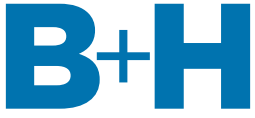
The Second Life of Tall Buildings

B+H

We Create Living Breathing Buildings™



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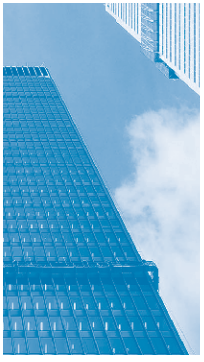


Cover image: Toronto-Dominion Centre, Toronto, Canada
(photo credit - cover/opposite page: Tom Arban)

INTRODUCTION

"**Buildings are the largest contributor to climate change.** With so much attention given to transportation emissions, many people are surprised to learn this fact. In truth, the building sector was responsible for nearly half (46.9%) of U.S. CO2 emissions in 2009. By comparison, transportation accounted for 33.5% of CO2 emissions and industry just 19.6%."

Edward Mazria, Architecture 2030.

Every North American, European and Asian city with a significant skyline will face a complex challenge over the next two decades; as they grapple with the need to curtail greenhouse gas (GHG) emissions, the materials and components of their tall buildings will reach the end of their natural life span. The number of buildings involved is staggering - Singapore, Hong Kong, New York City and Toronto alone have close to 20,000 buildings that are over 12 storeys high.[1]

While Singapore and New York boast iconic tall buildings that date back to the 1930s, the vast majority of towers in Europe and North America were built in the 1960s and 1970s, while the tall buildings in Asia date from the 1980s and 1990s. The result: a significant number of tall buildings around the world are now between 30 and 40 years old - the age at which their major systems and components need replacement.

These buildings not only show the effects of everyday wear and tear, but were designed in a time when energy costs were low and the awareness of GHG emissions did not exist. Today, buildings account for the lion's share of GHG emissions, and retrofitting existing building stock is one of the most important and effective strategies for combating global warming.

The time has come to give tall buildings around the world a second life.

The purpose of this white paper is to highlight the challenges that major cities face when their towers start to age while their governments and citizens request sustainable communities. It will also show how building retrofits are a cost-effective solution that can make tall buildings energy-efficient and give them a second life.

The B+H Tall Building Team

1. www.emporis.com/application/?nav=skylineranking& lng=3

(photo credit: Tom Arban)

PART 1

THOUGHTS ON REVITALIZATION

Challenges of the Aging **Metropolis**

Toronto skyline, present day (photo credit: Michael Mattner, istockphoto)

The predictable aging of building systems, combined with skyrocketing energy costs, the pressure to reduce greenhouse gas emissions and hyper-competitive real estate markets, are the drivers of tower renewal in every major metropolis in the world.

All buildings require care and attention. They have a variety of systems with varying degrees of durability; and thusly the building lifespan will be truncated if these systems are not maintained nor refreshed. A typical tall building will function 30-40 years before its major systems and components need replacement. Many of Europe's and North America's skyscrapers were built in the 1960s and 1970s, while Asia's towers date from the 1980s and 1990s. A large percentage of these structures have reached, or will soon reach, a critical point where their age must be addressed if their owners want to retain tenants in today's competitive real estate market.

In addition, many of these towers were designed when the general public lacked awareness about GHG and global warming. Today, buildings are the largest source of GHG in the United States[2] and can account for up to 78% of a city's emissions.[3] As the issue of GHG grows more critical, governments around the world are supporting policies and incentives to reduce their emissions. This means building owners must update their systems to meet these new standards, lower their energy costs and attract the innovative and socially-responsible companies who want to lease space in green buildings.

Why Retrofit Instead of New Construction?

Unless a building has serious structural issues, tearing it down is rarely an option; it is financially prohibitive, difficult and time-consuming. The cost of rebuilding is also high in dollars and time – it can cost upwards of C$250 per square foot for new construction, with a timeline of at least four years. Many tall towers are also landmarks that can't be demolished.

Since building structures are generally designed for a 100-year durability timeline, retrofits are perfect for bringing a building back to life for less than half the cost of new construction. An envelope reskinning is 15%-20% of the cost of new construction, or less than C$100 per square foot.

What Are the Most Common Areas for Retrofits?

The building skin, mechanical and electrical systems, elevators, escalators, and building interiors are the most common targets for retrofits.

The building envelope:

- The envelope is the outer layer or enclosure of a building that protects the interior from the surrounding environment.[4] Typical retrofits of the building envelope can include:
  - Replacement of single-pane to double-pane windows
  - Replacement of the 'skin' or surface material of the building
  - Replacement of the insulation panels beneath the surface skin
  - The placement of a completely new skin over the old envelope – an option that allows for a complete redesign and update of the building exterior

Mechanical and electrical systems:

- Replacing the plumbing system is one of the most effective means of lowering water consumption.
- Upgrading the electrical system allows building owners to meet their tenants' electrical demands while reducing the building's overall energy consumption.

2. The Washington Post - http://www.washingtonpost.com/wp-dyn/content/article/2008/07/11/AR2008071101581.html
3. PlaNYC: Inventory of New York City Greenhouse Gas Emissions
4. National Institute of Building Sciences, http://www.wbdg.org/design/env_wall.php

Moving parts:

- Upgrading the escalators, elevators and other moving mechanical parts can provide tenants with a higher level of comfort and safety.
- Keeping elevators well-maintained can also make buildings more accessible for all a building's tenants and visitors.

Interiors:

- The refurbishment of common and retail areas enables commercial properties to retain Class A building status.

Drivers of Renewal

The main factors driving the demand for renewal and retrofits are skyrocketing energy costs, legislation to reduce GHG emissions, hyper-competitive real estate markets and buildings nearing critical junctures in their life spans that require extensive repairs.

Operational efficiencies/Lower operating costs

Significant energy savings are realized by replacing/retrofitting the building envelope and performing mechanical and electrical [M/E] retrofits. The energy cost saving can range dramatically, depending on the building's location and whether it was originally constructed with insulation. Typical American commercial buildings achieve a 10%-50% energy savings.[5]

Competitive Drivers

The condition of a building is a key factor for attracting and retaining tenants. A building must be maintained to the highest standards to keep its status in the leasing hierarchy, procure premium rents and attract the world's leading companies. Companies who value innovation and social responsibility are increasingly looking for green building renovations, which can garner significant rental premiums for buildings that meet this criteria. Revitalization is also motivated by the desire to improve tenants' physical comfort.

Risk Drivers

Mitigating the safety risk of failing panels (and the associated public relations and economic costs) is another factor that drives the revitalization of tall buildings. Failures can range from the catastrophic to the quotidian, including:

- Falling building parts such as pediments and cladding panels,
- Failing systems including elevators and escalators,
- Aging faulty wiring and plumbing.

Many building owners have no way of monitoring building failure as part of due diligence because the building's height poses additional challenges.

Environmental and Policy Drivers

Commercial buildings use almost 20% of the energy generated in the US and are significant contributors to GHG emissions.[6] As GHG emissions become a more important issue for building owners, the new environmental policies and increasing power costs are significant catalysts for tower retrofits.

More governments and organizations are also introducing incentives to help building owners undertake sustainable recladding and retrofit projects. Financial incentives are increasingly common: For example, the Singapore Building and Construction Authority (BCA) introduced the $100 million Green Mark Incentive Scheme for Existing Buildings to encourage building owners to retrofit their

5 & 6 Pike Research, Energy Efficiency Retrofits for Commercial and Public Buildings

Above: New York panorama, present day.

buildings. The United States offers a similar program through Energy Service Agreements and Property Assessed Clean Energy bonds.

Retrofit Challenges

Operational Challenges

One of the greatest challenges of revitalizing tall buildings is that the retrofit must often be conducted while the building is operational. Changing the windows on a 50-storey tower while companies conduct business is no easy task. As illustrated in the Toronto-Dominion Centre and First Canadian Place case studies, it often involves developing state-of-the-art processes for managing retrofits with minimum disruption to tenants, combined with inventive solutions for dealing with the particularities of construction, as every tall building is uniquely structured and clad.

Financial Challenges

Building owners and managers face several financial and technical challenges when embarking upon a revitalization project, whether it is a skin recladding or the replacement and upgrade of mechanical and electrical systems or elevators. The process often starts with a branding challenge which relates to the tower's ability to maintain its status and qualitative rating in its local real estate market. Building owners also face financial challenges; the capital costs and life cycle costs of a building are not easily tied together, and while interest rates are low, it is not easy to get a bank to fund a building retrofit. A recent McGraw Hill study indicates that green retrofits are financed almost entirely from operations revenue. Many building owners use alternative financing measures in addition to company profits, 41% also use energy-efficiency savings that result from retrofits/renovations and 14% use performance contracting.

Owners can capitalize on their energy savings by working with an Energy Service Company (ESCO). ESCOs finance the upfront cost of the retrofit and take a percentage of the savings achieved. Fewer than 20% of building owners indicate that they've used bank loans to finance their green retrofit and renovation projects.[7] ESCOs help address the challenges of making a building energy efficient, most notably acquiring financing for the initial investment. An ESCO provides the design, construction and financing for energy-efficient building upgrades, as well as assistance in the maintenance and operations of key systems. This helps an owner to enter into such a

7 & 8 Green Building Retrofit & Renovation: Rapidly Expanding Market Opportunities Through Existing Buildings, SmartMarket Report, McGraw Hill Construction, pg. 11.

New York City panorama from Hoboken, NJ, USA; (http://en.wikipedia.org/wiki/File:NYC_Panorama_edit2.jpg)

project with minimal risk. In return for their investment, the Energy Savings Performance Contract between the ESCO and the building owner requires a percentage of the savings achieved by the upgrade to be delivered to the ESCO over the length of the contract, typically 10-15 years. After that point, the owner reaps the full benefits of the energy savings.[8]

Financing varies widely between building types. Research such as the McGraw Hill study shows that financing for retrofits is often derived from operating cash flows. In the case of prestigious Class A towers (usually privately owned by large developers or governments), financing is not an issue: competitive pressures, market presence and the occupants' safety and comfort are paramount and drive the retrofit.

Retrofits of aging Class C buildings and housing towers pose huge social, financial and environmental challenges that won't resolve easily. Financing becomes a major issue for buildings classified as Class C and lower – whether they are privately or publicly owned. For example, 30 and 40-year old social housing projects and condominium towers with poor maintenance records are now in dire need of repair and pose a huge challenge to owners, occupants and cities, which may need to step in and remediate.

Historical Preservation

Finally, tall building renewal can be complicated by the challenges of including historical preservation, which necessitate a very strict adherence to aesthetic parameters. Preservation can introduce a number of technical challenges - from environmental remediation to sourcing materials that may no longer be available
In spite of the financial, operational and historical challenges, building retrofits are a cost-effective solution for building owners who want to go green, extend the lifespan of their property and attract tenants.

Sustainability and Renewal at Home and Abroad

Four international metropolises: New York, Singapore, Hong Kong and Toronto, provide a telling snapshot of one of the key drivers of tall building renewal - the pressure to reduce carbon footprints and energy consumption. Buildings are responsible for 48% of all GHG emissions and fossil fuel energy consumption.[9] As awareness about how GHG emissions affect global climate change and the cost of power increase, governments are developing legislation and policy incentives to help building owners undertake sustainable retrofit projects. A recent McGraw Hill Construction report projects a rise in green retrofit and renovations from a $2-$4 billion market to a $10-$15 billion market by 2016. Currently, green building comprises 5%-9% of the retrofit and renovation market activity by value and is projected to grow to 20%-30% in just five years.[10]

Where is the Global Legislative Environment Going?

New York

In October 2007, New York City Mayor Michael Bloomberg signed an executive order that mandates an aggressive GHG reduction plan targeting a 30% reduction in emissions for municipal facilities and operations (relative to 2006 levels) by 2017 and a 30% reduction in citywide emissions (below 2005 levels) by 2030.[11] According to the PlaNYC study, roughly 78% of GHG emissions are related to heating, cooling, powering and lighting buildings. As part of its broader vision, this aggressive plan also aims to work with the global community to help avoid some of the serious consequences of climate change.

At a federal level, the US Government, through the American Recovery and Reinvestment Act , has committed to investing in innovative clean energy technologies and doubling the share of electricity from clean energy sources by 2035.[12] The Federal government also recognizes the significant contribution that buildings make to GHG emissions, introducing the Better Building's Initiative (BBI), which will make commercial buildings 20% more energy efficient over the next decade. The BBI will seek private sector investment by offering incentives to upgrade and retrofit offices, retail stores, schools, universities, hospitals and commercial buildings.[13] The

9. Edward Mazria, Architecture2030.org
10. McGraw Hill Smart Market Report
11. PlaNYC: Inventory of New York City Greenhouse Gas Emissions
12 & 13. Whitehouse, Office of Media Affairs, Press Release, February 3, 2011

Above, left: Shanghai skyline, 1990 ("Reflections on the Shanghai Skyline", www.adamsmith.org); 2013 (Photography: Oscar Tarneberg)
Above, right: Shanghai skyline, 2013

Above, left: New York skyline, 1970; **Above, right:** New York skyline, 2013 (Photography: Giovanni Carrieri)

Above, left: Hong Kong skyline, 1970; **Above, right:** Hong Kong skyline, 2013 (http://china.luaforfood.com/why-hong-kong/skyline/)

following are examples of incentives that the President's budget will propose to make American businesses more energy efficient:

- New tax incentives for building efficiency.
- More financing opportunities for commercial retrofits.
- The Better Buildings Challenge: The President is challenging CEOs and university presidents to make their organizations leaders in saving energy, which will make them eligible for benefits including public recognition, technical assistance and peer best practice groups.
- Training the next generation of commercial building technology workers.

Singapore

The Government of Singapore has set a target to reduce carbon intensity (carbon dioxide emissions per dollar of GDP) to 25% below 1990 levels by 2012. In Singapore, buildings consume about 31% of electricity. That number jumps to 49% of all electricity consumed when households are included. Commercial and institutional buildings produce 16% of total CO2 emissions.[14]

Improving existing buildings is the key to achieving greater sustainability and efficiency. In any given year, the percentage of new building construction in Singapore is very small, typically less than 5% of total construction.[15] This means that new construction isn't enough to solve the problem, according to the Building and Construction Authority "Existing Building Retrofit" study.

Several government incentives have been developed to aid property owners and developers with existing building upgrades that improve energy efficiency such as the Energy Efficiency Improvement Assistance Scheme, the PUB Water Efficiency Fund and the BCA Green Mark Incentive Scheme.

The Inter-Ministerial Committee on Sustainable Development (IMCSD) has also set energy targets to reduce Singapore's energy intensity per dollar GDP by 20% from 2005 levels by 2020 and 35% by 2030. This commitment is laid out in Singapore's Sustainable Development Blueprint, according to the Building and Construction Authority "Existing Building Retrofit."

Hong Kong

The Government of Hong Kong is committed to building a sustainable future. The Electrical and Mechanical Services Department has implemented a voluntary Hong Kong Energy Efficiency Registration Scheme for Buildings (HKEERSB). Much like North America's LEED program, the HKEERSB promotes energy efficiency in buildings. In 2009, the Central People's Government announced voluntary targets for greenhouse gas reduction. The government mandated a reduction of CO2 produced for each Yuan of national income by 40%-45% by 2020 (below 2005 levels) in support of worldwide efforts to control greenhouse gas emissions.[16]

In 2010, the government of Hong Kong launched a three-month public consultation strategy to define Hong Kong's climate-change policy. To reduce GHG emissions, the government proposed to set a target to reduce carbon intensity by 50%-60% below 2005 levels by 2020. This would reduce Hong Kong's GHG emissions from 42 million tons in 2005 to 28-34 million tons in 2020, representing a 12%-33% reduction.[17]

14 & 15 Existing Building Retrofit, Building and Construction Authority

16 & 17 Response to Hong Kong's Climate Change Strategy and Action Agenda Public Consultation, CLP Power Hong Kong Limited

Toronto Skyline 1970's

City of Toronto Archives

Toronto Skyline 2013

louslakeviews.com

The government of Hong Kong has singled out buildings as the highest offenders of GHG emissions: 90% of electricity-related GHG emissions in Hong Kong are related to buildings. In conjunction with the government of Hong Kong, CLP Power Group in Hong Kong has developed programs and incentives to encourage building owners to reduce energy consumption by retrofitting their buildings. The GEEN PLUS program was in launched in 2010, aimed at helping small- to medium enterprises and non-governmental organizations implement energy efficiency and conservation methods.[18]

The government of Hong Kong's Council for Sustainable Development was established by the Chief Executive as one of the city's sustainability initiatives. The council will advise the government on the priority areas for promoting sustainable development and on the preparation of a sustainable development strategy that will integrate economic, social and environmental perspectives. It will also facilitate community participation in the promotion of sustainable development through various means including awarding grants and promote public awareness and understanding of sustainable development.

Toronto

Buildings in Toronto account for 76% of greenhouse gas emissions and of that, commercial and residential buildings account for 60.9%.[19] In 2007, the City of Toronto developed a framework to reduce GHG emissions in the city. The "Change is in the Air: Toronto's Commitment to an Environmentally Sustainable Future" sets the following targets:

- Reduce GHG emissions by 30% below 1990 levels in the Toronto urban area by 2020
- Reduce GHG emissions by 80% by 2050
- Reduce smog-causing pollutants by 20% by 2012

Recognizing that buildings cause a large percentage of GHG emissions, the City proposes to develop financing for high-rise rental and condominium energy efficiency retrofits. The Better Buildings Partnership New Construction Program [BBP-NC] was established to encourage building owners to design buildings to be more energy efficient than those designed to only meet the minimum requirements of the Ontario Building Code. Eligible buildings include commercial, industrial and multi-unit residential buildings that are being constructed under Part 3 of the Ontario Building Code.

18. Whitehouse, Office of Media Affairs, Press Release, February 3, 2011

19. Greenhouse Gases and Air Pollutants in the City of Toronto, Towards a Harmonized Strategy for Reducing Emissions

(photo credit: http://upload.wikimedia.org)

Singapore skyline, present day

(photo credit: Tom Arban)

PART 2

PROJECT CASE STUDIES

First Canadian Place Renewal

Location 100 King Street West, Toronto, Canada
Size 3,468,610 s.f. | 325,150 s.m.
Client Brookfield Properties Corporation

Right: First Canadian Place image from time-lapse camera looking south-east (photo credit: Lenscape Inc., courtesy of Brookfield Properties Inc. and EllisDon Corporation)

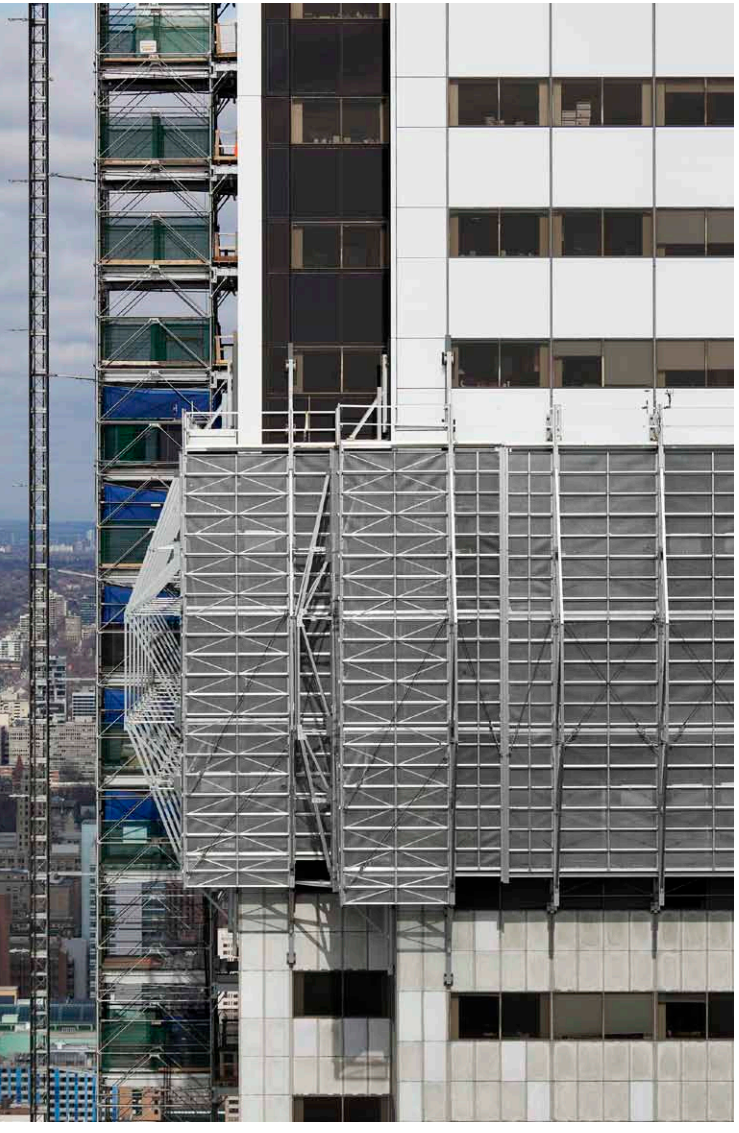
Still unrivalled as Canada's tallest office tower, First Canadian Place is undergoing a massive transformation. In September 2009, owner Brookfield Properties and its partners embarked upon an extensive exterior and interior renovation.

Originally completed in 1975, First Canadian Place established a new standard in the design and construction of tall buildings. Innovative from its inception, First Canadian Place incorporated many design, construction and engineering firsts. It was one of the earliest examples of structural tube steel construction. Its design also included double-decker elevator cabs and a state-of-the-art mechanical infrastructure with enormous fresh air capacity. B+H was the architect of record and worked with design architect Edward Durell Stone (1902-1978). At almost 35 years of age, First Canadian Place has reached a critical point in its lifespan, suffering from many common ailments a building of its generation can face. The multi-faceted rejuvenation of the 72-storey tower involves recladding the exterior of the building; renovating the office lobbies and retail areas; and extensive mechanical and electrical systems upgrades.

The exterior treatment is complex and technically challenging. The 45,000 marble panels that make up the building's skin will be removed and replaced by over 5,600 white fritted glass and bronze glass panels. The new brilliant glass facade will once again give First Canadian Place a commanding silhouette on Toronto's skyline.

Many other aspects of the renewal are invisible and systemic, including mechanical and electrical system upgrades that will bring a new standard for sustainability and operational efficiency to the building while providing its tenants with ultimate comfort. Interior renewals include updated lobbies, staircases, water features, an underground market and retail areas.

One of the client's goals was to redefine First Canadian Place's position as Canada's premier business address by transforming the building from the inside out. According to Tom Farley, President & CEO of Canadian Commercial Operations for Brookfield Properties, "This rejuvenation



View of moveable scaffolding system (photo credit: Tom Arban).

program will reinforce the iconic status of one of Canada's most prominent and recognizable buildings."

Project Challenges

How do you undertake a massive internal and external renovation with minimal disruption to tenants? Reskinning a building of the size and scale of First Canadian Place is unprecedented. Each marble panel weighs 90 kg. Safely removing each panel was critical to this challenge.

Refacing the Façade

A unique scaffolding unit was designed to safely and systematically remove each panel. The system is mechanically connected to the building and has the ability to scale up and down the building, starting at the top and working down.

The scaffolding unit is a three-storey suspended elevated platform with 14 separate sections that can hold up to 160 workers. On average, it takes three days for 80 workers to replace all of the marble on a single floor. Work is done in three shifts, with the loudest and most disruptive work done during the night shift to minimize tenant disruption.

After the marble panels are removed on the bottom level, workers remove the sealant, stone and panel support brackets. Carts wheel the discarded panels to the elevator hoist. The installation of the glass panels then begins on the top level of the platform. The 450-kilogram glass panels are transported to the platform by an elevator hoist and carried across by a monorail.

The new glass panels are being sourced and manufactured locally, less than 50 km from the site, significantly reducing the carbon footprint. The 45,000 marble panels being removed will not end up in a landfill. Each panel is being recycled and repurposed for multiple uses including concrete, base product under roadways, landscaping, and community art projects.

An In-Depth Look at the Façade

1. Suspended Elevated Platform

Four suspended platforms wrap around each corner of the building, attached at the middle level by tie-in struts bolted to temporary brackets. Winches on the roof suspend the platforms from above and move them down the face of the building.

2. Marble Removal

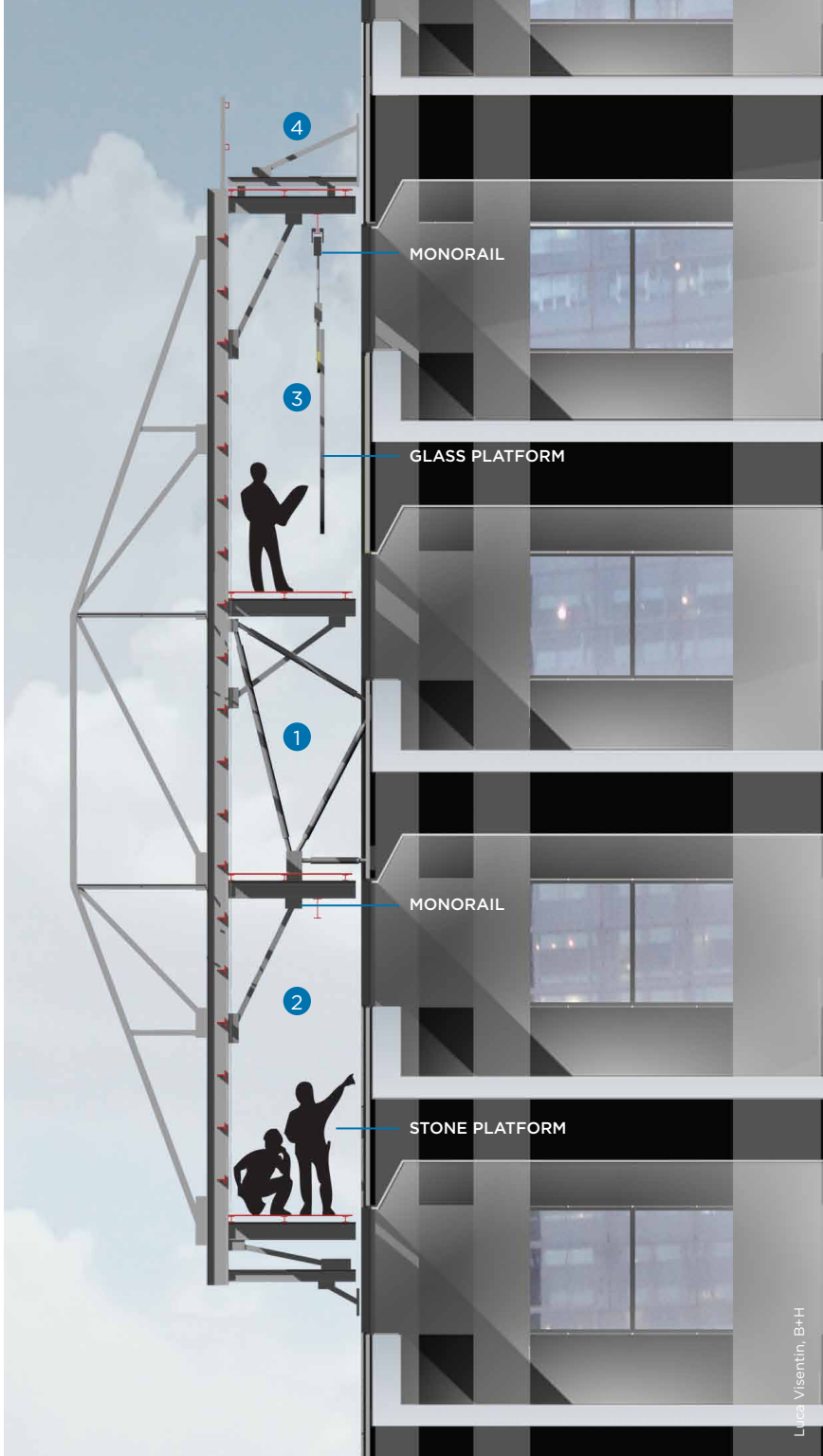
The first step is to remove the marble from the bottom level of the platform. Workers remove the sealant, the stone and the panel support brackets. This material is wheeled by carts to one of two temporary construction elevators at the east and west sides of the building.

3. Glass Installation

Glass installation begins on the top level. The 450-km glass panels arrive via the elevator and are hoisted across by monorail.

4. Platform Descent

The tie-in struts are removed and the entire structure moves down one floor. Each step takes about four days.



Luca Visentin, B+H

A Look Inside the Suspended Elevated Platform

Level 1: Stone removal and remediation deck (Photo credit: B+H)

Level 2: Stone removal (Photo credit: B+H)

Level 3: Curtainwall installation deck (Photo credit: B+H)

Image Left First Canadian Place image from time-lapse camera looking south-east (Photo credit: Lenscape Inc., courtesy of Brookfield Properties Inc. and EllisDon Corporation)




Aesthetics

First Canadian Place has assumed a commanding presence along the Toronto skyline since its completion in 1975. Its iconic image has stood the test of time and the building remains Canada's tallest office tower. It was imperative for both the owners and the designers that the building maintain its image while also enhancing it. The design solution was therefore to renew the image while paying homage to the original Edward Durrell Stone design. The beautiful white colour of the original Carrara marble had lost its lustre, succumbing to years of weather damage and pollution. The designers chose to use modern glass technology that could restore the whiteness of the building while adding sharpness and flair. The slim build of the tower was accentuated by tinted glass in the re-entrant corners - giving the tower a sleeker look. The overall design is new and exciting but the building remains highly recognizable.

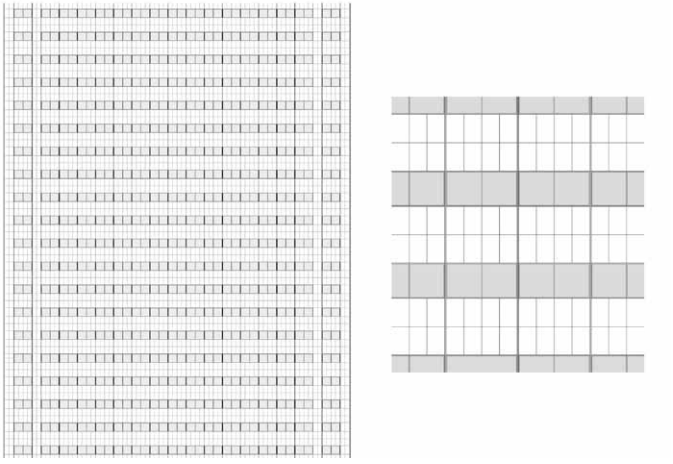


Diagram of Cladding System Before

Detail of First Canadian Place facade before re-skinning
(Photo credit: B+H)

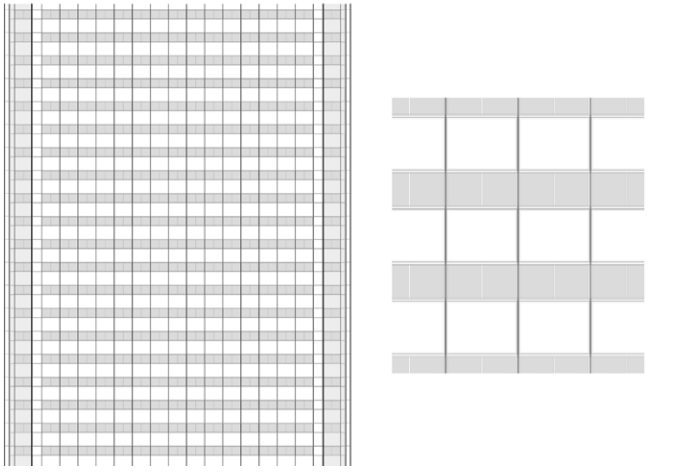
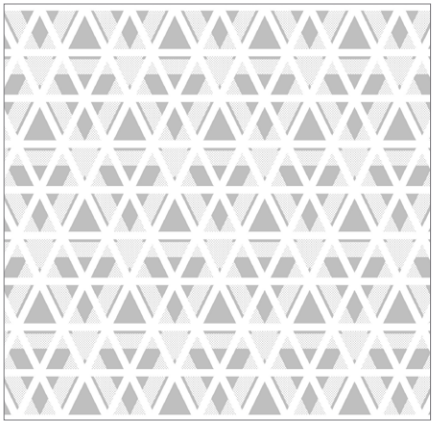
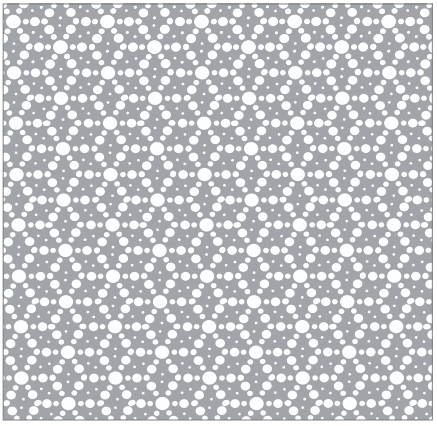


Diagram of Cladding System After

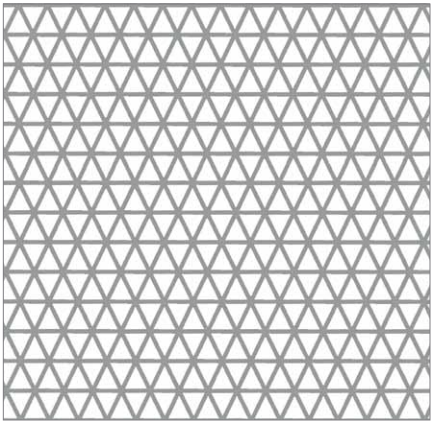
Frit Pattern Study



Frit Study: Option 1



Frit Study: Option 2



Frit Study: Option 3 (final option)

Moed de Armas & Shannon & Doyle Partners

Full Re-Clad Varied colours

Full Re-Clad Change colours

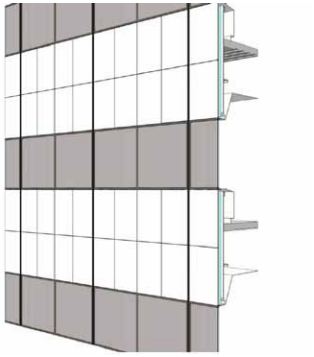
Full Re-Clad Glass spandrels, aluminium sunshades

Full Re-Clad Stainless steel

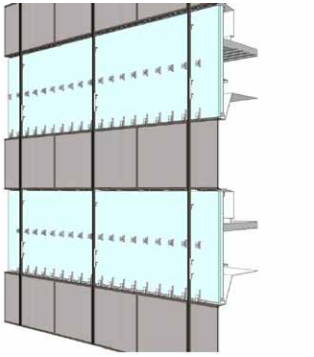
Luca Visentin, B+H

Glass Panel Installation

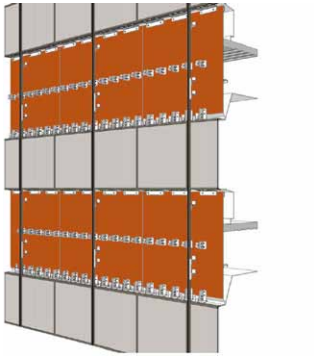
Moed de Armas & Shannon



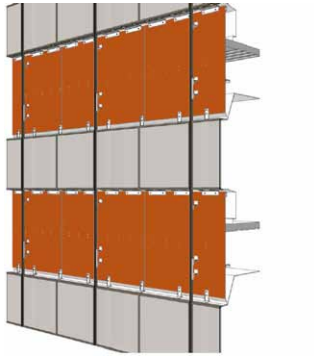
Step 1: Existing marble panels are removed



Step 2: Existing insulation is removed



Step 3: Existing marble support clips are removed



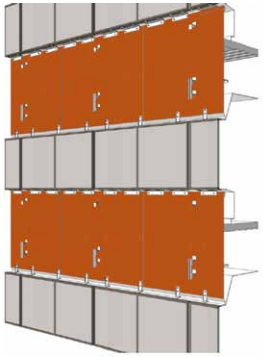
Step 4: Window washing tracks are removed

Maximizing Building Operations

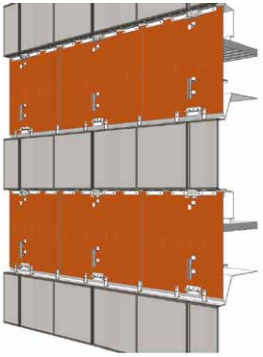
The project is presently undergoing LEED Existing Building: Operations & Maintenance (EB:O&M) certification. This process includes significant building retro-commissioning and energy benchmarking. This process will inherently lead the owners and designers to become intimately aware of the building performance and how it can be improved. The process is also inherently ongoing; requiring a commitment to establish and achieve goals – and maintain performance levels.

The re-skinning is taking place within a spectrum of retrofit strategies. Many of the strategies focus on energy optimization. For example:

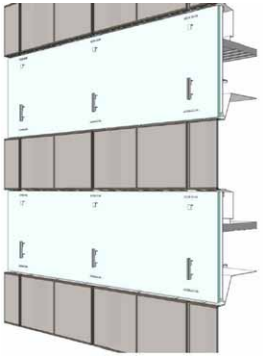
- **New heat recovery chillers**
  - High performance chillers that recover heat from the existing cooling systems
  - Continuous Domestic Hot Water pre-heat
- **New High Efficiency Condensing Boiler installation**
- **Retrofitted and re-calibrated induction system**
  - Original ventilation system is completely retooled with variable volume, heat recovery and C02 demand operation. Improved controls and high efficiency drive (DDC) systems included
- **Scavenger Exhaust Heat Recovery**
  - Heat recovery exhaust system installed for washroom exhaust fans
  - Program will revitalize system and obtain energy recovery benefits
- **Variable-Speed-Drives on all motors**
  - Motors spool up and down according to load, using only the minimum required electricity
- **New lighting and lighting controls**
  - Dimmable Ballasts for Demand Response charge reduction



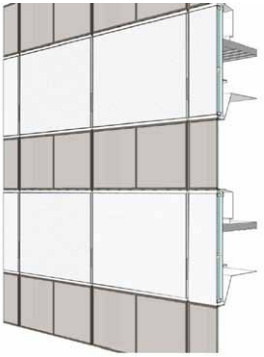
Step 5: Remedial work



Step 6: New anchors for curtain-wall and new window washing tracks are installed



Step 7: New insulation is installed



Step 8: USP curtainwall and trim is installed

Smarts

An integral part in targeting LEED EB:O&M was incorporating smart energy management systems into the design. These include:

- Controls Upgrades
- Variable Frequency Drive's (VFD) on heating, ventilation and air conditioning (HVAC), and pumps
- Office floor conversions to DDC
- Office floor lighting integrated with BAS for setback adjustment & shut down

Demand Response Charge Reduction

Innovative strategy to re-set office floor temperatures from approximately 24C to 26C (75°F to 78°F) and dim office lighting by agreement with Ontario Power Generation during peak times. Because of significant building size and large air volume there is a substantial thermal lag. It would take three hours before noticeable temperature variation occurred; and in the meantime the power authority reserves the power.

Reproducibility

In order to safely and systematically remove each panel, a highly sophisticated scaffolding system was designed specifically for this project. Beginning at the top and working its way down, this truly unique system is mechanically connected to the building giving it the ability to scale up and down the building. The scaffolding unit is a 3-storey movable platform with 14 separate sections that can hold up to 160 workers at one time. On average, it takes 3 days for 80 workers to replace all of the marble on an entire floor. In order to minimize tenant disruptions, work on the building is done in 3 shifts. The loudest and most disruptive work is done during the night shift so as not to disturb the tenants in their offices. The marble panels are removed on the bottom level of the platform. Workers remove the sealant and the stone as well as the panel support brackets. Carts are used to wheel the discarded panels to the elevator hoist. The installation of the glass panels occurs on the top level of the platform. The 450

kilogram glass panels are transported to the platform by an elevator hoist and then carried across by a monorail.

Water Conservation

- High Efficiency Fixtures: washroom low flow fixtures installed throughout.
- Heat Recovery Chillers reduce cooling tower water: The installation of the Heat Recovery Chillers not only saves energy but also saves the operation of cooling towers, which therefore saves cooling tower water usage. Incidentally, the cost of water savings due to reduced cooling tower usage paid for the retrofit of the chillers.

Opposite page: Interior Renewal - the new Market Place at First Canadian Place (photo credit: Tom Arban).


EXIT
RECYCLE


BMO

Renewal by the Numbers

- 5,625 fritted glass panels replace 45,000 marble panels
- 80 glass panels cover one floor (vs. 320 marble panels)
- Each glass slab weighs 450 kg
- Each marble slab weighs 90 kg
- On average, it takes three days for 80 workers to replace the panels on one floor
- The custom-designed construction rig weighs 113,000 kg, is 15 meters high, supports 160 workers and can withstand winds up to 265 kph
- The fritted glass panels are locally sourced
- Lifespan of the glass: 100 years

Original Construction

- 1.3 million man hours saved thanks to the advanced building technologies
- 48,7741 sq.m. or 120,000 sheets of drywall – if stacked, the sheets are nearly eight times the height of the finished building
- In a traditional building, it would take 6.3 minutes to bring a sheet of drywall into the building, versus 1.0 minute per sheet for First Canadian Place
- 4,400 tonnes of marble – enough to build a 26 km sidewalk from Toronto City Hall to Port Credit
- 46,450 sq.m. of insulation– enough to cover 8 football fields
- 56,600 linear feet or about 17 kilometres of window

Original Building Architects

Architect of Record: B+H
Design Consultant: Edward Durell Stone

Retrofit Architects

Architect of Record: B+H
Design Architect: Moed de Armas & Shannon

Project Team

Principal-in-Charge: Douglas Birkenshaw
Project Director: Kevin Stelzer
Project Manager: Bronwyn Sibbald

Retrofit Consultant Team

Construction Managers: EllisDon
Structural Engineer: Halcrow Yolles
Engineering Consultant: Brook Van Dalen
Preconstruction Engineers: Halsall Associates Ltd.

Project Timeline

1973 November
Construction begins

1975 April
Occupancy begins in lower levels

2010 November
Construction begins

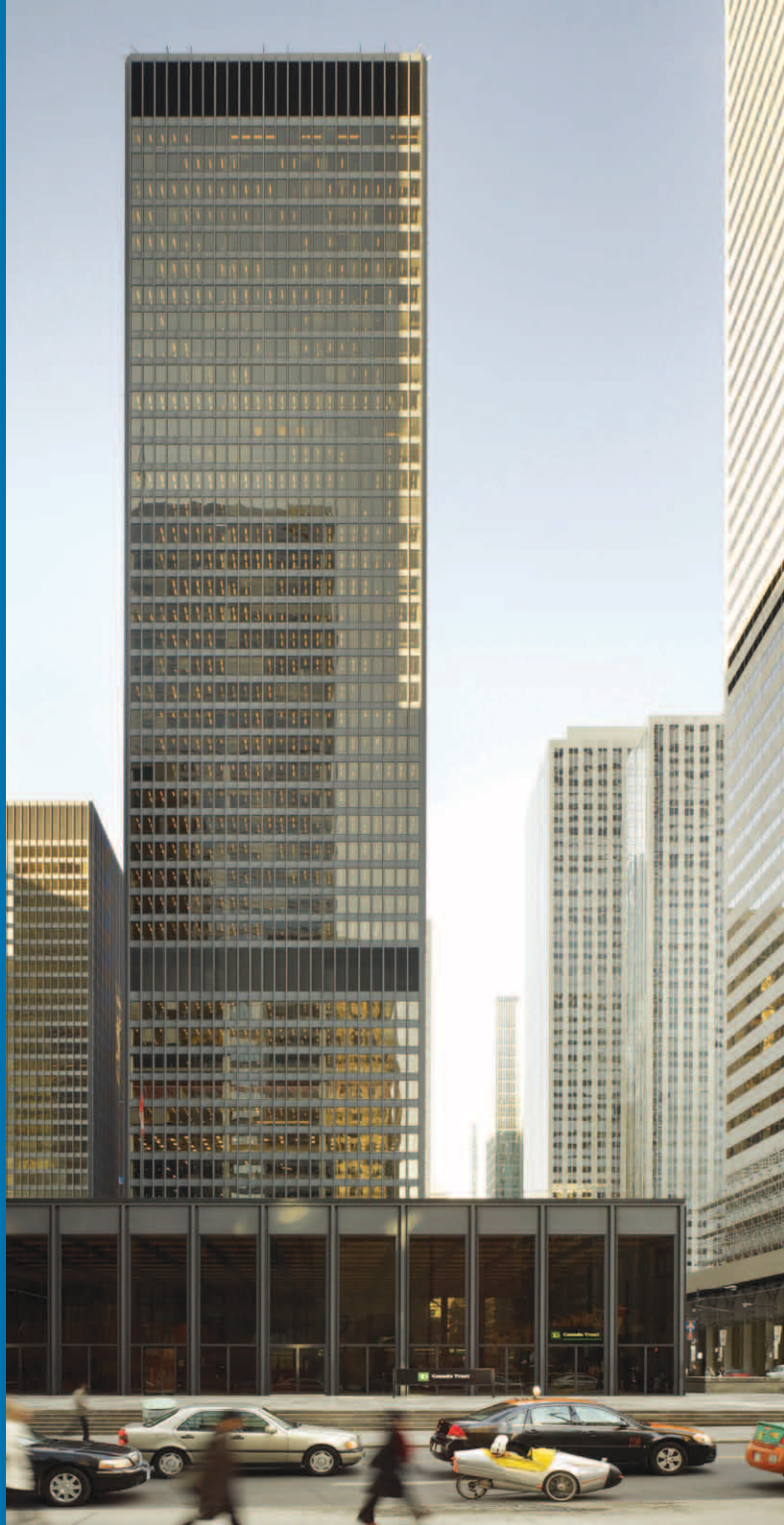
2012 Spring
Re-clad complete

Opposite, left: before renewal (photo credit: Panda Associates); **opposite, right:** after renewal (Artist's rendering: Moed de Armas & Shannon).

Toronto-Dominion Centre Revitalization

Client: Cadillac Fairview Corporation
Location: 77 King St. West, Toronto, Canada
Size: 1,212,610 s.f. | 112,696 s.m.

Right: Toronto-Dominion Centre Revitalization
(photo credit: Tom Arban)



"……when completed, the Centre will be more than a landmark, more than a business home for thousands of people. Enhancing all the surrounding areas, it will be a true city centre, adding new impetus, colour and beauty to the commercial and cultural life of Toronto: a fitting start to the next one hundred years."

– Extract from Toronto-Dominion Centre: Marking A New Century for Canada, an original publication created by the Toronto-Dominion Centre prior to original construction.

Designed by Ludwig Mies van der Rohe, one of the seminal modernist architects of the 20th century, the Toronto-Dominion (TD) Centre is located in the heart of Toronto's financial district. The Centre was commissioned by Allen Lambert, Chairman of TD Bank, in partnership with Fairview Corporation.

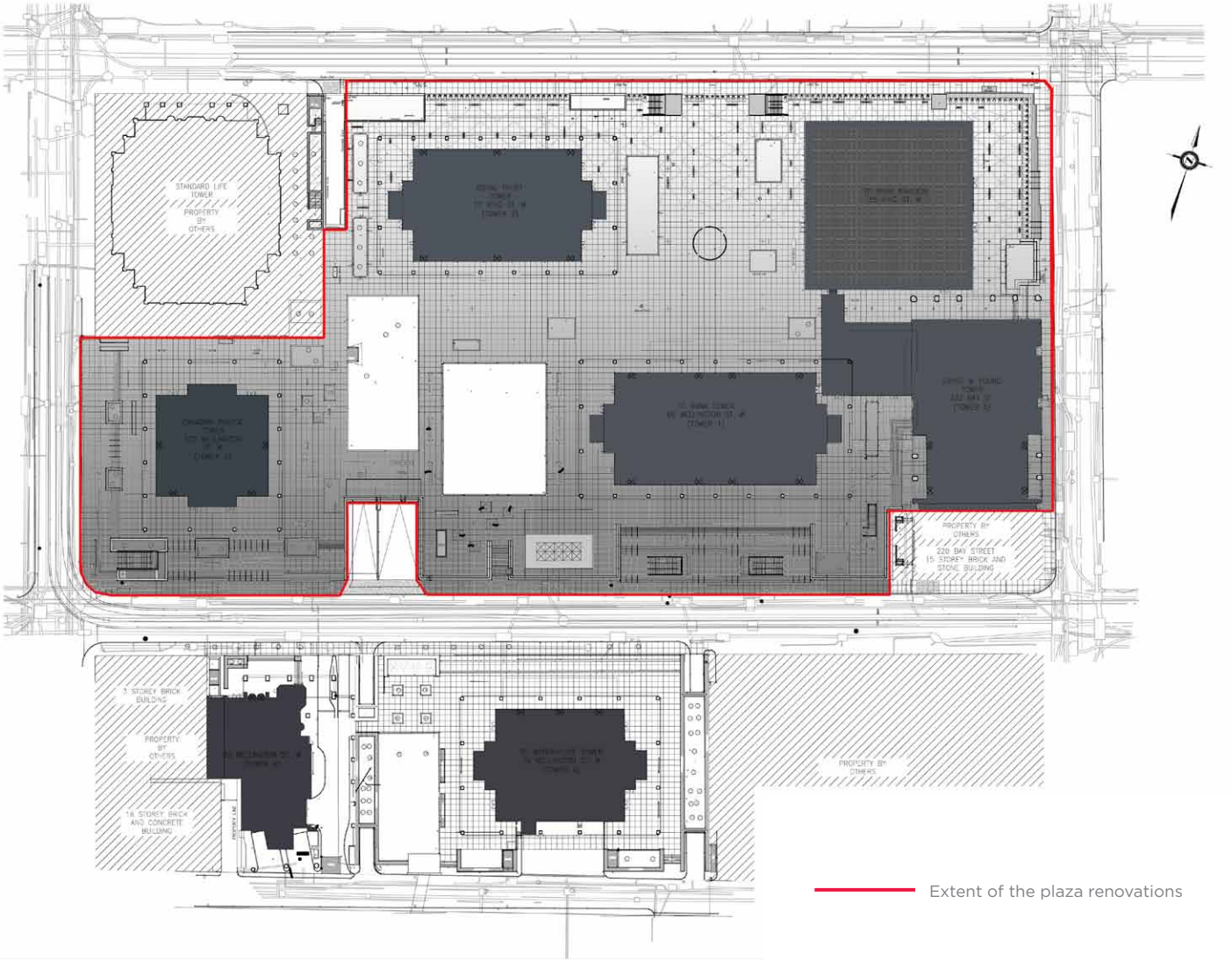
The complex is arranged around a granite-paved pedestrian plaza and originally consisted of three buildings: the 56-storey TD Bank Tower (1967), the one-storey Banking Pavilion (1968) and the 46-storey Royal Trust Tower (1969). The TD Centre is an icon in Toronto one of the world's most important examples of Mies van der Rohe's large projects and one of the only modernist buildings to receive Ontario Heritage Act designation (2003). All three original TD buildings were designed by Mies van der Rohe, working in association with B+H and John B. Parkin Associates.

After the completion of the TD Bank Tower in 1968, construction methods were evaluated and refined for the second tower, the Royal Trust Tower. Its steel cladding was pre-assembled into large panels to speed and simplify construction. The panels were two-storeys (24 feet) high and 30-40 feet wide. The pre-assembly technique was developed after a study of steel construction methods used for the TD Bank Tower, in which sections of cladding were erected piece by piece.

Revitalizing a Living Heritage Monument

Because the TD Centre is one of the most historically significant buildings in the city, the decision to undertake a complete revitalization was not taken lightly. In May 2010, Cadillac Fairview Corporation announced that it would begin the revitalization of the TD Centre, starting with the Royal Trust Tower. Following the move of a major tenant out of the Royal Trust Tower, 17 floors suddenly became vacant. Cadillac Fairview seized the opportunity to revitalize

TD Centre Site Plan



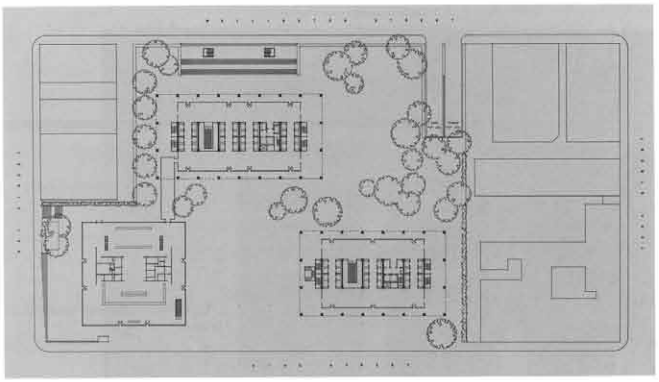
the property, part of a strategy to attract tenants in an increasingly competitive commercial real estate market.

"Implement a variety of projects that will improve tenant comfort, and significantly enhance energy efficiency, while maintaining the architectural integrity of the property. The work will focus on architectural and infrastructural revitalization, including mechanical upgrades as well as interior and exterior renovations." – From TD website

The primary challenge of this project was to ensure that all interventions remained true to the original design by Mies van der Rohe. Under the Ontario Heritage Act, no owner of historically-designated property is permitted to alter the property in a way that is likely to affect its attributes.[20] In addition, the client wanted to replace the windows with minimal disruption to the tenants. The revitalization includes replacing the existing windows, painting the exterior, performing mechanical and electrical system upgrades, replacing elevators and the complete renovation of the lobby and exterior plaza.

The renovation of the plaza, now called Oscar Peterson Square, is a critical component of the revitalization. Over the course of the plaza's life, cracks in the thick, honed granite pavers were simply patched, resulting in a quilt-like appearance in the stone. Intact original pavers are being repurposed to replace broken pavers, and the waterproofing under the plaza is being replaced.

"Often the space between buildings is as important as the buildings themselves" – Ludwig Mies van der Rohe



Right, above: TD Centre original site plan (Toronto-Dominion Centre: Marking a New Century for Canada); **right, below:** view from the plaza (photo credit: Tom Arban)

20. Ontario Heritage Act, R.S.O. 1990, Chapter O.18, Part IV: Conservation of Property of Cultural Heritage Value or Interest, Article 33.1

Renewal is in the Details

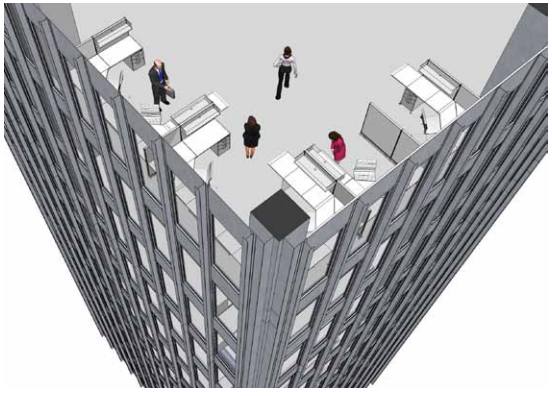
To guarantee the meticulous historic preservation of this architectural gem, B+H is working with noted heritage architect Michael McClelland of E.R.A. Architects. The team has gone to great lengths to ensure that all of the interventions remain true to Mies van der Rohe's original design vision.

When it came time to choose paint for the exterior of the building, the team travelled to Chicago to meet with consultants at the firm Wiss Janney Elstner and Associates. It took two months and several mock-ups to select the most appropriate paint to match the original, unique graphite paint. Some 5,676 single pane windows are being replaced with double-glazed thermal pane windows that are tinted bronze to match the originals and reduce heat loss by 50%.

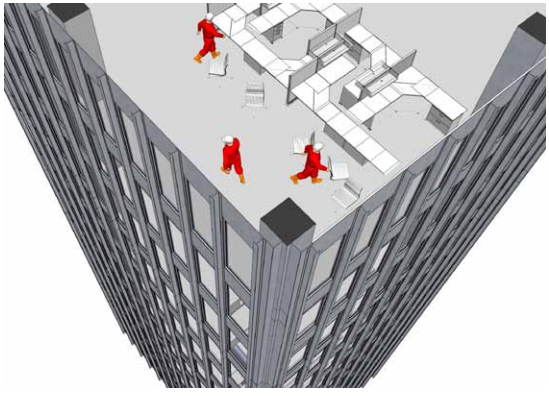
During replacement, considerable care is taken to minimize disruption to tenants. Instead of starting the retrofit from the top down or the bottom up, the windows are systematically replaced based on tenant occupancy, with vacant floors and offices retrofitted first. The windows are replaced using a swing stage that can support six workers who work overnight. The furniture is moved to the interior of the building to give workers unobstructed access to the windows. Workers cut out the existing windows and install the new ones. Once work is complete, the furniture is returned to its original location. At a rate of 16 windows per night, it takes just over a week to replace the 132 windows on each office floor.

A unique system devised to facilitate revitalization:

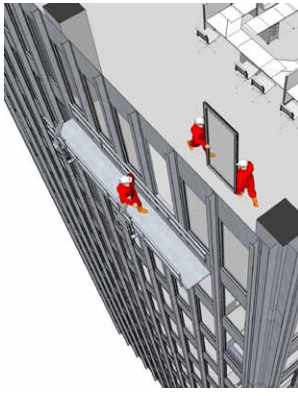
A crew of 16 workers can replace 16 windows in one night



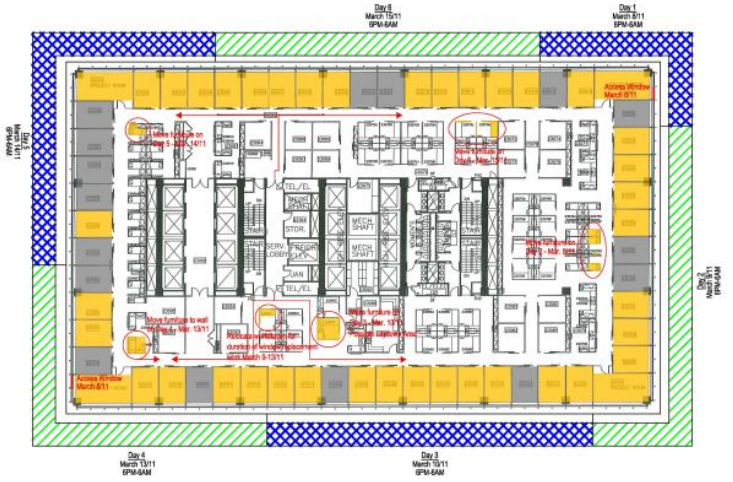
5 p.m. - office staff leave for the day



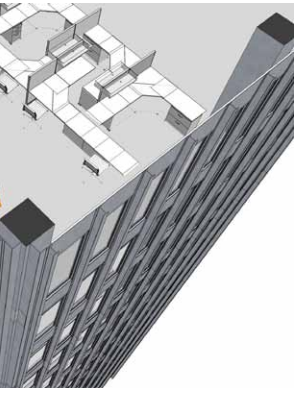
7 p.m. - contracting personnel arrive and set up the space for revitalization



10 p.m. - replaceme



Left: Window replacement / furniture dismantling sequence - Floor 23 (PWC)



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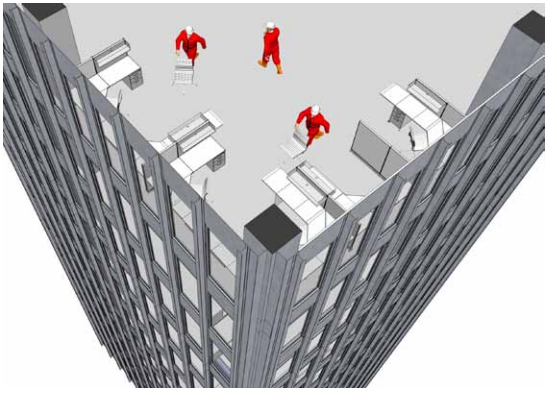


5 a.m. - contracting personnel reorganize the space as it was originally

9 a.m. - the workforce arrives to a revitalized office

Raja Moussaoui, B+H

An In-Depth Look at the Façade

1. Reglazing

All glazing above ground floor was replaced with double glazed recycled units. These units were installed at night as to avoid disrupting tenants. A crew of 16 workers could replace 16 units per shift; two on the swing stage and two on the floor of the building.

2. Replacement of Induction Units

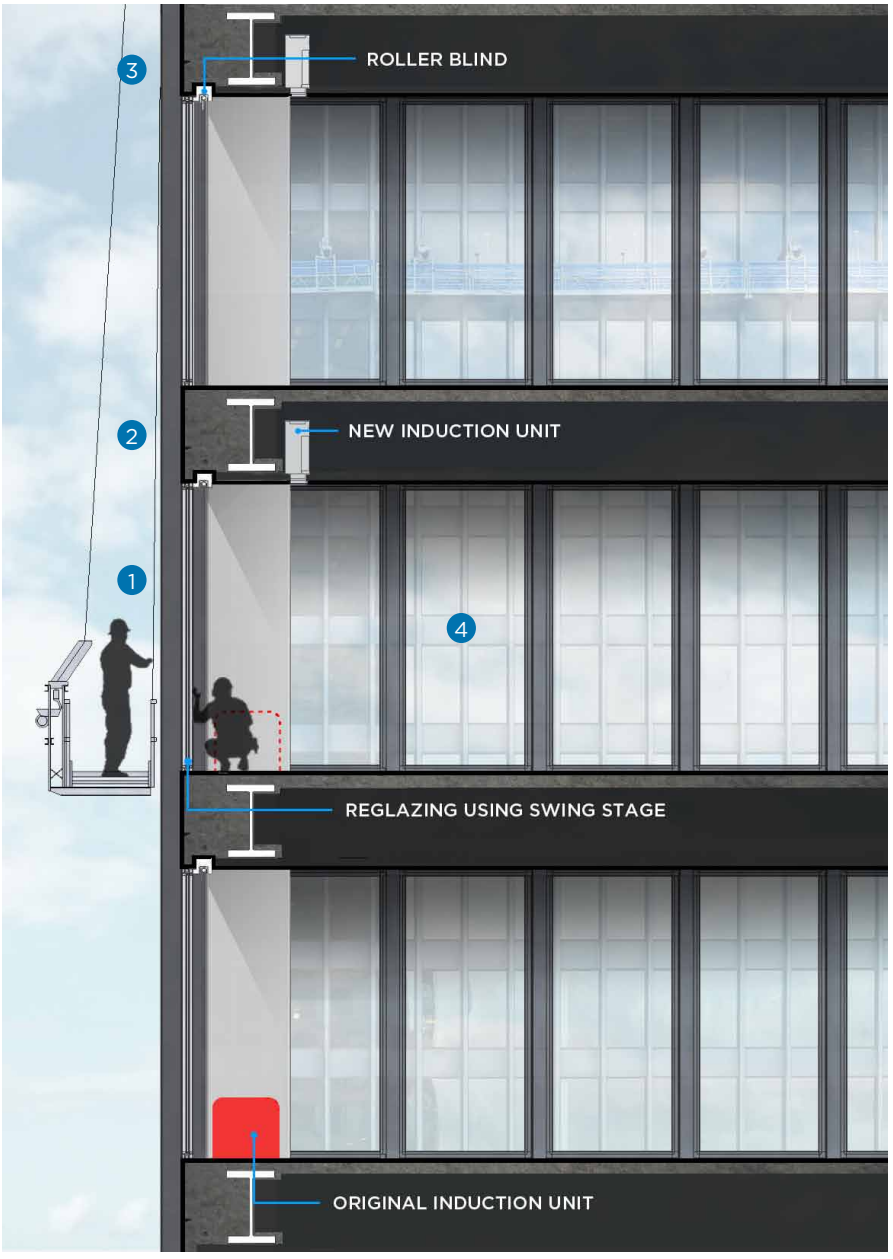
Original induction units on the floor at the perimeter were removed and replaced with more efficient induction units in the ceiling. The removal of the original induction units allows direct access to the floor-to-ceiling windows.

3. Sun-control

New roller blinds were installed in the ceiling to control sunshine and glare.

4. Heat Loss

The combination of all of these new systems resulted in a 50% reduction of heat loss per linear meter.



Raja Moussaoui, B+H

Renewing a Heritage Jewel

The exterior of the building was not the only challenging aspect of this project; the interior, also designated as a heritage space, required significant care and detail. For example, to restore and repair the existing glass mosaic tile ceiling, the design team spent over two months searching for matching tiles. With no success, they decided to remove the mosaic ceiling so the tiles could be cleaned, polished and repaired. The existing ceiling was cut down into 3' x 3' pieces with the drywall still attached. The pieces were then soaked overnight and tumbled so crews could pan for tiles to clean and polish them. This process resulted in a 20% loss, so new glass tiles were blended back in with the original tiles, re-assembled onto 1'x1' sheets and re-installed.

In the lobby, the office directory and information desk were redesigned to keep much of their original material. The information desk maintained its original granite surround and internal structure. Only the interior of the desk was changed to allow space for computers and storage. The directories were also updated with touch-screen monitors.

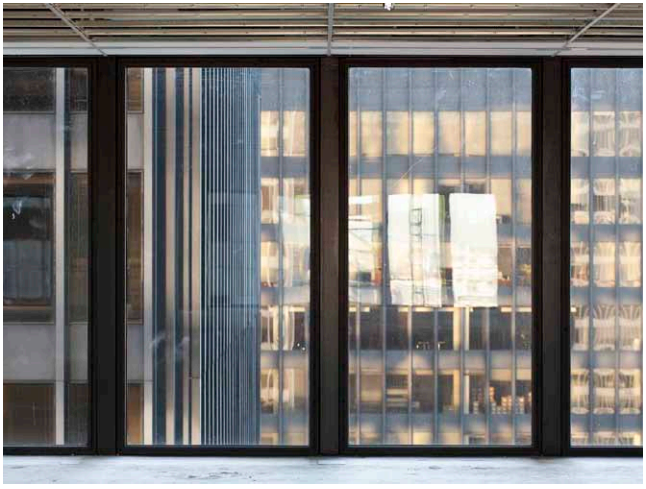


Photo credit: Tom Arban

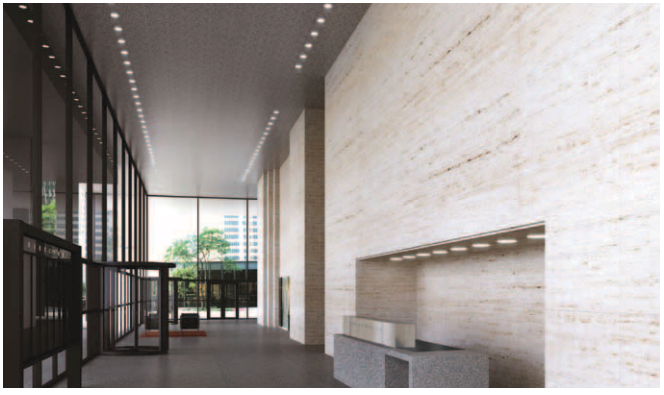
Above left: window - before revitalization (with induction units); **above right:** window - after revitalization (without induction units).

Above left: Existing tiles soaking in water in order to facilitate the removal of the tiles from the substrate; above right: soaked tiles are placed in a tumbler to remove the substrate from the tiles; below left to right: tiles in the tumbler; cleaned and polished tiles are mixed with new tiles (in order to compensate for loss) and placed in plastic bags; cleaned tiles are removed from the tumbler and placed on screens

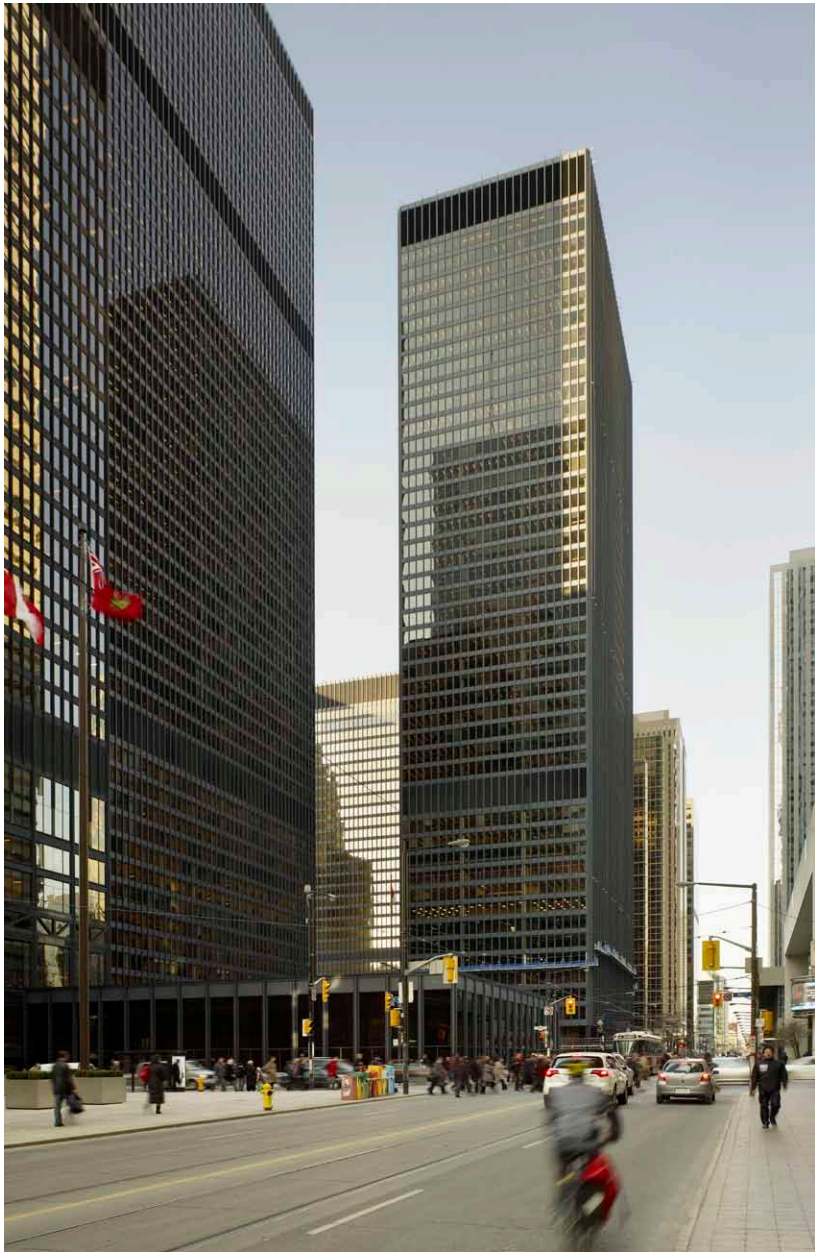
"It is so easy to spoil a fine space by introducing arbitrary elements; I ask you to imagine the lobby of The Seagram Building with a cigar stand! I feel that our lobby in Toronto should be seen at its best right from the moment that the public has access to the building."

— Mies van der Rohe, in a letter to Sidney Bregman concerning an idea to place a temporary pavilion in the tower lobby until the banking pavilion was in operation.

Below: Refurbishment of the TD interiors: washrooms (top image) and food court (bottom image). **Opposite, left:** before revitalization (photo credit: Ron Vickers Ltd. Photography); **opposite, right:** after revitalization (photo credit: Tom Arban).



Above: lobby - before revitalization (top image); **left, below:** lobby - after revitalization (bottom image). Photo credit: Tom Arban.



Renewal by the numbers

- 132 windows per floor X 43 floors = 5,676 windows total
- A crew of 16 workers can replace 16 windows in one night
- Royal Trust Tower: 600 feet (46 floors)
- Structural steel weighs 23,500 tons

Building Architects:
Design Architect: Ludwig Mies van der Rohe (1886-1967)
Architects of Record: John B. Parkin Associates and Bregman + Hamann Architects (B+H) – architects in joint venture

Retrofit Architects:
B+H

Project Team:
Executive Principal: Tonu Altosaar
Principal in Charge: Neal Barkhurst
Project Manager (Tower 2) and Contract Administrator (Plaza): Mohsen Boctor

Consultant Team:
Structural: EXP
Mechanical & Electrical: H.H. Angus
Lighting Design: Gabriel McKinnon
Vertical Transportation: KJA
Landscape: Janet Rosenberg + Associates
Heritage: E.R.A.
Painting Consultant: Wiss, Janney, Elstner Associates Inc.
Envelope Consultant: ZEC

Project Chronology - Original Construction

Stage 1 - Toronto-Dominion Bank Tower:
66 Wellington Street West, Toronto, Canada

June 1964
Ground breaking

April 1966
Topping-off of tower

April 1968
Official opening of Toronto-Dominion Bank Tower

Stage 2 - Banking Pavilion:
55 King Street West, Toronto, Canada

November 1966
Ground breaking

May 1968
Pavilion Bank open to public

Stage 3 - Royal Trust Tower:
77 King Street West, Toronto, Canada

June 1966
Construction begins

July 1968
Topping-off of tower

December 1969
Completion of Royal Trust Tower

Project Chronology - Revitalization

Stage 1 - Royal Trust Tower:
77 King Street West, Toronto, Canada

May 2010
Toronto-Dominion Centre retrofit announcement

June 2010
TD Centre receives LEED Gold Certification under the Existing Buildings: Operations and Maintenance category

January 2010
Re-glazing begins on Royal Trust Tower

October 2010
Painting mock-up

March 2011
Re-glazing completed on Royal Trust Tower

April 2011
Decision on paint

May 2011
Painting begins on Royal Trust Tower

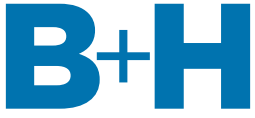
2014
Royal Trust Tower retrofit completed

"...I am hopeful that The Toronto Dominion Center will become one of the finest of building groups; but this can be so only if we set certain standards below which we never fall. In my opinion, a building is fine precisely because of an accumulation of such standards—from the top to the bottom and every detail."

— Mies van der Rohe, letter to Sidney Bregman, July 5, 1966

Right, above: TD Centre original model (Toronto-Dominion Centre: Marking a New Century for Canada)

We Create Living Breathing Buildings™



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