LEEWARD

residence and training facility for wind influenced sport

CTBUH 2014: Tall Building

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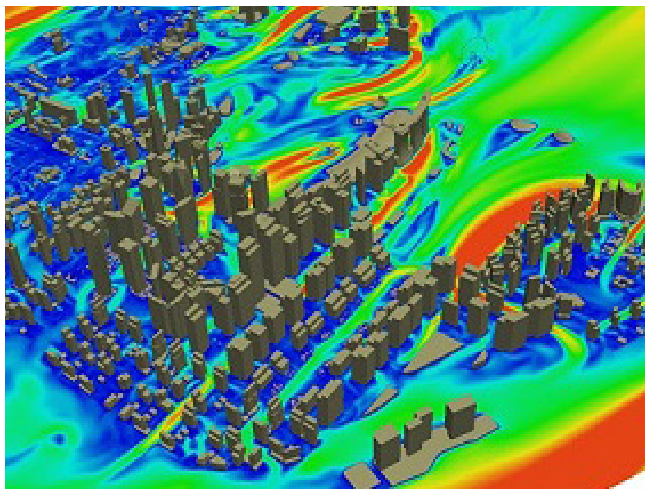
Contents



This design was created in collaboration with Kimberley Adamek, who in large part influenced the nature of the work due to her academic research pertaining to wind and its' influence on the built environment, but most importantly how that experience can be used to impact the people buildings are supposed to be made.

Figure 1.1 Fluid Dynamic Modeling Visualization

Leeward, a conceptual tower for wind experience and technical outdoor sport training was imagined for the Council on Tall Buildings and Urban Habitat International Student Tall Building Design Competition. As noted in the brief, past competition chair, and partner at KPF architects, William Pedersen spoke about the role of the urban tall building:

> There has been a major transition in the sense of the value of the tall building and what it can contribute to the urban realm, and society in general. This transition moves the tall building away from just an instrument of financial exploitation and toward a development highly concerned with its impact on the city, the environment, and the urban habitat.[1]

The competition brief does not provide many requirements, as site(though it must be a real place), program, and desired scale(both height and floor area) are determined by the participants. The final guidelines were based on project success in fulfilling a set of themes under the title "Towards a Sustainable Vertical Urbanism."

An outlined list of the terms to consider were as follows:

- local climate
- urban grain
- neighbouring buildings
- city requirements
- community requirements
- social sustainability
- environmental sustainability
- efficiency of materials, space, and usage
- aesthetics
- proportions
- local, social, and cultural conditions
- materiality
- new technologies
- structure
- innovative program/functionality
- adaptability
- transit/mobility
- infrastructure[2]

Our project approached the brief by exploring the effects of wind in architecture. This exploration was informed firstly, by the wind conditions upon the site, and then was developed further in regards to suitable program, in relation to the site context. From here, energy harvesting and an analysis of possible conditions are speculated upon.

Built structures heavily influence the direction and speed wind travels through the city, an influential research interest that developed from a simple observation: How is it that one can turn down a street and be met with a gust of wind, on a typical street on a typical day? These conditions can occur during gentle winds and on a street no more remarkable then the street just passed or the street just beyond.

Everytime a new tower is erected, wind paths through the city change. At times towers may make the wind faster by funneling it between other buildings, or slow higher speed winds down with a tower's form. The addition and substraction in the urban fabric can create unexpected loads on surrounding buildings. Examples such as Bridgewater Place in Leeds(figure 1.2), or the EEMCS building at the TU Delft campus in the Netherlands(figure 1.3)[3] both exhibit environmental wind changes that have contributed to inconveniences, injuries, and in one instance, death.[4] Wind is not the easiest element to design with since it is fluid, unexpected and most importantly, visually imperceptible.

How can we begin to not only understand the effects of the structures we build but reduce the negative impact and work with these forces?

The following paper outlines the design development according to the brief outline above, categorizing precedent studies into three categories:

1. Site
2. Form
3. Program
4. Sustainability

Figure 1.2 (top) Bridgewater Place
Figure 1.3 (right) EEMCS Building Campus

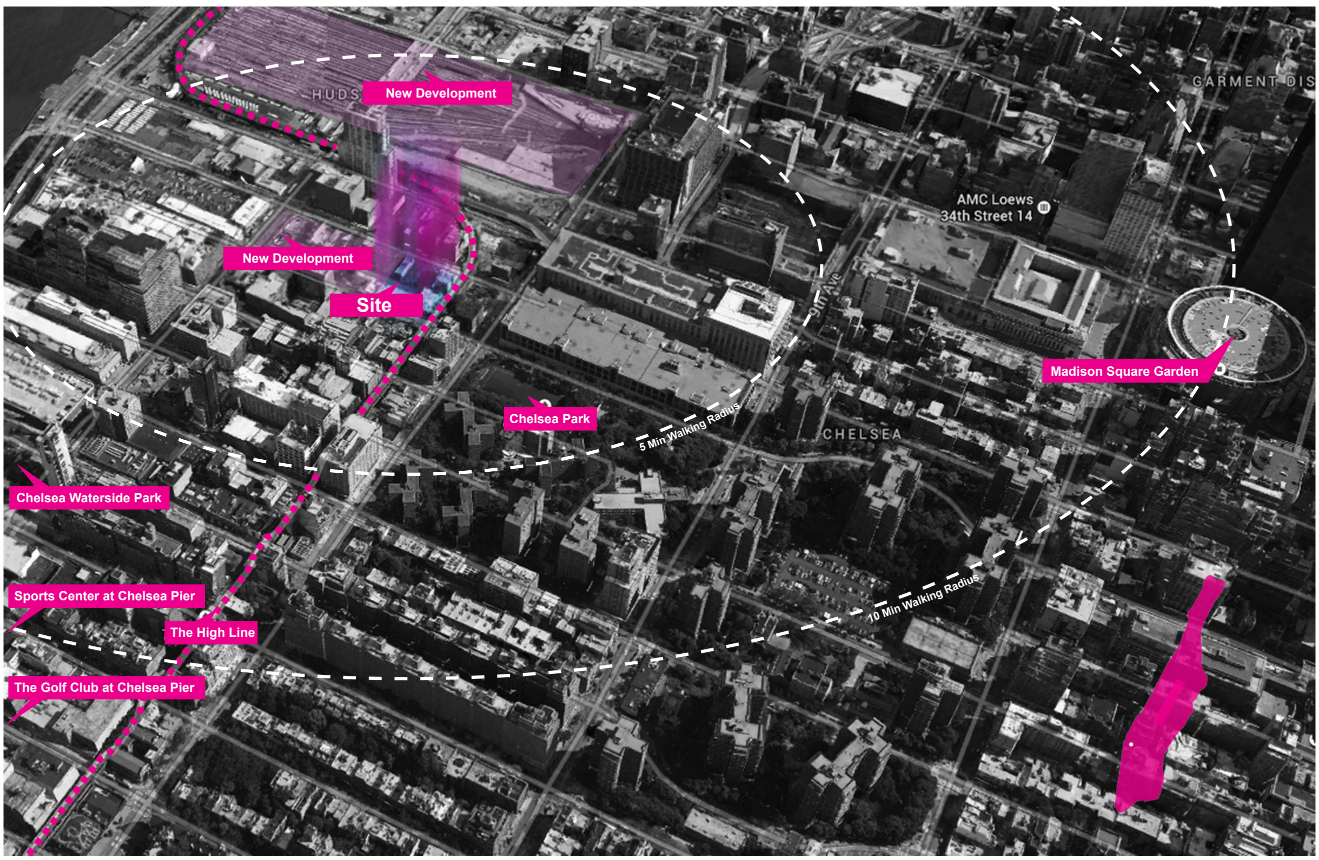
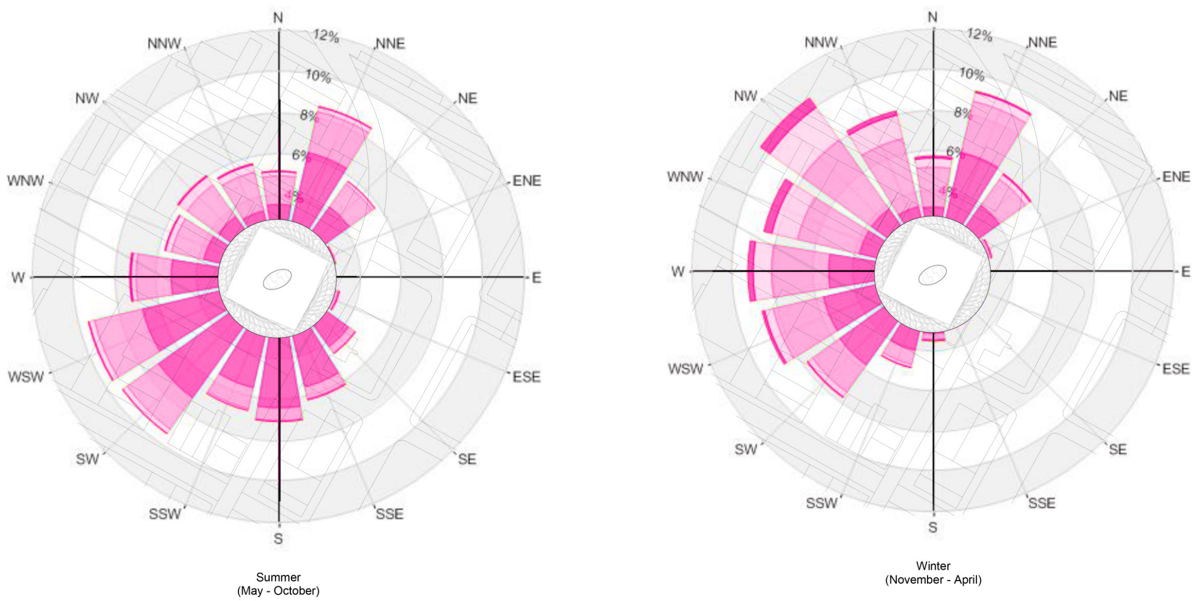


Figure 1.4 (left) Site Diagram



Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	4.2	4.4
1-10	22.4	17.1
11-20	50.5	42.0
21-30	19.7	26.8
31-40	2.8	7.8
>40	0.4	1.9

Figure 1.5 (right) New York City Wind Rose

Site

The site chosen for this project was New York City's Chelsea district of Manhattan. The reason for selecting this site was due to the area's unique design problems related to the wind conditions that come from the West across the Hudson river, and how they are to be considered in the ongoing development that is seeing the implementation of several towers upon land that is primarily railyard. The drastic shift occuring in this particular urban landscape should also consider how the possible designs of new development can impact the quality of experience for the pedestrians who frequent the adjacent High Line Park, or will be enjoying the podium amenity spaces of the new development, seen for example in figures 1.6 and 1.7.[5] The allocated site at 517 W 28th Street, is currently under partial development, as part of it is gated off, protecting a hole in the ground, while the other portion is under construction for a typical multi-storey residential tower with a podium. Upon selecting the site as a point of interest for interrogating the use of wind conditions next steps included a brief contextual understanding of the area.

Although the existing urban fabric is primarily composed of buildings between 5 and 12 stories, there are several examples of tall structures, such as the existing Standard Hotel(figure 1.9), or the Abington House on the High Line(figure 1.10). These existing buildings, in combination with the major Hudson Rail yards proposal, exemplify the ongoing densification of the area, setting precedent for other tower development.

The last building in the area that has been tagged for consideration is the twisting commercial office building at 837 Washington street(figure 1.11), slightly further south in the Meatpacking district. As outlined on the website of Morris Adjmi Architects–the designers responsible for the building–the design intended to take cues from the high line park, and celebrate the steel structure, placing the members on

Figure 1.6 (top) Hudson Rail Yards Public Square
Figure 1.7 (middle) Highline Phase 3
Figure 1.8 (bottom) Hudson Rail Yards Masterplan

the outside of the building, forming a twisting exoskeleton.[6]

By assessing the local context, cues in construction size, material choice and form can be found in the surrounding area. The tall building proposed sits at a similar height to these buildings. Though not as tall as the rail yards proposal (Leeward stands at approximately 180m, where some of the new developments could stand up to 275m), the project contributes to the density of this part of Manhattan.

Additionally, the proposal incorporates a twisting steel structure, as a means of creating a facade that can foster wind turbulence, dissipating strong wind forces by deflecting its current flow in multiple directions. Turbulence is created through formal strategies existing at multiple scales. The overall tower form twists gradually throughout its whole height. In addition, a steel diagrid exoskeleton forms a rigid frame around the large plate structure, while allowing winds to pass directly between the members, creating varying but experienced wind conditions within the building.

Figure 1.9 (top) The Standard Hotel
Figure 1.10 (bottom right) Abington House
Figure 1.11 (bottom left) 837 Washington Street

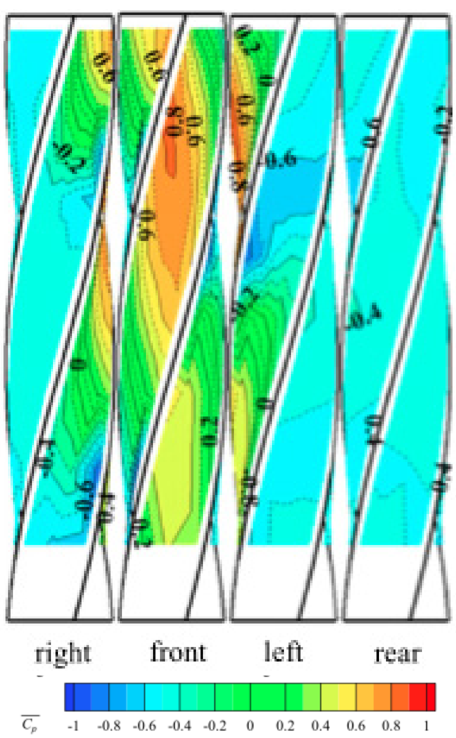
Form

This strategy was influenced by the paper "Experimental Investigation of Aerodynamic Forces and Wind Pressures Acting on Tall Buildings with Various Unconventional Configurations" which outlines the results of wind pressures and aerodynamic forces of varying unconventional forms of tall buildings that elaborate upon the square plan building. The studies found that helical models have higher performance aerodynamic behaviour due to the irregular nature that it interacts with wind conditions along its height. (figure 1.13) This was observed while comparing several building morphologies, including basic plan extrusions, corner modification models, tilted models, tapered models, helical models, opening models and composite models.(figure 1.12) The study also discovered that combining different modifications provides better wind behaviour than towers with a singular modification.[7]

During the design process a brief catalogue of two configurations, twisting, and open towers were made. "Open" tower projects such as ShoP Architects 111 West 57th Street(figure 1.14) tower proposal in New York exemplify how engineering considerations can influence the final configuration while still fulfilling the primary design intentions. In this case, the goal was to create a tall tower with a small floor plate. This was achieved by inserting openings through the building intermittently, paired with tuned-mass dampers in order to minimize lateral acceleration and improve the comfort for inhabitants.[8] However enticing or technologically advanced this structure is, it still represents an architectural preconception that the natural environment is something to be opposed, viewed as an uncontrollable perturbation. The project stands to question the desired homeostatic notions of modern contemporary architecture. As architect and engineer Michelle Addington elaborates, on the conventional practice of how,

> we design with the quite perverse preconception that "the human body is treated as a problematic perturbation that disrupts the optimum functioning of systems whose only purpose is to maintain an environment for the human body[9]

This design also considers the other extreme of the building envelope, the environmental forces that are traditionally mitigated from the majority of architectural spaces.



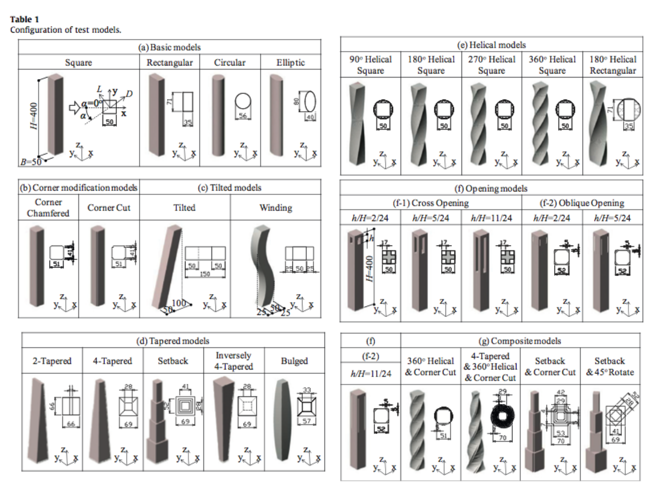
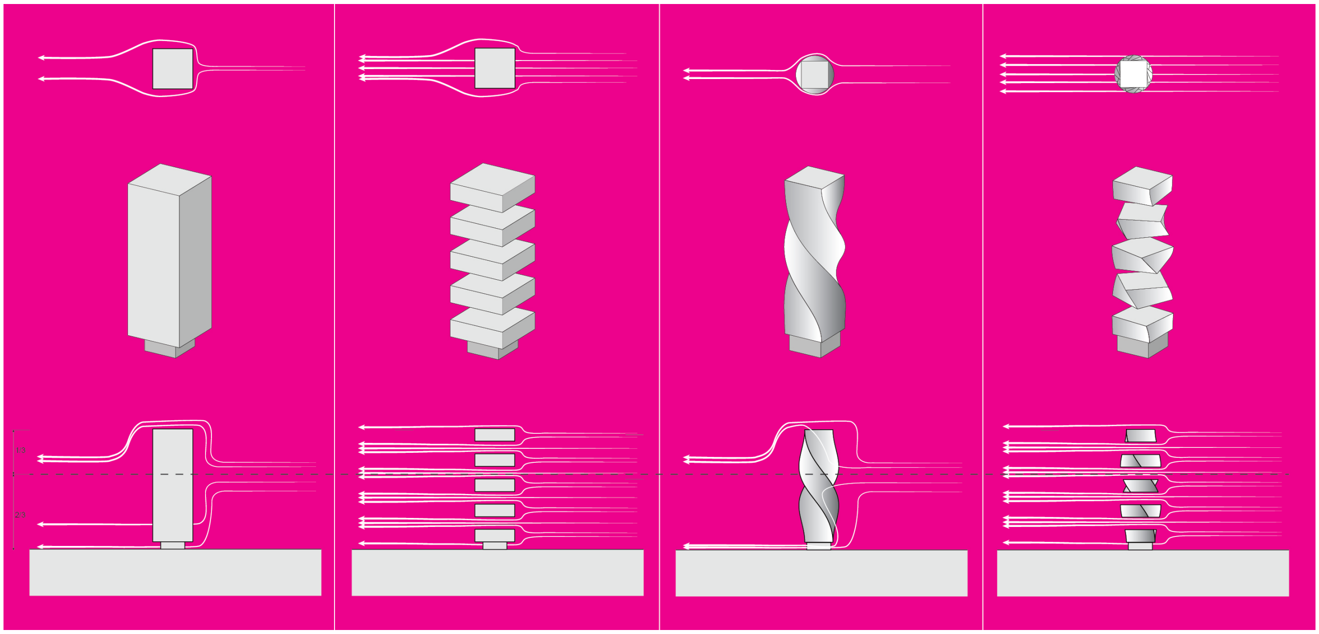


Figure 1.12 (left) Table of Tower Configurations
Figure 1.13 (right) Analysis of Helical Model

Possible alternatives to these architecture and engineering solutions that dedicate specific space in order to modulate wind conditions could be considered as a cellular condition, mediated throughout the varied living units of the tower.

Another, more pronounced example of creating a tower that worked with it's local climate is The Met tower in Thailand by WOHA(figure 1.15). The tower utilizes the moderate wind conditions within the humid climate in order to dramatically reduce the loads on mechanical systems. In the same effort, the project attempts to move away from the traditional Western tower model, commonplace in North American temperate climates. The form consists of three monolithic forms linked together at repeated intervals which allow for captured breezes, while staggered spaces allow for cross-

Figure 1.14 (top right) 111 West 57th Street
Figure 1.15 (bottom right) The Met
Figure 1.16 (bottom left) Absolute Towers



ventilation.[10] Although a completely different climate, the use of form to allow for natural ventilation and to blur the threshold between inside and outside is inticing. This concept is an attempt to utilize wind within the design of the varying climate conditions and see what potentials could exist.

An example of ecologically responsible helical towers are the Mode-Gakuen Spiral Towers in Nagoya, Japan by Nikken Sekkei Architectural Group(figure 1.19). The twisting design houses a double-glassed air flow system in order to reduce heating and cooling requirements by harnessing a ventilation system that exchanges interior and exterior air as needed, using the envelope cavity to assist this process.

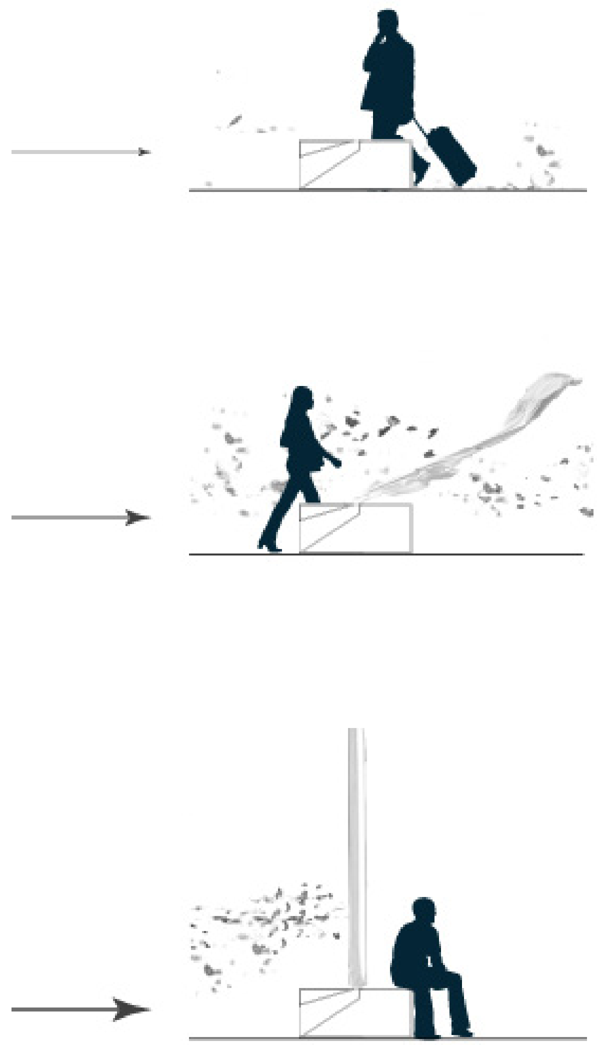
Additional helical buildings studied as formal investigation, include MAD architects' Absolute Towers(figure 1.16) in Mississauga, Ontario, as well as the Turning Torso by Santiago Calatrava(figure 1.18) in Malmo, Sweden.

The final form strategy result is an open helical model, that allows for the harnessing of wind for energy production as well

Figure 1.17 (top) Configuration Evolution
Figure 1.18 (bottom) The Turning Torso

as the human experience. The combination of understanding local context as well as exploring the general understanding of wind research, in an effort to inform the precedents that could be used. Rather than having an individual idea about the form, it is derived from the forces that are acting upon it.

moved beyond a single tower, and created a multi-functional building complex, with a wide array of building program, including leisure and recreation. The mixed use approach to high density towers was considered uncommon at the time, but gave way to all sorts of programmatic imaginings for the



Program

Within a ten minute walk of the site, several existing fitness and recreation areas can be found. These facilities provide varying sports activities at a number of calibre levels, including elite athletics viewed and played at the Madison Square Garden, or the recreational golf driving range that can be found at Chelsea Pier. These signify the potential for this area of Manhattan to become an athletics hub within the city. New York is no stranger to hybrid recreation towers, as a couple seminal examples of this type of program can be found in the city. The Downtown Athletic Club, built in 1930 by Starret and Van Vleck, was an early example of a tower that featured a variety of programs, including sports, recreation, office and domestic units. The Rockefeller Center, which was completed in 1939,

Figure 1.19 (left) Mode-Gakuen Spiral Towers
Figure 1.20 (top right) Wind I Tunnel

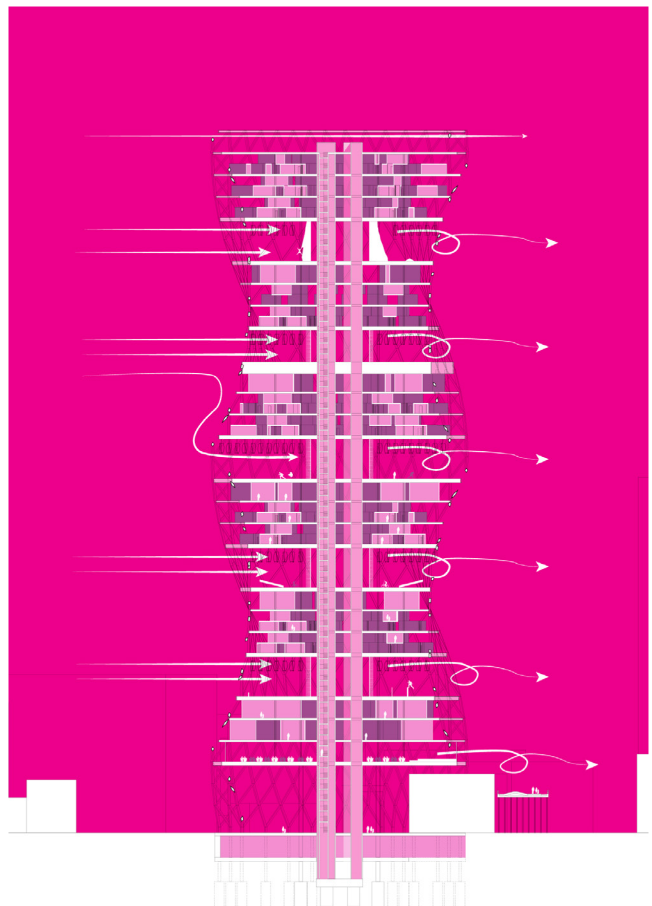
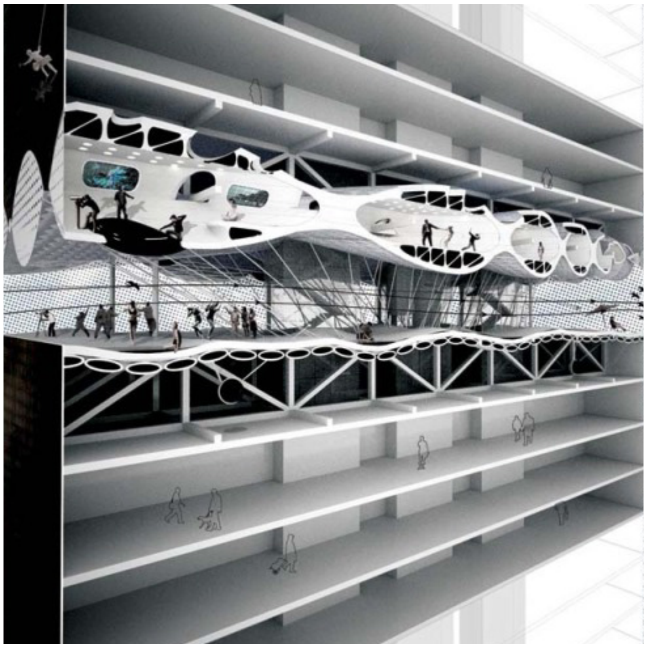
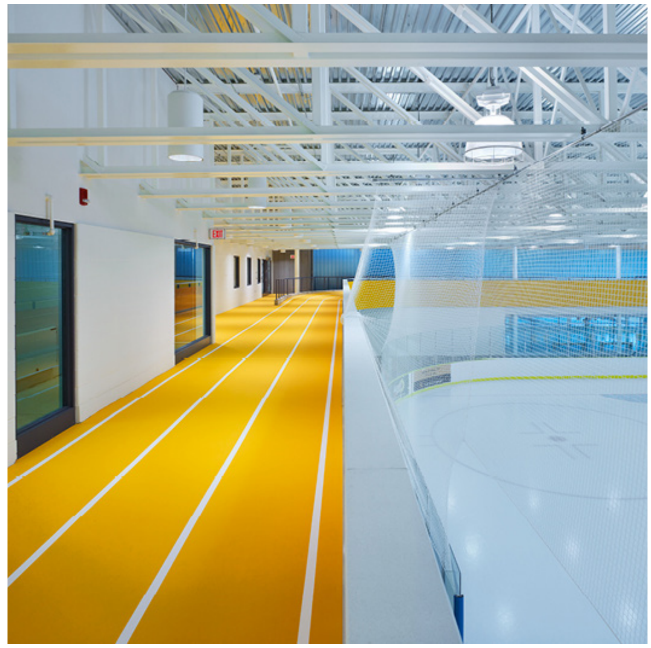


Figure 1.21 (left) Program Diagram
Figure 1.22 (right) Building Cross Section



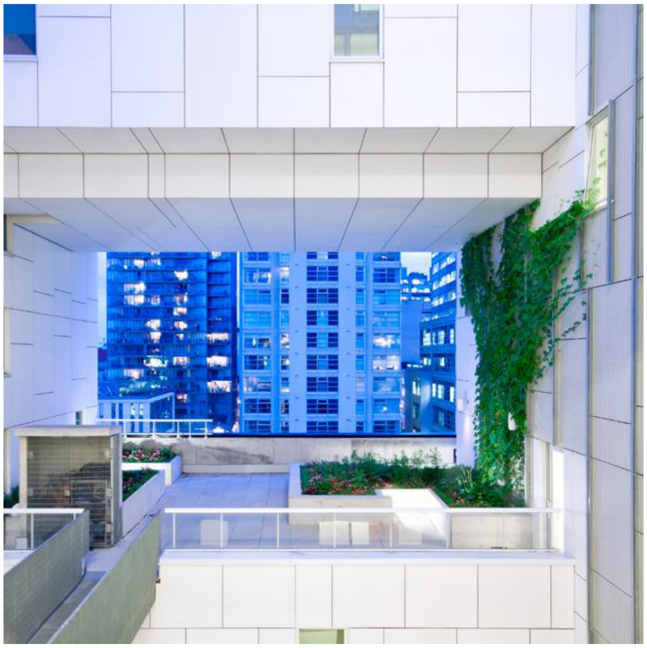


city.[11] The proposed tower is a sports training facility that would help emulate the experience of wind conditions during competitive circumstances. Thus, facilitating outdoor sports, such as the triathlon, rock climbing, and parkour. Although many of these sports can be practiced in their natural setting, this facility not only allows for analysis and development of technique for given sports, it also creates somewhat emergent wind circumstances that can impact conditions during a race. This method of working with wind is reminiscent of the "Windbreak" project known as Wind I Tunnel by Emily Schlickman(figure 1.20). The project proposes to use wind as a means of mediating exterior conditions where public spaces are uncomfortable. The concept involves the responsive deployment of a balloon structure that forms a wind wake, providing shelter for pedestrians in the area. This balloon inflates with the very wind it diffuses.[12] Leeward is designed in a similar manner, moving beyond energy production, aiming to harness the qualities of wind for strengthening the human body. In addition, wind changes will result in different wind experiences, and different levels of resistence.

A similar, but potentially more fantastical approach to the concept can be found in the "Super Galaxy" tower proposal by Future Cities Lab. This project creates lacerations in the traditional building fabric, that introduce energy flow through the building. This slice in the existing building is filled with varying program types that introduce responsive microclimates blurring the boundaries between interior and exterior, while working with the often unassuming energetic qualities of a place. A particular word used by the design team is that of coherence, where the manifestation of architectural influence, no matter it's physical state, is in play, through the exposition of patterns, and the atmospheric changes that can occur in the fluctuating energetic states of temperature, moisture and wind movement.[13] The Leeward proposal learns

Figure 1.23 (left) Super Galaxy
Figure 1.24 (right) Innisfil Recreation Complex

Figure 1.25 (top left) Silos Zeeburg
Figure 1.26 (top right) BIG Mountain Dwellings
Figure 1.27 (bottom right) Regent Park Aquatic Complex
Figure 1.28 (bottom left) Copenhagen Expo Pavilion



from the open plan, open air concept, however, at this time the design does not result in major responsive mechanized changes besides proposed energy harvesting systems.

In a more traditional sense, the tower also contains residences and health facilities which supplement high intensity training, allowing for varying groups and individuals to socialize and train in a collective environment. These floors house villages of cellular program, designed to allow for varying environmental conditions for physiotherapy, video review, and spas, as well as microliving residences for long term guests. These spaces are inset from the main floor plates, but provide a predictable inhabitable interior enclosure.

Although the tower may not be distinctly of the same architectural typologies, the work of particular architects exploring hybrid program, or inserting recreational program in non-traditional building types are briefly explored. The

Figure 1.29 (top) 60 Richmond Street
Figure 1.30 (bottom right) Citigroup Tower
Figure 1.31 (bottom left) Rotterdam Market Hall

Figure 1.32 (top left) Caixa Forum
Figure 1.33 (top right) Hong Kong Design Institute
Figure 1.34 (bottom) Market Space Ground Floor

work of MJMA, a Toronto based firm, is responsible for many recreation and community center designs. These facilites not only negotiate the varying demands of programmatic adjacencies, but they also give an understanding of the basic needs and design cues for producing quality spaces for particular sports activities. The execution of the running track at the Innisfil Recreation Complex(figure 1.24), and the swimming pool at the Regent Park Aquatic Centre(figure 1.27) both shed light on ways to design large scale sports facilities.

Projects such as NL Architects' "Silos Zeeburg"(figure 1.25) explore the retrofitting of existing Silos with rock climbing facilities. Transforming the roof of the Copenhagen Expo Pavilion into a cycling path is another example of architecture deliberately celebrating recreational city activity in an non-traditional building typology.(figure 1.28)

The appropriation of the BIG "Mountain Dwellings" by inhabitants as a parkour playground, also gives hints at how the built environment can be activated differently from its original intention.(figure 1.26)

Lastly, the building operates a restaurant, using ingredients from the gardens growing on the outer edges of residence floors, nourished by captured rainwater, and the open ventilation strategies. This strategy was influenced by the 60 Richmond Housing Co-operative by Teeple Architects in Toronto, Ontario.[14] Surplus herbs and vegetables grown on site can be sold in the market space found at the ground level, while simultaneously promoting other urban growers and makers, whom are looking to sell their products. Although this space is not directly related to the design intentions of fostering wind, it continues to build on the porous nature of the building, creating a generous open forum for various activities. A space whose vitality could be found in the hybrid typology of market residence, recently completed by MVRDV(figure 1.31), while taking cues from the Citigroup building, where a lifted tower base reveals an open ground area.(figure 1.30) In Leeward this allows for visual connection and light collection into the public ground floor area, stitching together the two parallel East-West Streets. The cladded underside similar to Herzog and de Meuron's Caixa Forum(figure 1.32) sits around the height of the existing brownstones, and a structural diagrid threshold, similar to the ground floor entrances at the Hong Kong Institute of Design(figure 1.33). The ground floor is finished with permeable pavers in order to facilitate stormwater management, and to create a soft surface for spontaneous sport and play to occur.(figure 1.34)

Sustainability

Although passive strategies were discussed in the previous section discussing form, the next portion of the precedent study explores the possible energy production options for the tower. Continuing the design premise that the tower is intended not only to create better spaces in its urban context, but also work with the wind in its' program development, the energy harvesting will come from wind systems. These three design methods working in tandem can create a building that not only works with the environment rather than against it, but also assists in creating perceivable elements of wind experience.

Energy harvesting occurs through two primary wind collecting systems. First, the core is covered in clusters of fibres attached to piezoelectric motors, which generate energy through the wind passing through. This system is exemplified in the proposal by Belatchew labs for an entire piezoelectric building envelope.(figure 1.35) This system not only generates energy, but it also is continuously animated by the wind passing through its hairs.[15] The translation of this into the proposal is shown below.(figure 1.37)

Another piezoelectric proposal can be found in the Masdar/ Windstalk project by Dario Nunez Ameni and Thomas Siegl, who, along with Atelier dna put together a renewable energy park for the 2010 Land Art Generator Initiative Design Competition.(figure 1.38) Other Land Art Generator proposals in 2014 also used piezoelectric discs, such as

ByungEon Song, SooHyun Kang and John Sang's proposal entitled "Lightfoam"(figure 1.41) as well as Manon Robert, Martin Le Carboulec and Marc Antoine Galup's fibres in their "Windshape" project.(figure 1.39) This technology whose implementation has the potential to yield productive energy outputs still has not seen major inclusion in architecture.[16]

In addition to the use of a piezoelectric fibrous core, the ceiling systems of all high activity training zones contain an array of wind turbines. The turbines implemented are called vertical axis turbines and were installed in 2012 at the Keele University Science and Business Park. These innovative turbines can operate at low wind speeds, and do not need to turn off, while also reducing previous noise problems and ground vibration.[17]

The array of turbines activate the ceiling condition, and provide a first-hand index of the wind movements happening in the space. A different formal approach to a similar strategy can be found in Toyo Ito's Tower of the Winds in Nishi-ku, Japan. This tower is a light sculpture that responds to the wind behaviours and sounds of the city, embracing the presence of natural patterns and the use of technology to make individual awareness of them. Not only will these conditions be visualized for people, but they will be able to simultaneously experience and feel the slight variations that occur around their bodies.[18]

Figure 1.35 (top) Miniature Vertical Turbine
Figure 1.36 (bottom)Interior Energy Harvesting Systems
Figure 1.37(bottom left) Energy Harvesting Systems

Figure 1.38 (top left) Windstalk
Figure 1.39 (top right) Windshape
Figure 1.40 (bottom right) Tower of the Winds
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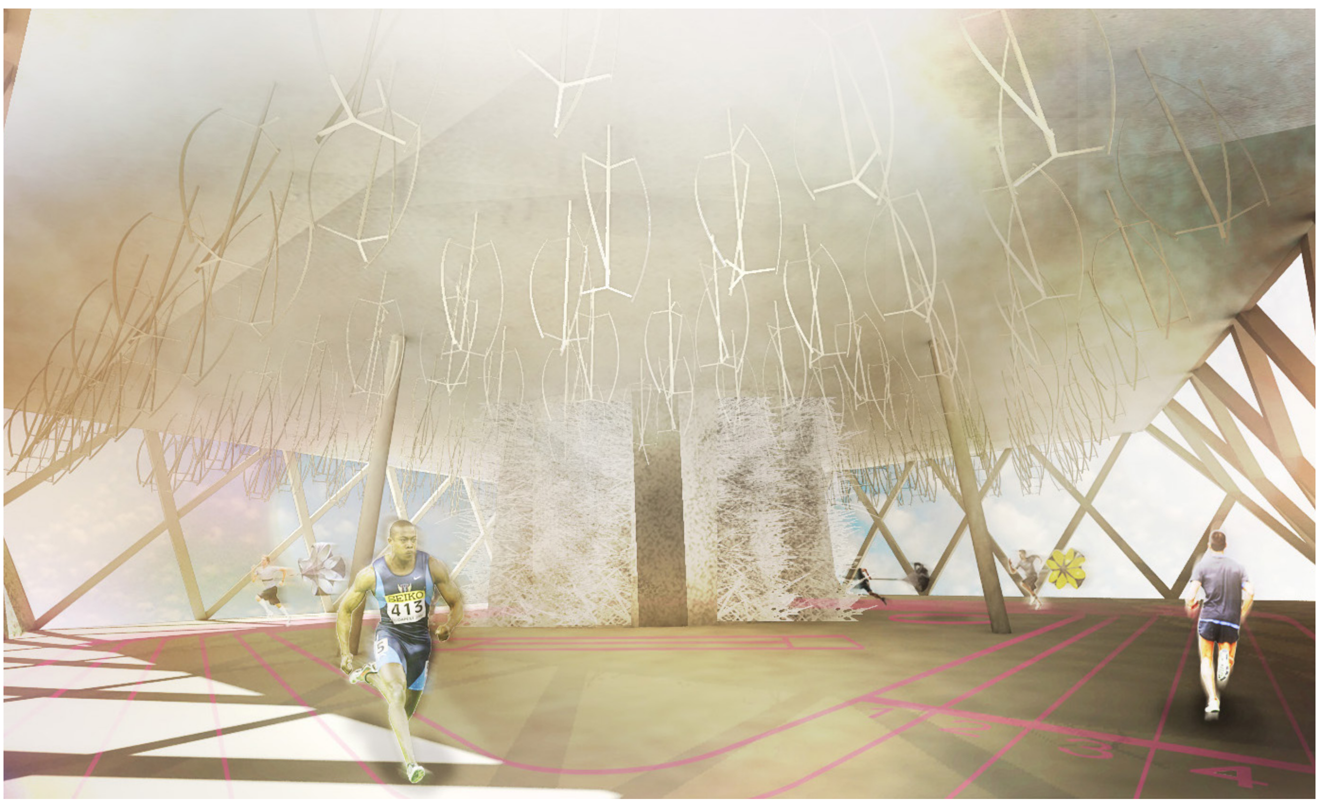


Figure 1.42 (top) Sprint Training Facility

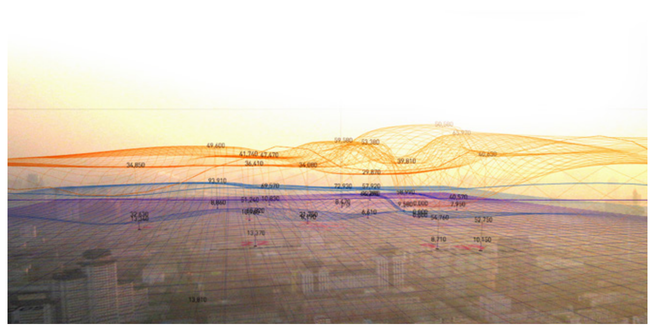
Conclusion

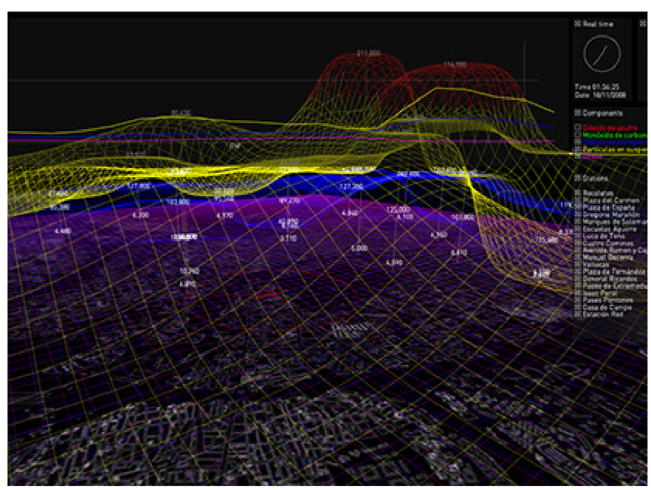
Precedent studies do not only aid in fulfilling design ideas, but they also help formulate an argument; by finding precedents that can warn of past issues in contemporary building practice, or precedents that explore the possibilities of particular technologies. It is important to cultivate precedent research that indexes a local building culture, if possible, evaluating existing buildings for their strengths and weaknesses, but more importantly, for how and why these buildings found themselves where they are. It is also acceptable to seek out precedents that align visions or interests with the project at hand. Sometimes, clarifying a value system, or method of working, in conjunction with the final formal endeavour, can be significant in finding design progress. By working with a multitude of precedents for varying facets of a design project, not only can the designer improve upon the examples set out before them, but there is a constant valuable resource. Not only do precedents assist in schematic formulation of ideas, they also can assist in the reflection upon a project, or the understanding of a thought trajectory.

Next steps that could be taken with this project–beyond continued rigour of design development–is the better integration, not only of passive strategies, and sustainable strategies but also of digital sensor based systems that can increase the sophistication of how those systems work, but also, improve upon the quality of individual awareness of these experiences.

An example of this is in the work by Nerea Cavillo and the “In the Air” project. The data visualization project attempts to make visible the gases, particles, pollen and diseases within the air of Madrid, Spain. This web-based dynamic model allows individualsto log in and use a filter based user interface to explore the “invisible” impacts on daily lives.[19]

The intention of Leeward was precisely this, to increase awareness of the natural environment, in this circumstance, wind, by making it visible. Through the aggregation of piezoelectric fibres, miniature wind turbines and the open floor plates that facilitate intense fitness training activity the presence of wind is made palpable, and as it affects us we understand our effect upon it.





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End Notes

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