investigation came to similar conclusions by identifying pedestrians caught on a CCTV walking through Bryant Park in Manhattan using internet searches.) The findings, the authors of the *Nature* paper note, "question whether current de-identification practices satisfy the anonymization standards of modern data protection laws" in jurisdictions such as the EU and California.

DATA GOVERNANCE, OWNERSHIP AND STANDARDS

In June 2020, the City of Toronto published an 85-page consultant's report on "data governance and digital infrastructure," prepared by a Montreal-based tech policy research non-profit called Open North. A detailed and far-ranging assessment, the document offers what amounts to a 360-degree survey of the largely unresolved policy, legal and tech management issues facing Toronto as it undertakes the kind of transformation cities such as Barcelona have pursued.

It's a long list that covers everything from approaches to the ownership of data (a hot button topic while Sidewalk Lab's plans were on the table), ethical uses, gaps in federal legislation and technical standards. While the smart city industry has been roaring along for years, the authors offer a caution: "[D]ata governance in the smart city context is still an emerging field. Therefore, tracking and measuring the outcomes of specific initiatives will require future research."

A case in point: the twin minefields of "data interoperability" and "open standards." Such jargon is enough to turn off anyone who's not a technophile. Yet the principle is as simple as the existence of standardized electrical outlets. There are long-established technical norms for circuits, which means that when you buy a toaster, you don't have to worry about whether you

can plug it into the wall. These concepts apply to some kinds of software, databases, networks and other types of digital infrastructure. They are viewed by many open cities advocates as the means of ensuring that huge technology companies can't elbow aside rivals by engineering systems that only they can expand — the so-called "vendor lock-in" problem.

Not everyone agrees with these principles, however. Technology critic Brett Frischmann, a professor of law, business and economics at Villanova University in Pennsylvania, questions the need for digital seamlessness because it tends to encourage governments to "over-collect" data in anticipation of future applications. "There's absolutely no reason to think that the thing that made the internet so successful is what we need for smart cities," says Frischmann, co-author of *Re-engineering Humanity*, an examination of the risks of predictive analytics.

For government officials like Anthea Foyer, but also city-dwellers, the importance of open standards in the context of smart city governance is that they prevent technology suppliers, especially very large multi-nationals, from making themselves indispensable (and therefore entrenched monopolies) because no other company's systems or software can be added on to existing ones.

(Sidewalk Labs attempted just that with a subtle proposal to deploy outdoor mounts dubbed "Koalas" into which its public space sensors could be plugged. These were ostensibly designed to make it easy to upgrade equipment, but the devices are proprietary to Sidewalk/Google, and trademarked, instead of standard USB ports.)

Mark Fox, a U of T professor of computer science, is leading an effort to establish common standards for "city data" through the International Standards Organization. It is a work in progress, he says, that tends to be overlooked in smart city debates because the subject is seen as dauntingly technical. "The adoption of standards is a governance dimension that has received little or no attention in the media, yet it represents the Achilles heel on the path to smart cities."

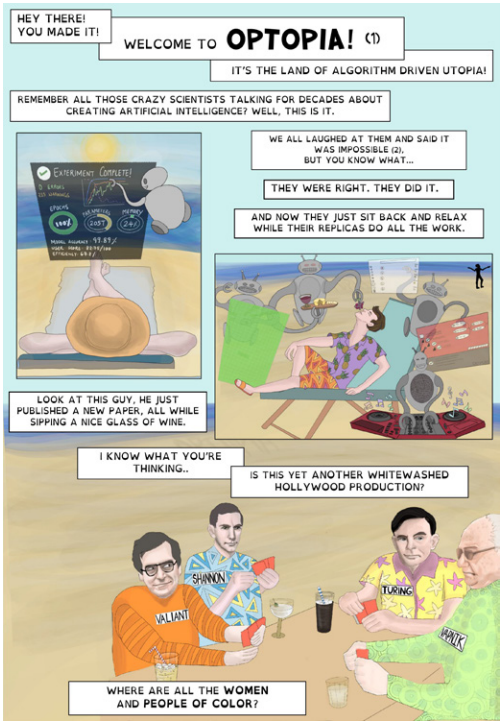
INSTITUTIONAL CAPACITY

Cities employ engineers, planners, architects, public health experts and a range of other professionals who have the expertise to devise and evaluate policies, deliver services, and provide technical input on procurement.

Municipalities, like other large government and private sector organizations, also employ IT staff — programmers, systems engineers, cyber security experts, etc. Yet if local governments intend to invest in smart city technology and infrastructure, they must also be recruiting professionals from disciplines like data analytics, data science, artificial intelligence, data visualization and digital anthropology, all with the goal of creating the kind of bench strength found in other city departments.

The City of Toronto since 2015 has had a big data innovation team, which is primarily focused on transportation applications. But smart city tech cuts across many other departments, so it will be important for municipal officials to ensure that these skills are present throughout the organization.

Beyond the technical aspects, the rapidly expanding role of digital infrastructure and artificial intelligence-driven software demands new approaches to policy-making, especially within municipal divisions whose officials traditionally didn't pay much attention to technology and data — among



them human resources, a field where AI-powered applicant screening tools are increasingly common.

As Toronto's director of strategy and program management Grant Coffey says of the yet-to-be completed Digital Infrastructure Plan, "This is the first time we're doing something like this in Toronto."

COMMUNICATION

Earlier this fall, Julia Stoyanovich, a New York University assistant professor of computer science, engineering, and data science, and Falaah Arif Khan, a research fellow and artist-in-residence at NYU's Centre for Responsible AI, published "Mirror, Mirror," the first of a series of "scientific comics" entitled "Data, Responsibly."

Although AI might not seem like an obvious topic for a graphic novel, Khan and Stoyanovich (who sat on New York's Automated Decision-Making Systems task force) have a clear-eyed view of their project. Their aim is to use relatable metaphors to explain AI (e.g., either rule-based recipes or cooking by trial and error) in order to make the concepts accessible to people who don't have college degrees or deal with disabilities that tend to exclude them from accessing technology or other facets of urban life. "This is the population that is most likely to be hurt by AI and algorithms," says Stoyanovich, who points to New York City's recent attempt to regulate employers' use of AI-enabled screening software in hiring practices. The idea isn't to side with the "techno-optimists" or with the "techno-bashers," she adds. "Our goal is really to create a nuanced understanding."

At the University of Toronto, meanwhile, the Centre for Ethics has been hosting multidisciplinary and open-ended public sessions about the applications and implications of the use of AI. As with "Data, Responsibly," the goal is to yank the subject out of the hands of computer scientists. "[AI] is not a narrow technology-specific issue that should be defined and solved by technical people," says U of T ethics expert Markus Dubber, who organizes these dialogues. "The more people who participate from different backgrounds, the more they realize there's no single answer."

Top: Mirror, Mirror," the first of a series of "scientific comics" entitled "Data, Responsibly" by Falaah Arif Khan and Julia Stoyanovich. Above: A page from "Mirror, Mirror," by Falaah Arif Khan and Julia Stoyanovich. ILLUSTRATIONS FALAAH ARIF KHAN

While neither of these projects explicitly target smart city tech, the overlaps are substantial as AI becomes increasingly integral to a wide array of digital and data-driven systems, including those used in AVs, traffic control and policing. Both examples also serve as a prompt for municipal officials to find innovative approaches to citizen engagement.

Consultation on matters such as planning is deeply embedded in our civic culture. But the city's long-established outreach practices can be rote, exclusionary, inconvenient or just dauntingly bureaucratic. Yet, as Stoyanovich makes clear, the power of these technologies demands, if anything, a far higher degree of public engagement to head off unintended consequences never envisioned in the slick and upbeat presentations of technology companies.

Lastly, communication is also about timely and robust disclosure. Goodman cites the example of Oakland city council, which passed an ordinance in 2018 requiring the municipality to publish detailed annual surveillance reports as well as "surveillance impact assessments" prior to the acquisition of any technology that gathers data that might be used by police. The bylaw also requires the city to seek approval for such investments from Oakland's Privacy Advisory Commission, which holds public sessions. "Push transparency," she says, "is really important."

DEMOCRATIC ACCOUNTABILITY

While researching this series, I interviewed a Dutch academic, Albert Meijer, who has published extensively about smart city technology, data infrastructure, digital governance and other related topics. Despite the Netherland's pragmatic and upbeat outlook on smart cities, his research has turned up mixed results.

Meijer has developed a systematic way of assessing the success of such investments. He has concluded that there isn't much evidence that smart city technologies generate value for money — an intriguing result, given the size of the smart city tech sector. Smaller, more focused systems can deliver results, he says, but the more ambitious ones have a way of falling short. "It is technology looking for a problem rather than the other way around," he says.

In a pointed assessment published in 2019 in the *Journal of Urban Technology*, Meijer and three other Utrecht University scholars turned their attention to "smart governance," which they describe as urban governments set up to draw on citizen participation and various communications technologies — online public meetings, social media, software tools, etc. — to make policy decisions.

Despite the proliferation of digital communications channels available to anyone with a smart phone or a Wi-Fi connection, Meijer and his colleagues found that many residents still preferred to engage in person, while those who participated remotely tended to drop out or lose the plot. "The wide net of online activities of many people breeds shallow attention … and transitory involvement," they observed. "Our review demonstrates that there is certainly no reason for having blind faith in smart governance."

The takeaway is clear. Cutting-edge digital infrastructure can play a role, either positive or negative, in determining how 21st-century urban regions evolve. But as has been true for millennia, cities will remain defiantly social spaces, populated by humans messily, and often sub-optimally, going about their business.

Truly smart smart cities will embrace this most pedestrian truth of urban life.

ACKNOWLEDGMENTS

Many years ago, I got myself a degree in math, and since then have spent much of my journalism career writing about cities. When I began to report about this fascinating new area we call smart cities, the appeal wasn't difficult for me to understand: here was a story about urban life, technology and numbers — in other words, the place where my interests intersected.

Before beginning the Atkinson Fellowship in Public Policy, I was able to cover this topic, in its various manifestations, for the *Globe and Mail*, *Walrus Magazine* and especially *Spacing*, which published a series of articles about Sidewalk Labs that ultimately prompted me to apply. I am grateful to my various editors, and Matt Blackett in particular, for providing me with an opportunity to dig in. The Atkinson gave me the time and resources to take this interest to a whole other level, and I am immensely indebted to the people who gave me this opportunity: Prof. Enid Slack and Scott Colby, who sent along letters of recommendation in support of my proposal; Prof. Pamela Robinson and Bianca Wylie, who both offered lots of valuable feedback early on; the formidable Atkinson selection committee and its chair, John Honderich; and finally the incredibly supportive Atkinson Foundation staff, Colette Murphy, Jenn Miller, and Phillip Roh. You only get to do something like this once in a career, and I offer my warmest thanks to all of these individuals for this chance.

When reporters specialize in one topic area or beat, they naturally develop a circle of sources to whom they can turn for tips, advice, background info, and gut-checks. I am very fortunate to work within an extended network of people who think and care about cities in general and Toronto in particular. Many of them never see their names in my stories, and I won't out them in this acknowledgments page, either, except to say that they've all taught me a great deal about a topic that never gets old, at least to my eye.

As a perennial freelancer, I am also extremely fortunate to work within a community of publications and editors who buy story ideas, give assignments, and listen to unsolicited feedback. In particular, I would like to acknowledge these media organizations: the *Globe and Mail*, the *Toronto Star*, *Walrus*, *Maclean's*, *Canadian Business*, *The Philanthropist*, *Corporate Knights*, *Pivot* and *Spacing*. Last, I have the amazingly good fortune to work as a non-fiction editor for Coach House Books and editorial director Alana Wilcox, who has agreed to publish a book based on, but extending, the Atkinson smart cities series in 2022.

JOHN LORINC
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A collaborative project of the Atkinson Foundation, the Honderich Family and the Toronto Star, the Atkinson Fellowship in Public Policy provides financial support for a Canadian journalist to investigate a public policy issue, with a goal toward promoting social and economic justice.

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