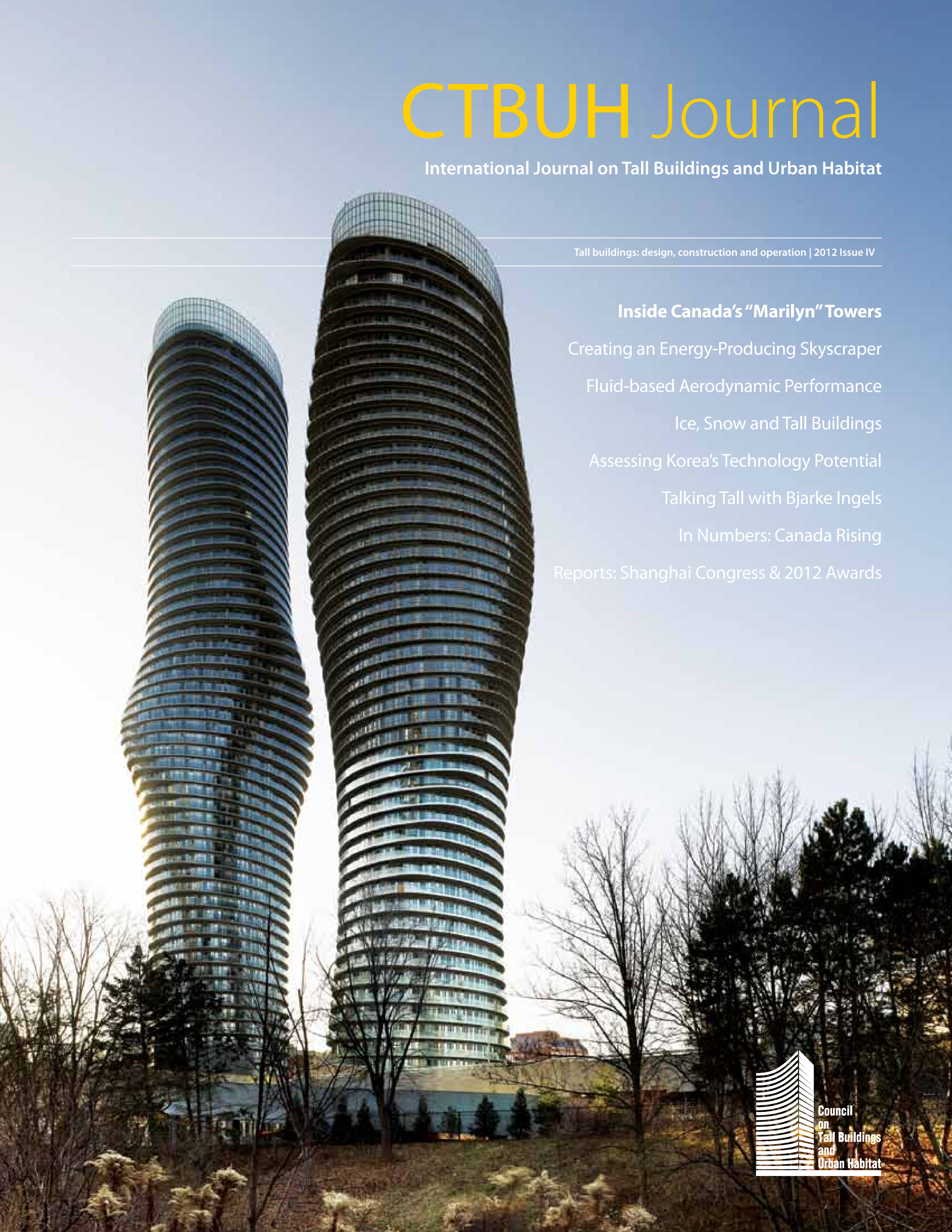

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Council on Tall Buildings and Urban Habitat

This Issue

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Front cover: Absolute World Towers © Tom Arban
Back Cover: Absolute World Tower 56 © Tom Arban

When I fly from Shanghai to New York, it usually takes me a few days to bounce back from the time change and 16 hours in the air. But this time, when I returned from the CTBUH 9th World Congress Shanghai, I was so energized by the meeting that I wanted to stop everyone and tell them about it.

My thanks to the more than 850 delegates (a sold-out Congress!), sponsors and speakers for three days of valuable presentations, stimulating panel discussions, and networking events. For anyone who did not get a chance to attend, the three days are summarized on the CTBUH website.

This was our first CTBUH Congress in China, which will soon set a record for the most tall and megatall buildings – buildings taller than 600 meters – in the world. The speed of urbanization in China and globally is unprecedented in human history: never before have so many people migrated to cities so quickly. China now has 15 cities with an estimated population of more than five million. Building up is the most economic, sustainable and practical way to address this rapidly changing demographic.

My one line summary of the Congress is to quote the science fiction writer William Gibson: "The future is already here – it's just not evenly distributed." When you walk around Shanghai – and other thriving cities across Asia – you have a sense that you are walking into the future of what a modern city can become. Embodying the Congress theme of *"Asia Ascending: Age of Sustainable Skyscraper City,"* many notable presentations indicated that present and upcoming designs incorporate the principles of sustainability at every level. In addition, many projects are paying more attention to the integration of new structures within the local context – the goal is not to be simply iconic but to also humanize the designs. I also noticed that Building Information Modeling and parametric modeling are being widely utilized, providing further evidence that advanced technologies are already having a dramatic impact.

After the Congress, CTBUH organized several tours for delegates in Beijing, Changsha, Hong Kong, Nanjing and Shenzhen. This gave delegates first-hand insight into growing cities in China. We at CTBUH take pride in playing such a central role in giving our members and colleagues access to the latest ideas and knowledge about emerging design trends and technologies. But there is always more to do. The Council can play a larger role in many areas affecting the industry, such as sharing up-to-date information on building codes in cities around the world and the latest data on industry innovations. To accomplish these goals, the Council needs to continue to grow and it requires more active participation from members.

In addition to providing global forums like the Congress, CTBUH also recognizes individuals and teams who have made remarkable achievements in the design of tall buildings. This year at the 11th Annual Awards Symposium, Ceremony & Dinner in October we saluted three individuals. For his simple and elegant designs, Helmut Jahn received the Lynn S. Beedle Lifetime Achievement Award, and the Fazlur R. Kahn Lifetime Achievement Medal went to Charlie Thornton and Richard Tomasetti, structural engineers who helped design many of the most innovative and advanced tall buildings around the world. The recognition of Charlie and Richard is the first time the CTBUH panel has awarded the prize to two people. My congratulations to Helmut, Charlie and Richard and to the recipients of "Best Tall Building" design awards. They are an inspiration to everyone in our industry.

All the best,

Dennis Poon,
CTBUH Trustee / Thornton Tomasetti

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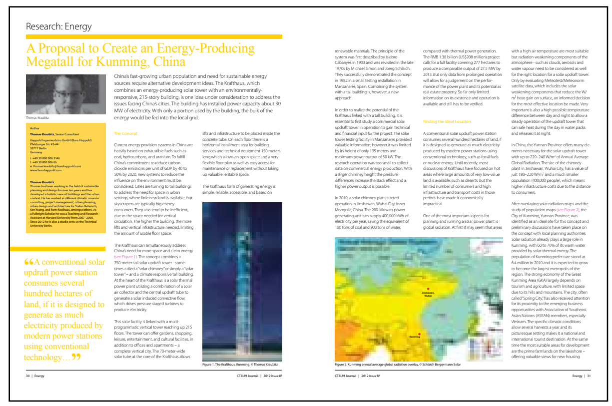

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"The challenges associated with the inherent inconsistency of air flow may open a new way of thinking about tall buildings as highly adaptive, dynamic systems capable of responding to the opportunities and challenges associated with spatially and temporally fluctuating resources."

Menicovich et al., page 18.

Tall Buildings: A Sustainable Future for Cities?

Creating efficient, livable urban environments was a hot topic at the recent CTBUH World Congress. But are skyscrapers part of the equation? This month's debate, "Are tall buildings an essential part of a sustainable urban future?"

NO

James Howard Kunstler, *author of "Too Much Magic: Wishful Thinking, Technology and the Fate of the Nation"*

One big surprise awaiting us is the recognition that the skyscraper is obsolete. They have already exceeded their "sell-by" date categorically, but we have not received the message. Even the architecture establishment does not recognize the problem. It's not primarily because of the issues of heating and air-conditioning, or about running all the elevators, though electric service may be a lot less reliable in the U.S. a decade from now. It's because these buildings will never be renovated. They have one generation of life in them and then they are done. Buildings take a beating day after day and eventually all of them need to be thoroughly renovated. Note that the duration of time from completion of a building to first renovation has gone down significantly over the past hundred years due to added complexity and the use of "innovative" materials whose properties over time are unknown and untried.

Reduced energy supplies means proportionately reduced capital available for anything. We'll be painfully short of financial resources and also of fabricated, modular materials – everything from steel to the silicon gaskets needed to seal glass curtain walls. The cities that are overburdened with skyscrapers will discover that they are liabilities, not assets. The skyscrapers deemed most "innovative" today – the ones most dependent on high-tech materials and complex internal systems – will be the most disappointing. This includes many so-called "green" buildings. Cities cannot be made of buildings that have no potential for adaptive re-use. We can easily see in this predicament another diminishing return of having lived through an age of cheap energy and easy miracles: innovative things by nature have no track record of long-term success, and sometimes don't work out, especially as basic economic conditions change. Innovation cannot be an end in itself.

It's even likely that in the decades ahead work will no longer be organized in the way that made the skyscraper necessary – as it seemed, let's say, back in the 1990s, when The Economist magazine cover story proclaimed that the world was "drowning in oil," and Wall Street ramped up its operations for the final chapter of massive capital accumulation. As events ride the flux of evolution, we lose track of what reality may afford us, of what "normal" is – until one morning we get up and everything has changed.

YES

Lester Partridge, *Global Director, AECOM*

The preservation of arable land and the regeneration of ecosystems must be first and foremost in any consideration for developing a sustainable community. Without the current finely balanced ecosystems our food production will be under threat and society as we know it cannot be sustained.

Tall buildings provide the opportunity for our expanding urban centers to increase population density with no reduction in arable land area. Tall buildings compress infrastructure requirements and provide opportunities for increased efficiencies. And although the buildings themselves may consume higher quantities of energy than low rise buildings, the opportunity for shared infrastructure such as district energy, waste to energy, water recycling and integrated public transport services provides significant efficiency benefits.

In addition, the opportunity for local food production in tall building districts is enhanced through the integration of local market gardens. The proximity of these gardens can reduce the demand for transporting food. And where waste water can be collected from the precinct's tall buildings, it can be recycled locally then re-distributed to where it is demanded in buildings and on local market gardens.

Tall districts also allow occupants to be within walking distance to services, work and recreation, thereby reducing the need for private transport usage. High speed transport links can connect a series of tall districts allowing occupants to easily commute to work. However, the critical benefit that a city of tall districts can provide is the opportunity to regenerate the local ecology between each area. Fingers of native fauna and flora can be reintroduced into our urban environments, putting a halt to the current rate of species depletion. And although we are yet to see this ideal model in practice, perhaps one of the best examples we have to date is Hong Kong, a city renowned for tall buildings. Hong Kong can boast that 40% of its land area is gazetted as natural habitats.

In summary, even though tall buildings on their own may not be an essential part of the sustainable future, they are an essential part of the future sustainable urban form. The challenge will be to convince city planners to place a moratorium on the development of all new green field sites and reacquire developed land within existing urban centers to promote native habitat. Indeed, not a popular decision for governments, as this will increase land values and the cost of home ownership, but a decision that will support the viability of tall building construction for the benefit of the planet.

Global News

*Visit the daily-updated online resource for all the latest news on tall buildings, urban development and sustainable construction from around the world at: **http://news.ctbuh.org***

Asia

The Hotel of Doom is back in the news. Photos of North Korea's most famous unfinished building, the **Ryugyong Hotel** in **Pyongyang,** appeared on websites around the world after a tour group was given access to the interior of the 105-story, pyramid-shaped building, which was first started in 1992. The photos show a stark, unfinished shell behind the imposing glass façade. In November, the CEO of Kempinski Hotels said the hotel will "probably" open in 2013.

In **Singapore,** Tange Associates opened the 209-meter **One Raffles Place Tower 2,** which was designed by Paul Maritaka Tange. Tower 2 joins the 280-meter Tower 1, which was designed by his father, Kenzo Tange, and completed in 1986. "The opening of Tower 2 reflects the confidence property developers see in Singapore's economy," Deputy Prime Minister Tharman Shanmugaratnam said at the opening ceremony.

Developers are also showing confidence in **Kuala Lumpur,** where the Tradewinds Corporation is moving ahead with plans to demolish a pair of tower to make room for a new development to be called **Tradewinds Towers.** Demolition work is expected to commence in early 2013 on the RM6 billion (US$2 billion) project, which will include a 65-story office tower, a 54-story apartment tower, a 14-story medical center, a 24-story corporate office block and a retail plaza.

In **Osaka,** Japan, the **Abeno Harukas Tower,** owned by the railway company Kintetsu Corporation, topped out in August. The building, which will be Japan's tallest upon completion, reached the landmark height of 300 meters when workers installed an 11-meter steel beam at the top of the structure. The building is scheduled for completion in 2014.

Also in Japan, **Shimizu Corporation** claims that its new **Tokyo** headquarters, which opened in August, is the world's least Carbon Dioxide-emitting building. The company reportedly developed and adopted a variety of technologies in an effort to improve efficiency, cut gas and oil use, and reduce CO_2 emissions, including radiant heating and even solar installations. But there were skeptics; "There isn't a clear certification standard for zero-energy buildings, which makes it difficult to verify this building's claims," Eric Bloom, a senior research analyst at Pike Research, told local media. "However, the building definitely uses a number of highly energy-efficient and CO_2-reducing features that aren't commonly seen in large buildings."

Europe

After years of delays and false starts, **St. Petersburg** officials approved plans for natural gas company Gazprom's **Lakhta Center,** a 463-meter building originally designed by RMJM on the city's undeveloped outskirts. UNESCO blocked original efforts by threatening to strip the city of its World Heritage status if it allowed the skyscraper to be constructed too near the city center. USE builder Arabtec proudly trumpeted an AED453 million (US$123 million) contract to build the revised and relocated tower.

UNESCO was also making news in London, where the group warned officials to more closely regulate tall building development in the historic areas of the city. A UNESCO report called on the government to "regulate build-up of the area around the Shard" and asked to review major projects before an "irreversible commitment is made."

Controversy flared up in August in **Venice,** where fashion mogul Pierre Cardin is planning to build a 244-meter Palace of Light in an underutilized area on the outskirts of the city. Citizens reacted strongly against the **Palais de Lumiere**'s avant-garde design. One Italian architect put it simply: "If you want to do something for Venice, do something else."


Ryugyong Hotel, Pyongyang. © Joseph Ferris III


One Raffles Place Tower 2, Singapore. © Tange Associates


Abeno Harukas Tower, Osaka. © Ogiyoshisan

Shapely Pair of Towers Challenges the Status Quo

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Bas Lagendijk
Bas Lagendijk deals with communication in Architecture at MAD. As a strategic thinker he informs on the potential of Architecture and communicates between clients, collaborators, governments, constructors and the general public.

Educated in Interior Architecture, Information Technology and Graphic Design, he previously worked at OMA, where he was involved in many contemporary issues ranging from buildings to large scale sustainability issues such as Zeekracht, Roadmap 2050, West Kowloon Cultural District and the Venice Biennale.

Anthony Pignetti & Sergio Vacilotto
Dominus Construction Group is a full service construction firm in the Greater Toronto Area. Drawing on the extensive industry expertise of senior management team members, Anthony Pignetti and Sergio Vacilotto, Dominus has distinguished itself within the industry as a new brand of builder focused on innovation and unique forms of partnership.

Dominus has earned a reputation for delivering projects unprecedented in engineering and technical complexity such as L-Tower, constructed atop of Toronto's renowned Sony Centre for the Performing Arts, in addition to the Absolute World Towers – CTBUH 2012 Best Tall Building for the Americas.

Dubbed the "Marilyn Monroe" towers, the CTBUH 2012 "Best Tall Building Americas" award-winning project is the result of a unique public-private partnership and an international design competition, which chose a new Chinese firm doing its first work in North America. The innovative design, however, created an array of issues for the builders.

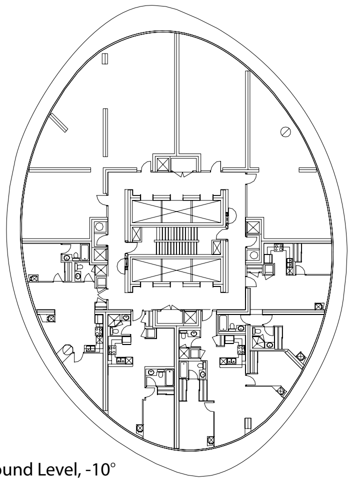
Like other suburbs in North America, the Toronto satellite community of Mississauga is quickly developing into an interdependent, urbanized area. Canada's sixth largest and fastest-growing major city, Mississauga has a diverse economy and multicultural character, as well as a new-found status as an important city center in the Greater Toronto area (GTA). However, its rapid development into an urbanized center has been at the expense of a unique cityscape character.

The redevelopment of a major downtown intersection was seen as an opportunity to redefine Mississauga's urban landscape through an innovative public-private partnership and internationally recognized architectural design. The project had to add something naturalistic and human to contrast with the existing backdrop of listless boxy buildings.

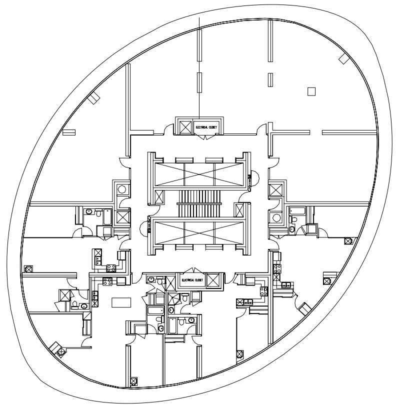
The winning design obeys many of the rules of the typical North-American high-rise: a central core, a straightforward and economic structure and a glass façade. However, the outcome is fundamentally different in the perception of the people. By the time of completion the result was recognized by the public and news accounts as an inspiring place to live, something more than a place that strives for simple efficiency. The buildings hope to provide residents with an emotional connection to their hometown and neighbors, and a local landmark to define the city.

A Risky Development Plan

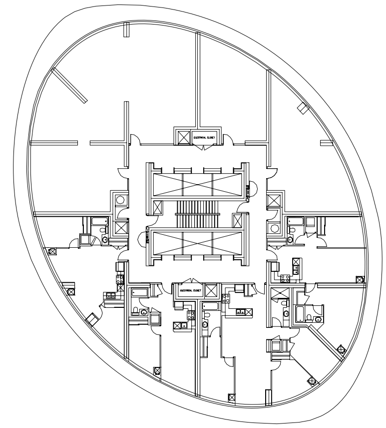
The developers of the site, Fernbrook Homes and Cityzen Development Group, were determined to tackle the lack of a unique character when they set out to redevelop the intersection in Mississauga's downtown core. It was determined that the best use for this important property would be a residential development. The entire project includes a master-planned community of five towers with more than 158,000 square meters, 1,850 residential units, a three-story 3,252-square meter recreation area, and retail facilities.



Ground Level, -10°



Level 24, 42°



Level 40, 159°

Figure 3. Typical floor plans of the Absolute World 56. © MAD

Figure 4. The towers' rotation difference. © PERI

straightforward, with restrictions limited only to the amount and size of units. This allowed the competing designers full expression and flexibility.

Eschewing the tradition of accentuated verticality in high-rises, MAD's design for the Absolute World Towers chose not to emphasize vertical lines. Instead, the design features smooth, unbroken balconies that wrap each floor of the building. In addition, at each successive level, the floor plate rotates in a range of one to eight degrees affording panoramas of the Mississauga skyline (see Figure 3). By maximizing the viewing potentials both inside and outside the buildings, the design created a medium for social interaction throughout the balconies and connected the city dwellers with naturalistic design principles.

Building an Idea

Many observers questioned whether the MAD design could actually be built. The unique features of this type of rotating structure had never before been subjected to Ontario building code requirements and there was no precedent for the construction challenges.

From the outset, local architectural and engineering firms were engaged to refine the design and ensure it would meet all local standards without compromising the initial design intent. While the lead time for most projects was normally three to four months before excavation was scheduled to commence, in the case of Absolute World, the preparatory period was extended to 12 months. This type of extensive pre-planning ensured the project was kept on schedule by anticipating potential issues.

While consultants always play a major role in the construction of any project, in this case their role was even more significant. The rotating design meant that every floor was unique. Meeting these challenges required extensive collaboration among all the construction disciplines throughout the process.

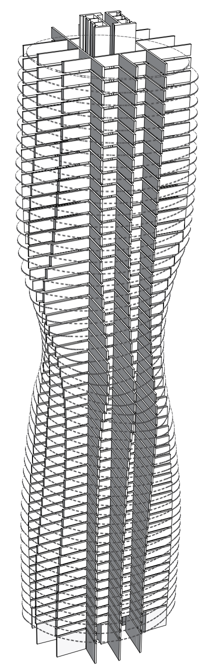


Figure 5. Typical structural configuration. © MAD

In addition, there was some initial concern that the unique layouts would limit the ability to market and sell residential units in the tower. However, the interest generated by the competition and the public's participation in the final selection helped the developers easily sell out the apartments in a few days. The developer had taken a significant gamble in committing to deliver a design developed out of a competition, but the results provided evidence that design does matter in the

A Different Approach to the Aerodynamic Performance of Tall Buildings

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David Menicovich is a Phd student at CASE, and is currently researching the development of building integrated flow control systems in collaboration with the Center for Flow, Physics and Control (CeFPaC) and the Department of Civil and Environmental Engineering (CEE) at RPI.

Jason Vollen is the Associate Director of CASE. He is a researcher focused on emerging material technologies, specifically, the integration of energy per-formative structural ceramics, dy-namic and environmental simulation, and digital fabrication.

Prof. Michael Amitay is a Professor and the James L. Decker '45 Endowed Chair in Aerospace Engineering at RPI, and the Director of the CeFPaC. Over the past few years Amitay has been exploring the feasibility of flow control to improve the performance of wind turbines in buildings.

Prof. Chris Letchford is the Head of Department of CEE at RPI. Dr. Letchford's research work has largely focused on physical modeling of extreme winds and their impact on the built environment. Currently Dr. Lechford is involved in NYSDOT funded research on the aeroelastic response of slender structures and in the topographic effects of wind on wind turbine siting.

Edward DeMauro is a doctoral student at RPI whose research is focused on the study of active aerodynam-ic flow control through experimental methods.

Ajith Rao is a policy and research analyst at the RAP, where he works on providing technical and policy support to policymakers and regulators on a broad range of energy and environmental issues.

Prof. Anna Dyson is the founding Director of the CASE – a consortium which attempts to achieve a collaborative model without the schism that has typically divorced building science pursuits from the aesthetic, social and conceptual aspirations of architectural design inquiry.

This paper examines the use of Fluid-based Aerodynamic Modification (FAM) methods derived from flow control techniques first developed for the aerospace industry. Instead of relying on the adjustment of the solid material within the structure to improve the aerodynamics of a tall building, fluid-based active flow control is added to the building systems' matrix to manipulate the building boundary layer and achieve a desired performance for both the interior and exterior. Experimental results are presented to demonstrate proof of concept for the FAM approach to tall building aerodynamic modification.

Introduction

While our environment consists mostly of fluids, we have primarily restricted ourselves to approaching investigations of the interactions between buildings and their surroundings by using solid modeling. As a result, the design of tall buildings has relied on both a Solid-based Aerodynamic Modification (SAM) approach to meet a desired aerodynamic performance and techniques to modify the geometry of the building (Geometry-based Aerodynamic Modification or GAM) or its structural properties, such as stiffness through the use of materials and auxiliary damping systems. Although these techniques do provide a narrow path for success, they do not adapt to fluctuating environmental conditions and are accompanied by a loss of useful floor area and an increase in total energy cost.

SAM for Cross Wind Response Reduction

The development and increasing use of light-weight and high-strength materials in the construction of tall buildings, offering greater flexibility and reduced damping, has increased tall building susceptibility to dynamic wind load effects (Li et al. 2011) that limit the gains afforded by incorporating these new materials. The main associated risk is resonant oscillations induced by von-Kármán-like vortex shedding at or near the natural frequency of the structure caused by flow separation. The effects of dynamic wind loading increase proportionally with the power of the wind, causing tall buildings to pay a significant material price to increase the natural frequency and/or provide damping. In particular, crosswind response often governs both the strength and serviceability (human habitability) design criteria.

While both SAM and GAM strategies have merit, they often come at the expense of valuable leasable area and high construction costs, due to increased structural requirements for mass and stiffness, further contributing towards the high consumption of non-renewable resources by the building sector. Therefore, a traditional aerodynamic based solution comes at the cost of habitable, and therefore valuable, floor area that, in turn, may require additional compensatory stories, which further increase the wind loads and construction costs (Tse et al. 2009).

A Novel Approach

While the SAM approach relies on the building, its geometry and material properties for aerodynamic performance, the proposed Fluid-based Aerodynamic Modification (FAM) approach is fundamentally different. Instead of adjusting the solid material to improve the aerodynamic shape of the structure, fluid-based flow control is used to manipulate the boundary layer characteristics (see Figure 1), i.e., the interaction domain between the building and the airflow, such that the airflow virtually "sees" a different shape. FAM is an Active Flow Control (AFC) strategy, i.e., a strategy that requires a power input and alters

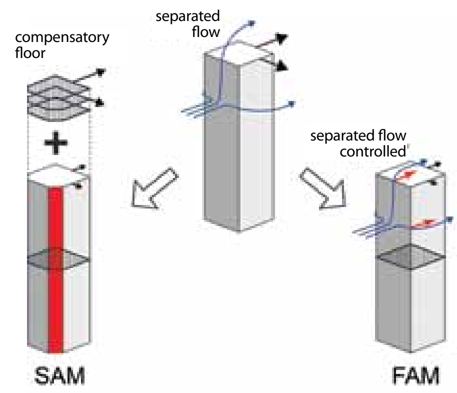

Figure 1. Schematic diagram showing a comparison of SAM that physically modifies the baseline building plan to reduce wind loads thus requiring additional compensatory stories, with FAM that controls airflow while preserving the baseline plan for economic optimization and maintenance of optimal Floor Area Ratio (FAR). © CASE

the flow only when desired. The main goal is to mitigate flow separation in order to reduce the impact of shed vortices, reduce wind loading and decrease pressure fluctuations across the building envelope (see Figure 2). The FAM approach relies on concepts developed for Boundary Layer Control (BLC) and its application to date has been mainly in the aviation industry. While this has been powerfully demonstrated in airfoils – smooth shapes in uniform low turbulent flow and mean loads, it is the application to bluff bodies (buildings) in highly turbulent flow and the impact on fluctuating loads that remains to be clearly demonstrated.

The science of BLC originated with Prandtl (1904), who introduced boundary layer theory, explained the physics of flow separation and described several experiments where a boundary layer was controlled (Gad-El-Hak 2000). Since inception, two strategies for BLC have emerged;

1. Steady forcing: aerodynamic performance modification using steady flow.
Boundary layer control, as a means of preventing separation, has traditionally been associated with the steady addition (blowing) of high momentum fluid, or the removal (suction) of decelerated fluid near a surface from a boundary layer to deflect the high-momentum free-stream fluid towards the surface.

2. Unsteady forcing: aerodynamic performance modification using periodic excitation.
The second, more recent and more energy efficient approach, is periodic excitation, often regarded as oscillatory addition of momentum. As opposed to the steady flow strategy, which seeks to simply add or remove momentum to the flow, periodic excitation takes advantage of knowledge of naturally occurring frequencies within the flow, and structures associated with them. Therefore, periodic excitation may be used to alter more effectively the steady characteristics of the flow by targeting the structures. (Nagib et al. 2004, Greenblatt & Wygnanski 2000).

Additionally, with a sufficiently high actuation frequency, it may be possible to achieve virtual shaping of the object, where the flow effectively sees a different shape (see Figure 3). Although the unsteady forcing strategy is more complex than steady forcing, it has three main advantages: power requirement is an order of magnitude smaller, actuators can be decoupled from a main propulsive system, and they are autonomous, small and light-weight (Greenblatt & Wygnanski 2000). Synthetic jets (which neither add nor subtract mass from the flow field, i.e., zero-net mass flux) are used as periodic excitation actuators in the present work. These actuators operate by the periodic motion of a diaphragm that is (typically) driven by a piezoelectric disc (Glezer & Amitay 2002).

The addition of momentum by forcing is generally quantified using the blowing ratio, C_b:

$$C_b = \frac{U_j}{U_\infty} \qquad (1)$$

Where U_j is the jet velocity and U_∞ is the free-stream velocity and the momentum coefficient, C_μ:

$$C_\mu = \frac{\rho_j U_j^2 bh}{\rho_\infty U_\infty^2 DH} \qquad (2)$$

Where ρ_j and ρ_∞ are the densities of the jet and the free-stream velocity, respectively. U_j and U_∞ are the jet and free-stream velocities. D, H, b, h are the model width, height, and jet orifice width and height, respectively.

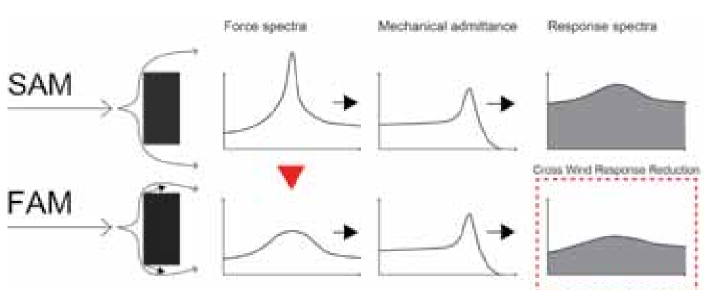

Figure 2. Schematic diagram of the research hypothesis: by affecting the crosswind force spectra on the building through the manipulation of the boundary layer, the required damping will be achieved through fluidic means, reducing the mechanical damping requirements of the building's structure to achieve the desired serviceability criteria. © CASE

"Instead of adjusting the solid material to improve the aerodynamic shape of the structure, fluid-based flow control is used to manipulate the boundary layer characteristics, i.e., the interaction domain between the building and the airflow."

About the Council

The Council on Tall Buildings and Urban Habitat, based at the Illinois Institute of Technology in Chicago, is an international not-for-profit organization supported by architecture, engineering, planning, development and construction professionals. Founded in 1969, the Council's mission is to disseminate multi-disciplinary information on tall buildings and sustainable urban environments, to maximize the international interaction of professionals involved in creating the built environment, and to make the latest knowledge available to professionals in a useful form.

The CTBUH disseminates its findings, and facilitates business exchange, through: the publication of books, monographs, proceedings and reports; the organization of world congresses, international, regional and specialty conferences and workshops; the maintaining of an extensive website and tall building databases of built, under construction and proposed buildings; the distribution of a monthly international tall building e-newsletter; the maintaining of an international resource center; the bestowing of annual awards for design and construction excellence and individual lifetime achievement; the management of special task forces/working groups; the hosting of technical forums; and the publication of the CTBUH Journal, a professional journal containing refereed papers written by researchers, scholars and practicing professionals.

The Council is the arbiter of the criteria upon which tall building height is measured, and thus the title of "The World's Tallest Building" determined. CTBUH is the world's leading body dedicated to the field of tall buildings and urban habitat and the recognized international source for information in these fields.

Council on Tall Buildings and Urban Habitat

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