CANADA'S INFRASTRUCTURE OF THE FUTURE

TEXT Douglas MacLeod

TOMORROW'S INFRASTRUCTURE MAY BE SMARTER, CHEAPER, AND MORE NIMBLE THAN TODAY'S—AND BUILDINGS WILL BE AN INTEGRAL PART OF IT.

OPPOSITE A building can be re-imagined as a platform that integrates cloud-based products and services, and connects to other buildings and infrastructure.

In 2013, McKinsey & Company declared that, "Simply to support projected economic growth between now and 2030, we estimate that global infrastructure investment would need to increase by nearly 60 percent from the $36 trillion spent on infrastructure over the past 18 years to $57 trillion over the next 18 years." In 2016, Dominic Barton, Chair of the Finance Minister's Advisory Council on Economic Growth, suggested that Canada alone has a $500-billion infrastructure gap.

There is no doubt that infrastructure plays an essential role in the Canadian and global economies. And because our infrastructure encompasses most of the built environment—from schools and parks to highways and bridges—its health is of critical interest to the profession of architecture.

The trouble is that we may be designing infrastructure for the last century rather than the next. Last year, I was one of the co-authors of a shortlisted submission to the Innovation Superclusters Initiative organized by the federal government that allocated $950 million in targeted investments to industry-led consortia. Our application focused on creating smart, sustainable and resilient infrastructure. It included some of the largest AEC firms in the country, major research universities and a wide range of forward-thinking architects, engineers and entrepreneurs. While ultimately unsuccessful, our investigation suggested totally new ways of looking at infrastructure—and by extension, at architecture.

Because we are one of the few truly multidisciplinary professions, we are well prepared to think about the built environment from different points of view and to find innovative solutions by integrating those perspectives. We can start by learning from what's already happening across Canada.

The town of Innisfil in Ontario, for example, has inked a deal with Uber to subsidize rides for its citizens within municipal boundaries. The town estimates it is saving $8 million per year in comparison to buying and maintaining buses and operating a similar degree of service. Similarly, large, centralized water treatment plants can cost millions of dollars—but smaller filtration units such as those developed by Zenon Environmental (originally a Canadian company) can provide clean water at a neighbourhood level for far less. The founder of Zenon, Andrew Benedek, who won Singapore's inaugural Lee Kuan Yew Water Prize in 2008, has compared our infrastructure to the evolution of computers. He notes that all computing was centralized and expensive in the era of mainframes and batch processing, but today we have cheap but more powerful machines on our desks

and in our pockets. Similarly, our infrastructure now has the potential to become smaller, less expensive and more decentralized.

Water and public transportation aren't the only areas where this could occur. Architects need to consider what will happen when our communities can generate more energy than they consume; purify more water than they pollute; recycle more waste than they produce; grow more food than they need; and sequester more carbon than they emit. It is possible we will be able to do all of these things by 2040. While none of this is written in stone, we do need to explore these possibilities, rather than fixate on massive megastructures that are based on outdated paradigms such as the fossil fuel economy.

To create this new kind of infrastructure, architects need to think outside the building. Many have suggested that our power grid needs to become more like the Internet in terms of flexibility, ubiquity, openness and modularity. To do so, however, requires an easy way to move packets of energy around, just as the Internet moves packets of information. In an idea called Vehicle to Grid, or V2G, the batteries of electric cars are used to move energy from one building to another. As electric, autonomous vehicles mature, the energy needs for neighbourhoods may well be met by a fleet of mobile batteries that constantly moves energy around from where it is created (such as the solar panels on roofs) to where it is needed. On-site storage of energy using stationary batteries may also become a key part of V2G. According to McKinsey, the costs of such storage may drop towards $100 USD per kilowatt-hour by 2020, making it cost-effective for commercial and industrial buildings.

These developments have led some to suggest that we need to re-imagine infrastructure as a "platform." A platform is a fashionable term for a framework or a set of shared tools that allow different people to develop different applications with a reasonable assurance that they will be interoperable because they all share a common development environment. For example, a contemporary building needs applications for energy management, lighting control and performance benchmarking. If these are all developed on the same platform, then they can share information and work together. Moreover, if a new application is needed, such as security, then it can either be purchased from somewhere else or developed cheaply and easily by using the platform tools. A powerful advantage of the platform approach is that it can be used to efficiently develop applications that we don't even know we need yet.

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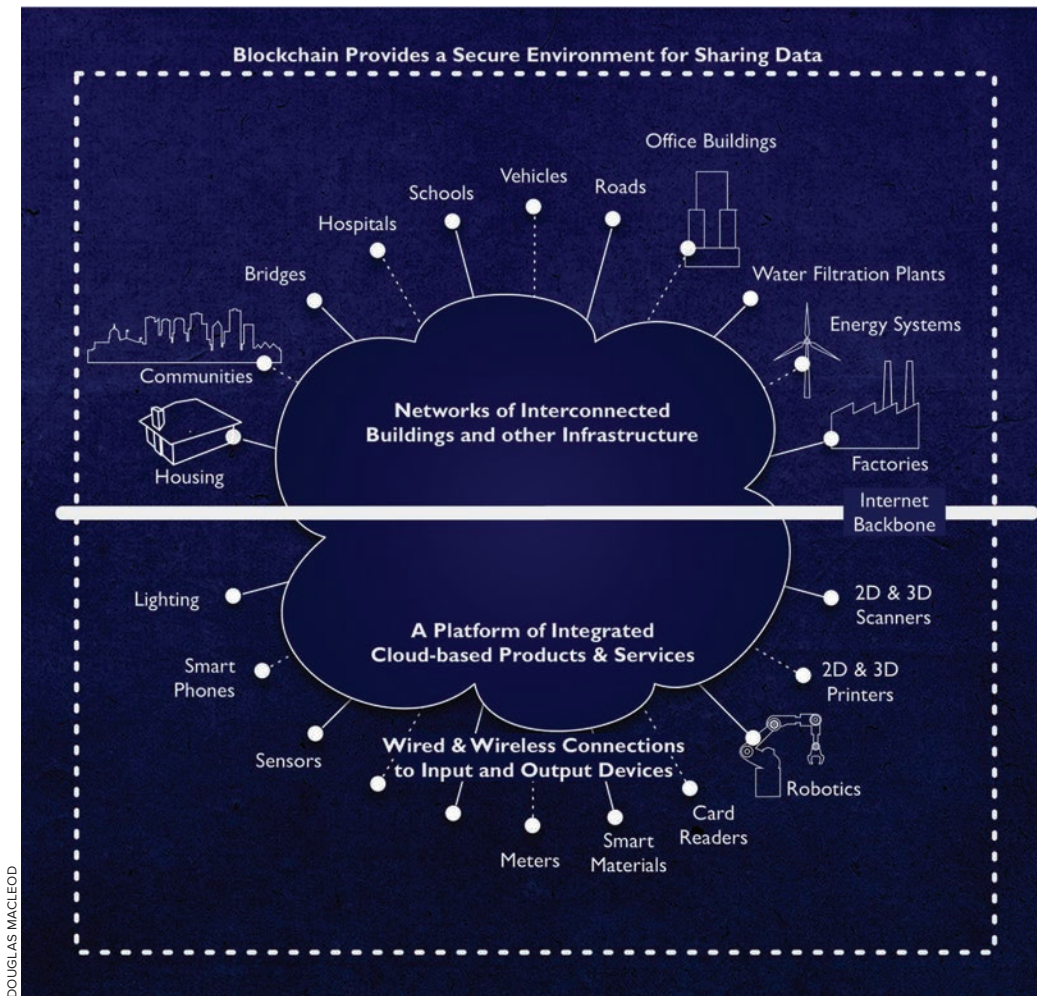
systems have already been implemented in buildings such as the WaterPark Place III building designed by WZMH in downtown Toronto. In this building, lighting, HVAC, fire and security systems are all integrated with PoE (or Power over Ethernet) which eliminates the need for electrical cables and produces significant cost savings. Moreover, these systems will also be able to share data in order to optimize their efficiency.

There are, however, numerous challenges to this work. A year ago, I attended a workshop organized by the NRC on the Future of Cities. There was impressive work being done in major cities across Canada that used data to make their operations more efficient and more economical. And yet, all of these initiatives were being done in isolation from one another. In each case, the wheel was being reinvented at tremendous cost to the economy. In addition, some participants complained that only large cities could afford these innovations, while the rest of the country was falling behind. Having a multitude of incompatible systems—that only serve the few—defeats the entire idea of a platform.

It is also not clear at this point who owns all of the data that buildings and infrastructure will generate, and who will protect it. Everyone needs to be aware

Re-imagining buildings as a platform technology of integrated products and services would transform the idea of architecture. Houses could become their own nano-infrastructure providers, potentially generating energy, information, clean water and even food to share with the micro-infrastructure of their neighbourhood.

This has implications right across the board. As Trevor Butler, principal of Archineers notes, "By designing buildings that are net positive or regenerative from a whole systems perspective, architects and engineers are redefining what it means to be a utility—because these kinds of buildings both give and receive energy, water and other resources. To do so effectively, we need to develop a new kind of infrastructure that can accommodate these bi-directional flows."

If our communities and buildings migrate to localized energy generation and storage, it raises the question: Do we still need elaborate, expensive grids, dams, and the large, corporate utilities that operate them?

No matter how this transformation plays out, architecture has an important role to play. As Guy Newsham, a Principal Research Officer at the National Research Council's Construction Research Centre (NRC-CRC) in Ottawa notes, "The building is the natural building block in smart cities."

This is where new technologies collide head-on with the ancient art of placing stone on stone. Just as the Internet revolutionized communications, so may IP (or the Internet Protocol) redefine architecture. This is more than the Internet of Things—but rather, the Internet of Buildings.

Trevor Nightingale, Leader, High Performance Buildings Program, also at the NRC, notes that, "It is now possible to converge all building systems onto a single IP network." Far from being science fiction, such

that a smart city will be gathering information about individuals and their behaviour, and they may have no control over what is done with the data and who it might be sold to. The privacy concerns of social media and the abuses that have occurred recently are nothing compared to the problems that could result when the built environment can monitor one's every move.

Financing is another critical issue. The federal government has established the Canadian Infrastructure Bank (CIB) as an arm's length Crown Corporation with an initial investment of $35 billion. According to the CIB's website, "The Bank model builds on Canada's mature public-private partnership market. The public-private partnership model is used to transfer certain construction and operating risks to the private sector. The Bank will foster partnerships between the public and private sectors where infrastructure projects are funded primarily by revenue from infrastructure usage."

While the public-private partnership (P3) model may be mature, it is not without its problems. In 2014, the OAA complained in a letter to Ontario's Minister of Infrastructure that under the Alternative Finance and Procurement (AFP) method being used, "Any innovation in design which is presented is not rewarded by offering advantage in the competition, nor is it monetarily compensated, and therefore innovation is not encouraged. The psychology is therefore to trim and not innovate. Once a design scheme has met the requirements of the base program, the low price becomes the focus."

But even low prices can be difficult to achieve in the P3 process, because of the enormous premiums included in the contracts to mitigate the transfer of risk to the private sector. Last June, the Columbia

Institute released a report that states, "British Columbia will pay an additional $3.7 billion as a result of contracts signed between 2003 and 2016 to deliver 17 infrastructure projects through public-private partnerships (P3s) rather than traditional procurement."

Alarmingly, the CIB is planning more than just a traditional P3 approach. According to Pierre Lavallée, the President of the CIB, "P3 arrangements typically include payments from the government when an asset becomes available—this model transfers construction and operating risk to private parties. The bank will use a co-investment model that takes the involvement of the private sector a step further to assume risks relating to usage or revenue. The bank's co-investment can mitigate some of the usage and revenue risks for private-sector and institutional investors, or 'inject' capital at key points, making projects more attractive."

The history of P3s in Canada is mixed, but the fact of the matter is that if the private sector invests in our infrastructure, then they will reasonably expect to make a profit. If the model is extended to usage and revenue, then they will continue to expect to generate revenue from that infrastructure long after construction is complete.

It is unclear what this means. Beyond road tolls, will it entail additional fees or taxes to send children to schools, or user fees every time someone visits a hospital? As Vivian Manasc, FRAIC, principal of Manasc Isaac Architects, has noted, "A systematic evaluation of all P3 projects in the world, completed in the past 25 years, has yet to be published. Before further large-scale P3 procurement experiments are undertaken, a rigorous analysis would seem to be in order. It would be helpful to identify the costs and benefits, and to whom each accrues."

As architects, we need to understand these procurement issues and prepare intelligent positions regarding them. In other words, the idea of infrastructure as a platform isn't just about a technical framework—

it has financial implications as well. Again, this emphasizes the need to think in a holistic manner about the built environment. When we do, it's easy to see that we haven't even begun to plumb the depths of these new opportunities in design and infrastructure.

For instance, how can our buildings go beyond being "smart" to actively being able to learn? What could a skyscraper in Montreal learn from one in Toronto about how to withstand a wind storm? With the sensors of the Internet of Things, this becomes a real possibility. Similarly, our infrastructure needn't just be sustainable; why can't it be regenerative as well? And finally, our infrastructure needs to be more than resilient—it needs to be adaptive, because we cannot predict what new challenges we will face in the future.

To this end, some are proposing radically new perspectives on the built environment. Philip Beesley, of the University of Waterloo, is leading a visionary interdisciplinary team of researchers in the Living Architecture Systems Group (LASG). As he explains it, "Integral to the LASG is the idea that we can create empathic environments in order to establish mutual relationships between individuals and their environments. These environments interact and react to their inhabitants in ways that suggest emotional intelligence and empathy, and that invite emotional responses from those inhabitants."

All of these ideas, from financing to empathic environments, have the potential to revolutionize the built environment—for better or worse. If we are not to be left behind, the profession of architecture needs to play a leadership role in exploiting the opportunities and addressing the challenges of our future infrastructure. ◀▲

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CALENDAR

ACROSS CANADA

Vancouver

05/07
AIBC Confab 2019
This new one-day event offers interactive workshops, panel discussions, and intimate seminars, all with the goal of promoting conversation and a shared learning experience.
www.aibc.ca

Calgary

03/12—03/14
EVDS Design Matters Block Week
The University of Calgary's Design Matters lecture series ramps up with three speakers: Dora Epstein-Jones of UC Berkeley, Julie Larsen of APTUM Architecture, and Florian Idenburg of So-IL.
www.evds.ucalgary.ca

02/15
Introduction to Passive House
This full-day course provides an overview of the core principles of Passive House design and building energy efficiency regulations.
www.passivehousecanada.com

Winnipeg

01/31
The Price of Everything
Presented in the Architecture+ Film series, *The Price of Everything* dives into the contemporary art world, holding a mirror up to our values and our times.
www.winnipegarchitecture.ca

02/08
Terra Cotta Architecture
Join the Winnipeg Architecture Foundation at the Millenium Library for a lecture by historian Gail Perry to learn about the city's rich history of terra cotta architecture.
www.winnipegarchitecture.ca

Toronto

01/17—01/20
IDS Toronto
IDS Toronto celebrates and promotes design in Canada and across the world, with a hyper-curated trade show and two-day symposium that focuses on future cities, experience, technology, and diversity and talent.
toronto.interiordesignshow.com

01/18—01/27
DesignTO
Programming this year in what was formerly the Toronto Design Offsite Festival includes over 100 free events, exhibitions, and window installations across the city.
designto.org

04/3—04/4
Architect@Work Canada 2019
Architect@Work is an exclusive event for architects, interior designers and specifiers with hundreds of innovative products and services.
/www.architectatwork.ca

10/26—10/30
RAIC Festival of Architecture
This year's Festival of Architecture takes place in Toronto, with the theme, "The Future of Architecture."
www.raic.org

Ottawa

01/21
Material Operations
Vancouver architect John Patkau presents a talk on the firm's recent research as part of the Azreili School of Architecture and Urbanism's Forum Lecture Series.
www.carleton.ca

—02/24
Anthropocene
The National Gallery of Canada's *Anthropocene* exhibition features new photographic and virtual reality works from the collective of Edward Burtynsky, Jennifer Baichwal and Nicholas de Pencier.
www.gallery.ca