RESILIENCE IN THE COMMERCIAL REAL ESTATE INDUSTRY

DESIGNING FOR A GRACEFUL & SURVIVABLE FUTURE

A BOMA Toronto Technical Guidance Note

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CONTENTS

Foreword from Susan M. Allen 1

Preface 3

Introduction 5

Drivers of Resilient Development

Driver 1: Site Selection 9

Driver 2: Planning Envelope 13

Driver 3: Incident Sequencing 17

Driver 4: Security Requirements 21

Driver 5: Integrated Design 25

Looking to the Future: Trends that Should Be on Your Radar 28

Commercial Real Estate (CRE) industry stakeholders recognize that extreme weather events have increased in intensity and frequency, and are posing new and very real risks to buildings and their occupants. This in turn is beginning to change how building owners and managers mitigate and respond to these risks. There are now business and societal pressures for leadership to enhance the resilience of the CRE industry to help ensure sustainability and prosperity.

In early October 2018, BOMA Canada presented its **2019 Resilience Brief** at BOMEX to address resilience in CRE and to establish a national strategy for the industry. **Resilience in the Commercial Real Estate Industry – Designing for a Graceful & Survivable Future** is a BOMA Toronto Technical Guidance Note on Resilience. It was specifically developed to address CRE resilience in the Toronto Region, and is also a complementary document to support the national resilience strategy. BOMA Toronto's work was carried out in collaboration with the City of Toronto, academia, and our members and stakeholders.

The City of Toronto is deploying a sector-based approach to make Toronto resilient through its participation in the global 100 Resilient Cities (100RC) initiative. Under 100RC, the City has a two-year mandate to develop a resilience strategy. BOMA Toronto was invited to participate in the ResilientTO Steering Committee and to help develop this strategy for the CRE industry. Our interests are aligned with our ongoing collaboration with the University of Toronto (UofT).

UofT was the first university in North America to establish a resilience research capability – Centre for Resilience of Critical Infrastructure. In 2016, the UofT/BOMA Toronto collaboration led to a study to investigate what city infrastructure can physically carry and the practical limits of densification and space optimization. The outcome of this study and the unique UofT/BOMA Toronto collaboration contributed to the development of the new UN standard on SMART City Connectivity to enable resilient communities. The learnings from this study are also being leveraged to meet the mandate of ResilientTO.

> *Resilience is "that essential ability of an operation (or organization) to respond, (adapt) and absorb the effects of shocks and stresses, and to recover as rapidly as possible to normal capacity and efficiency." Ideally coming back to normal operation stronger than before.*

As a member of the City of Toronto Steering Committee (and under BOMA Canada's broader national strategy), our approach is twofold:

1) Create a **business case for CRE resilience**. Develop a risk-based evaluation model that considers the influence of critical infrastructure on the building's capacity to operate, and the building's capacity to recover should the utility from one or more critical infrastructure in the building be interrupted (a mathematical model with a quantifiable and verifiable input and output). Once the risk exposure and the capacity to recover are determined, building owners and managers may need direction on how to manage and change input variables so that they can aim for the output that meets their business requirements. The extent to which the input variables are changed (or expected to change) would form the basis of the users' resilience strategy and planning. The outcome would lead to a resilience strategy that aims to minimize risk exposure and maximize the ability to recover and achieve normal operational/ performance levels (or better) in the shortest possible time.

2) Develop a **Building Infrastructure Resilience Planning Guide for Commercial Real Estate**. The planning guide will include a set of best practices that could directly impact the outcome of #1 above. This supplemental guidance document would walk the owner through the initial site selection and investment decisions through to integrated design.

This BOMA Toronto Technical Guidance Note on Resilience is the first step towards meeting our objectives under ResilientTO. It aim is to highlight the "Triple Bottom Line" benefits of resilience, and to emphasize the need for the CRE industry to consider resilience as part of its risk mitigation or business continuity strategy.

If you are a portfolio manager, risk and sustainability manager, general manager, asset manager or development planner in CRE, this document was written for you. And while it will have special relevance for those in the Toronto Region, its insights are equally applicable nationally and globally. The more detailed Building Infrastructure Resilience Planning Guide for Commercial Real Estate will be published in 2019, to coincide with the City of Toronto's announcement of its Resilience Strategy.

We are very pleased to publish this **Technical Guidance Note on Resilience**. We would like to thank the Centre for Resilience of Critical Infrastructure's Alexander Hay and his team for this world-leading research and for our continued collaboration and partnership. We would also like to thank one of our member firms, First Capital Realty Inc., for their participation and contribution to this research. Lastly, special thanks to Trisha Miazga of Hidi Group, for distilling the results of the research into this informative guidance note.

Susan M. Allen, MBA | RPA
President & Chief Executive Officer
BOMA Toronto

PREFACE

A Resilience-Building Partnership

BOMA Toronto is currently developing a resilience strategy for the CRE sector under the auspices of the City of Toronto's Resilience Office. BOMA Toronto's goals for the project are twofold:

1. *Create an airtight business case for CRE resilience*
2. *Develop a comprehensive Building Infrastructure Resilience Planning Guide for CRE*

The "Triple Bottom Line" Benefits of Resilience

1. *Greater assurance that your buildings are performing better and can attract higher-value occupants and operations*
2. *Low implementation costs as it is an extension of green-building standards*
3. *Prevention of a property failure that can put you out of business*

Climate change. Technological change. Social change.

As these three forces gather momentum, they are transforming today's operational world, and making tomorrow's increasingly unpredictable. Succeeding in the face of this triple threat takes resilience: the ability to survive, adapt to and recover from extreme events.

But resilience, as it's come to be accepted in the Commercial Real Estate (CRE) context, has generally been about a building's features. Instead, we should be focusing is on its operational requirements. And here's why:

When we invest in property, we make a statement about our future. We own this property now and will own it tomorrow because we believe in its value. That value is defined by who uses it and to what purpose. It is in our interest to protect our investment, to nurture it and see it grow.

> *In fact, business guru Peter Drucker once said that protection against loss was the first fiduciary responsibility of every company's Board and Officers.*

So, when we say we must safeguard a building's real property value, what we're really talking about is protecting its use, its function.

For CRE professionals, that is the essence of what resilience is about and why it is important. Yes, it is the right thing to do, but ultimately, by bolstering our resilience we are protecting the continued value of our property. Never has this been more relevant than today.

Should You Read This Document?

If you are a portfolio manager, risk and sustainability manager or development planner in CRE, this **BOMA Toronto Technical Guidance Note on Resilience** was written expressly for you. And while it will have special relevance for those in the Toronto region, its insights are equally applicable nationally and globally.

What You Will Get Out of It

You will learn about the Five Drivers of Resilient Development and how to use them to apply a critical eye to your existing properties, assess and enhance their resilience, and inform design decisions on new properties. Implemented effectively, the drivers will help you protect property values over the operational lifetime of your buildings.

How to Use the Five Drivers of Resilient Development

Each of the drivers is structured in the following way, using only what is reasonably foreseeable:

1. An objective statement
2. An explanation of the driver's supporting principles and concepts
3. Guidance for executing it

Implementing any one of these drivers will enhance your building's resilience. Implementing them all will do even more, advancing the resilience of your tenants and the neighbouring community as a whole.

A Note About Scope

The guidance presented here focuses on "reasonably foreseeable" impacts. Building on a floodplain means you have a reasonable expectation of being flooded. But for our purposes, the bigger issue is building function. We simply intend to draw your attention to risk considerations that have long been assumed in standard practices, but in today's more volatile environment need a reassurance confirmation.

Why Are There No Ratings?

Since only a property's owner or manager-design team can define their specific resilience objectives and parameters, it would be meaningless to compare the resilience rating of one property with another; each has a different risk context as well as different occupants and operations. Instead, this document is about helping you reduce the consequences of an incident and enabling rapid response and recovery within market and operational tolerances.

INTRODUCTION

Our Buildings are Failing: The Imperative Behind this Paper

The past few decades have tested our built infrastructure. Increasing storm intensity combined with sea-level rise have produced the most destructive and expensive extreme weather events on record.[1] Our shared power and transportation infrastructure grows fragile with age and unreliable under pressure.[2] And when tested, many of our buildings are unable to meet their minimum performance requirements, much less the expectations of their owners and occupants.

> *Most shocking is that our "lifeline facilities," our hospitals and police and fire stations – buildings that have been designed to higher performance and reliability requirements – are also failing.*

At the same time, the built infrastructure that our buildings rely upon has become much more complex. Case in point, our Information and Communications Technology (ICT) networks. While they provide businesses with exceptional efficiency and concentration of value, their failure also represents the potential for crippling loss of functionality.

Safe to Fail

For the purposes of this paper, we are less concerned about the likelihood of extreme events – clearly, they are now the norm – and more interested in what happens when infrastructure we depend on fails. Can we manage that failure and still operate? This Safe-to-Fail condition assumes that some systems will inevitably go down.

Now More than Ever, We Need to Get Resilience Right

With all the talk about resilience these days, it would be easy for us to assume we are getting this critical issue right – that we are making good on our fiduciary responsibility to safeguard a property's function. Unfortunately, we would be wrong – for two inescapable reasons.

> *First, we are hamstrung by a fundamental misunderstanding of the purpose and intent of building codes.*

[1] Hiroko Tabuchi, "2017 Set a Record for Losses from Natural Disasters. It Could Get Worse." *New York Times*, January 4, 2018, https://www.nytimes.com/2018/01/04/climate/losses-natural-disasters-insurance.html (accessed September 6, 2018).

[2] American Society of Civil Engineers, "Failure to Act Report," *2017 Infrastructure Report Card*, https://www.infrastructurereportcard.org/the-impact/failure-to-act-report/ (accessed September 6, 2018).

Building codes exist to protect building occupants and the general public when exposed to an identified hazard. They are not concerned with continuity of operations, even when the value of those operations is significantly greater than the value of the building itself.

> *And second, our resilience efforts to date, while laudable, focus only on enhancing building features rather than enabling the operations within.*

The fact is, a building can have flood-proof mechanical rooms, onsite fuel supplies, backup power for domestic water pumps and more, and still fail to give its tenants a place to conduct their business, to run their operations, to execute their corporate mission.

A New Way Forward: Operational Requirements

Imagine for a moment that an extreme event has just ground the city to a halt. To stay up and running, one of your tenants may require only functional telephones and enough fresh air to maintain safe CO_2 levels. But another needs potable water 24/7.

These tenants have different **operational requirements**, and thus different tolerances for disruption. Our design criteria for buildings need to go beyond typical building codes. They need to be derived from a tenant's operational requirements or be matched with an appropriate tenant operation.

Only then will a building be truly resilient: able to minimize the impact to tenant and building operations from specified shocks and stresses, and address and minimize the duration of recovery.

That's where our Five Drivers of Resilient Development can help. Read on to learn more about them.

~~Open for Business:~~ The Operational Impacts of Hurricane Sandy

A survey conducted by BOMA New York following this 2012 super storm revealed that many tenants were frustrated when they tried to return to their buildings even days after the event. While transportation routes had been cleared, the buildings themselves were still no-go zones: the electricity – and the fire detection and suppression systems that rely on it – was still out.[3]

[3] BOMA New York, Hurricane Sandy: Lessons Learned Study.

DRIVER 1:

SITE SELECTION


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DRIVER 1:
SITE SELECTION

Objective

Incorporate location-based hazards and reasonably foreseeable consequences into the site selection process and investment decision criteria.

Explanation

The most important thing you can do to improve resilience is to **understand the risks inherent to the location**. Investigate all hazards in parallel and understand their impacts on the infrastructure servicing the site. This allows you to determine which risks can be accepted or easily managed and which risks should be avoided or transferred.

Guidance

Natural hazards are recurring, and recurring events are foreseeable. The ice storm that hit Atlanta in 2014 was preceded 41 years earlier by one that knocked out power for up to seven days. The Sanriku region of Japan, which experienced a tsunami and correlated nuclear meltdown in 2011, had experienced three equally destructive tsunamis in the 115 years prior. The 2013 Calgary flood, which cost more in insurable losses than Hurricane Katrina, was preceded by one in 2005.

To a lesser extent, accidental or technological hazards are also foreseeable. An ammonia or chlorine spill is possible where such chemicals are produced, transported or used in bulk. A site near a freight mainline, water treatment plant or refrigerated manufacturing facility will be exposed to this risk. Sites further removed will not.

And while malicious activity and deliberate disruption are harder to predict, there are obvious trends with respect to target selection. Transit and government facilities are often targeted by terrorists, while embassies attract demonstrators looking to express frustration with the resident's foreign policy. Proximity to such sites can carry varying levels of hazard exposure that can represent a greater risk to you than to the target property, simply because you aren't configured for such threats.

A wise investor will **conduct an all-hazards analysis** to investigate these location-based risks as quantitatively as possible. "Proximity to a rail line" is not a particularly useful finding. We need to know how close it is. Does the line move freight? What products and at what frequency? What is the intervening terrain, and from which direction are the prevailing winds? Now the due diligence team can confidently assess whether or not the hazard represents a risk to the property that is manageable with straightforward engineering solutions.

Similarly, "not located within the regulatory floodplain" is insufficient for decision making and risk mitigation. Where is the floodplain relative to the site, and how does that elevation compare to the grade and basement elevations of the building in question? How does the mapped floodplain compare to historical flood events? Have neighbouring facilities reported basement flooding or drainage-related problems? Does the building's power or water supply depend on infrastructure that is located in the floodplain? Again, your due diligence team can determine whether simple design solutions can provide a reasonable level of protection, or whether investing in mitigation would be too costly to justify.

The results from this early study of location risk should become part of a building's Integrated Design (refer to Driver 5) to ensure any special mitigation requirements are captured by later design teams.

Disasters: Natural v. Man-Made

Do we play a role in so-called "natural" disasters?[4] Evidence would suggest we do: We build on floodplains, we increase runoff intensity by hardening the watershed, we suspend power lines across the ice-prone north. We understand a lot more about natural disasters than we care to admit. And yet, development decisions do not make full use of our knowledge around the risks and hazards.

[4] Kendra Pierre-Louis, "There's actually no such thing as a natural disaster," Popular Science, October 2, 2017, https://www.popsci.com/no-such-thing-as-natural-disaster (accessed September 6, 2018).

DRIVER 2:

PLANNING ENVELOPE

DRIVER 2:
PLANNING ENVELOPE

Objective

Understand the capabilities of the facility and its servicing infrastructure and compare it with the needs of tenant operations. This will assist in determining the most suitable use for each space, and in prioritizing any investments that may be required.

Explanation

Sites are better suited for some uses than others. Within a building, some suites or floors are more appropriate for select tenants. **Begin by mapping out the operations that must occur in a space, as well as the critical and essential supporting functions.** Your engineers can determine the load, or demand, to the building and utility infrastructure. **Compare this with the capacity of the infrastructure, or ability of the building, block and neighbourhood to service the demand.**

Guidance

Consider a call centre, a law firm and an architectural practice occupying high floors in the same building. During an extended power outage, the demands of each tenant will vary considerably.

The call centre requires its staff to be physically present. But without HVAC and restrooms, the workplace will become uninhabitable very quickly. Investments in extensive backup-power infrastructure to keep their data centre and workstations operational are in vain if staff cannot remain in the building to receive calls. However, move the call centre to the third floor with operable windows, and now the investment may make sense. Restrooms are functional because additional pumping is not required, a combination of open windows and fans provides sufficient ventilation for staff workspaces, and most employees can manage the three-storey climb without an elevator.

Perhaps the law firm and the architectural practice can both function at a reduced level with staff working remotely. The law firm, dealing primarily with documents, has an IT system configured for real-time offsite backup, and will transfer data processing to a cloud service fairly seamlessly when it senses a failure. Here, too, investment in additional backup power may not be warranted if the existing IT strategy is sufficiently resilient.

The large volumes of models and graphics produced by the architectural practice, however, are restricted by cost and bandwidth to daily or weekly backups after hours. For this tenant, an investment in backup power is justified by the costs of lost data as well as lost production while operations are transferred to offsite servers.

Note that the site itself may have bandwidth limitations and be inappropriate for large volumes of data transfer. Or perhaps the building is on the same block as a hospital, and one can be reasonably assured that any local or area-wide outage will be restored promptly at this particular site.

Do not compare each building's capabilities with other buildings, but with the unique requirements of the user groups, and then consider the larger infrastructure context to adequately grasp its suitability for resilient operations.

DRIVER 3:

INCIDENT SEQUENCING

DRIVER 3:
INCIDENT SEQUENCING

Objective

Understand what tenants need to achieve to stay in business, and work backwards to assess the level of facility performance required to enable it.

Explanation

This is where we incorporate the element of time into the analysis, and where hazard effects and recoverability of function become important. **Any gaps between a tenant's recovery requirements and the ability of the facility to deliver them will define your risk-mitigation strategy.**

The planning points 1 and 2 in Figure 1 below indicate the Minimum Operational Capability and Minimum Sustainable Capability, respectively. These points are different for every business and determine what "safe to fail" means in their particular case.

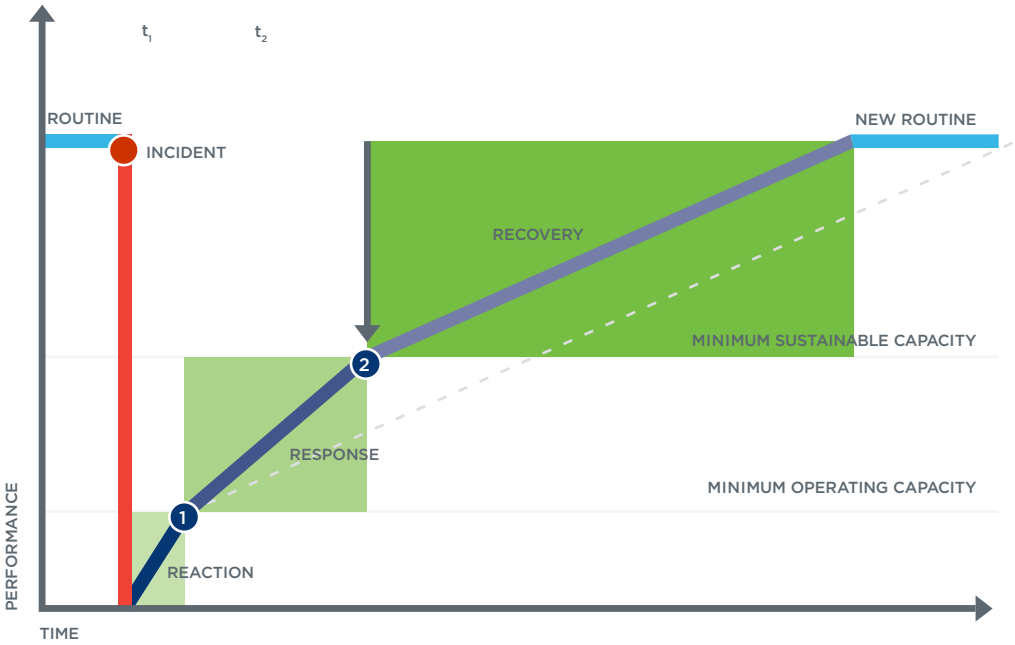


Figure 1: The Incident Sequence

Guidance

Consider a supermarket that has lost refrigeration. There is a limited window of time during which this failure is recoverable – once the temperature in coolers and freezers exceeds that required by food-safety regulations, perishables must be disposed of and incoming shipments diverted. If this refrigeration failure is due to a loss of mains power, standby generators can likely be counted on. If the failure is due to flooded electrical switchgear in the building's basement, they typically cannot. The delta between the time available to avoid a cascading failure and the expected/actual performance of essential functions defines the mitigation strategy.

Flood-proofing the electrical room is an option, but so is a tap box in a loading bay with a manual transfer switch that can bypass the flooded switchgear and allow a portable generator to directly power the equipment. So is a more efficient cooling system with just enough solar or geothermal energy available to keep stock from spoiling, paired with switchgear that is not subject to inundation.

If the flood event or ice storm that caused the initial failure is also expected to impact access to the property, measures that create additional dependencies on the transportation network – like a portable generator or fuel-oil resupply – will not improve operational resilience.

> *The key here is to interrupt a cascading failure and buy the time required to implement active recovery measures, like pumping out the basement, repairing the leak or riding out an area-wide outage.*

Prescriptive design requirements like eight hours of standby power and two diverse sources of water are commonplace in corporate design standards and guidelines. As we can see, these are often not useful and can obscure important hazard effect and recoverability details.

DRIVER 4:

SECURITY REQUIREMENTS

DRIVER 4:
SECURITY REQUIREMENTS

Objective

Understand where residual risk remains and design your security requirements to fill these gaps. Security functions themselves also need to be protected. An all-hazards awareness must be maintained as these security functions are developed to ensure that measures to address one risk do not exacerbate the vulnerability to, or impact from, another.

Explanation

Resist the urge to develop a security plan based on the ones you developed for nearby properties, to hire a security contractor near the end of construction to provide you with some cameras and card readers, or to blindly implement the prescriptive requirements of a tenant.

Understand where gaps remain and secure them accordingly. Include monitoring requirements here. For example, limiting and logging personnel access to an equipment or server room would be one way to assure its availability and integrity, but so would a leak detection sensor.

Guidance

Consider a commercial office building with government tenants. Continuity of electronic security systems must be maintained, which means the power supply to these systems must also be considered part of the system. With the rise in "smart buildings" placing more security devices on the converged building IT network, LAN equipment in IT closets and in mechanical and electrical rooms is increasingly serving not just communications, but power to these devices, further increasing the criticality of this infrastructure. A good network integration consultant will ensure that these systems have redundant and diverse power supplies and that they can be disentangled to meet life safety requirements. A good electronic security consultant will assure that, in addition to physically securing their equipment and associated power and data, strong cybersecurity is also specified.

Magnetic locks are a popular means of securing revolving and glazed lobby doors. Consider that in most jurisdictions, these locks require a special permit and must be interlocked with the fire-detection system so they automatically unlock during a fire-alarm event. This means that these doors must "fail open" when power is lost. In a long-term outage situation, your building could be left wide open if a mechanical means of locking exterior doors is not provided.

Consider also how surviving an extreme event could actually cause a security problem for you. The building's context could completely change as a result of the event. If you are in the unfortunate situation of being the only building in the neighbourhood with power and water, the threat of vandalism or break-and-enter increases as the neighbours become more and more desperate. Planning ahead for this possibility could include providing convenience outlets in your lobby, where neighbours without power could be allowed to charge their phones, and hoses or fountains for filling water bottles.

> *With "smart buildings" placing more security devices on the IT network, LAN equipment is increasingly serving not just communications, but power to these devices, further increasing the criticality of this infrastructure.*

DRIVER 5:

INTEGRATED DESIGN

DRIVER 5:
INTEGRATED DESIGN

Objective

Understand the value in having all functional and operational interests represented early and throughout the facility lifecycle. Requirements and assumptions must be documented, and key performance requirements verified by testing critical processes and systems against the failure scenarios (defined by the incident sequences) to assure that each scenario unfolds as expected.

Explanation

Gaps between design disciplines are where things will go wrong, so integrated systems commissioning is critical to verify that failure progresses as expected and as designed for. Failure should never create additional hazards to life safety or hinder first responders. And remember that neighbours can help or hinder your recovery, so be mindful of community relations.

Guidance

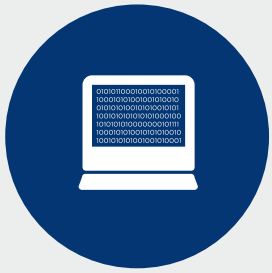
Looking back at our Planning Envelope example on page 13, consider the data centre on an upper floor of a commercial building. Using the base building's mechanical infrastructure to cool the space is likely the more efficient design choice in terms of both construction cost and energy consumption. Cost control is always in someone's job description, and with more awareness of sustainability, someone usually has an eye on energy consumption. However, the better solution for a tenant who needs to keep servers online may be to decouple it from the base building, which is likely neither the cheapest nor the "greenest."

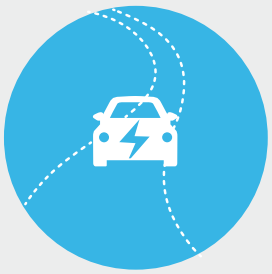
Consider also that a typical corporate design standards document will not include any requirement for cell phone and radio signals. However, low-emissivity glazing, common on new green buildings, blocks these signals. When such glazing is used, antennae and repeaters should be provided inside the building; these must be provided with emergency power so that first responders can communicate with each other during an emergency.

Caution should be exercised when deploying green design strategies, as many are unproven over time in the field, and the pursuit of an efficiency score has occasionally been at the expense of other functional requirements, with detrimental impacts to the overall building performance.

However, sustainable design with a holistic approach to energy management and awareness of durability, recoverability and other project goals, can synergize remarkably well with resilience as it decreases the building's dependence on infrastructure beyond its control.

> *Caution should be exercised when deploying green design strategies, as many are unproven in the field, and the pursuit of an efficiency score has occasionally been at the expense of other functional requirements.*





LOOKING TO THE FUTURE: TRENDS THAT SHOULD BE ON YOUR RADAR

There can be no doubt that the market and the world around us are changing. As we've discussed, many of the long-held assumptions that underpinned our familiar practices are less valid every day. But what else is going on?

The most significant trend that will influence future decisions around resiliency is **technological change**, specifically around ICT. Advances here have allowed us to become far more productive using fewer people and less material and space. This trend is known as "concentration of value" and it affects both building and tenant operations. First of all, it means that the consequences of failure are far greater than ever before. It also means that the redundancy that occurs naturally in a large and dispersed operation is lost as production occupies progressively fewer sites and smaller spaces.

It is also clear that we are poised at the point of **a revolution in ICT**. Quantum computing and artificial intelligence hold limitless possibilities for how business will be conducted in the future, but what will these advances require of our buildings and the infrastructure that supports them? We don't know yet, but we do know that the cost of failure from large catastrophic events already exceeds the capacity of governments and insurance to cover them. There is an expectation that we take responsible action to protect our operations. It is, after all, our first fiduciary responsibility.

Advances in ICT have also triggered a public expectation **that the network will be better able to rebound from catastrophic events**. Today, the common default for most businesses is to restore stable operations by 8 a.m. the next business day. But there are examples from Europe where stable business operations have been restored even as flooding continues. We need to know how to do that here at home.

ICT has also enabled our use of big data and more specifically the centralized collection, processing and direction of big data, which is the basis for **Industry 4.0**. Industry 4.0 is already changing logistics chains and manufacturing production lines, and impacting data-based professions such as law, design and medicine. In Ontario, Industry 4.0 is causing the reconfiguration of electrical utilities. Tolerances of supply interruption are going down, and for good reason. The costs incurred are growing for even a minor disruption.

The ways in which we are designing and operating buildings are changing, too. The adoption of **Building Information Modeling** (BIM, or as it's commonly known, Revit, the software tool used in North America). These tools allow distributed consultant teams to collaborate on a model in near - or real-time, and more important, to incorporate parametric details about the building components in addition to their geometry. We are currently leveraging only a small fraction of BIM's capabilities – the type and granularity of the parameters modeled will directly influence the model's future value. Use of design-developed BIM models for facility and asset management is possible today, but is currently the exception, not the rule. Integrating security operations and building automation platforms with BIM is still on the horizon and will unlock opportunities to influence design using actual building-performance data.

The other technology trend that is influencing the market and making sustainability more financially viable is the shift towards the **Electric City**. Electric vehicles and electrified transit will become the norm in cities within the next 10 years. Microgeneration and electricity trading between neighbours through a blockchain-enabled market application already exists, and some businesses that set up in new retail/industrial parks are already opting to go off-grid.

Risk management is becoming more important and needs to be evidence-based. By comparison, climate change that increases the ambient temperature and increases the frequency and severity of extreme weather events simply means more occasions for a system failure. It's up to us to ensure that the increased occurrences don't result in increased losses.

The sustainability consultant is now ubiquitous on design projects and we expect a similar specialist role to emerge from the resilience domain, someone who is responsible for teasing the operational requirements out of the user groups or intended tenant profile, translating them into design criteria, and assuring these are coordinated and achieved through commissioning, handover and into operations. In the meantime, architects and engineers would do well to build competence in **resilience planning**, to understand regional hazard and climate-change impacts, and to expand our concept of the project lifecycle. We must design not just for handover or for sustainable operations, but for graceful and survivable failure.

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