Manitoba Hydro Place

Integrated design process exemplar

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ABSTRACT: Manitoba Hydro Place (2004-2009) will be presented as a model for extreme climate responsive design and a case study for the Integrated Design Process (IDP). Lead participants - design architect, Bruce Kuwabara of KPMB Architects, climate engineer Thomas Auer of Transsolar ClimateEngineering, client represented by Tom Gouldsborough, and IDP Team Director, Glen Klym of Smith Carter Architects and Engineers, will demonstrate the IDP was integral to balancing energy performance goals against objectives of signature architecture, urban revitalization, and supportive workplace to achieve a daunting 60%+ energy reduction for a 64,650 m² building in a climate that fluctuates from -35 ºC to +40 ºC annually.

Every aspect of Manitoba Hydro Place is integrated to achieve an unprecedented 60%+ energy savings using passive energy sources while prioritizing user health and comfort and the revitalization of the downtown with signature architecture and a highly urbanistic response to the streetscape. Targeting less than 100 kWh/m²/a compared to 400 kWh/m²/a for a typical large-scale North American office building, Manitoba Hydro Place offers a model for extreme climate responsive design in northern countries. In view of Canada's lagging behind its commitment to the Kyoto protocol, Manitoba Hydro Place is an exemplar of the Integrated Design Process for achieving energy efficient, human-centred design.

BACKGROUND

CLIENT

Manitoba Hydro is a crown corporation and the primary energy utility in the Province of Manitoba, Canada. Nearly all the electricity Manitoba Hydro generates is from self-renewing water power from 14 hydroelectric generating stations, primarily on the Winnipeg, Saskatchewan and Nelson Rivers. The utility's annual generating capacity is 5480 MWs.

VISION

Manitoba Hydro committed to build a new office building in downtown Winnipeg as a condition of purchasing Winnipeg Hydro from the City of Winnipeg. The goal was to bring together 2000 employees from disparate leased offices in the suburbs to work under one roof in an open, collaborative environment. The vision for the new building was evolved under the leadership of Bob Brennan, President; Tom Gouldsborough, Division Manager of Corporate Planning and Business Development and Project Manager for Manitoba Hydro Place; and Tom Akerstream, Manager Facilities directed the PowerSmart program.

As an energy utility corporation, Manitoba Hydro was highly motivated to create a landmark building with daunting goals to achieve 60% energy savings in a 64,650m² building while prioritizing the well-being of its employees and contributing to the revitalization of civic life in downtown Winnipeg. Architecturally, the form, massing and expression had to be a visible demonstration of response to Winnipeg's climate and public realm.

"Manitoba Hydro's new head office building in downtown Winnipeg will be a functional, state-of-the-art energy efficient (Power Smart) cost-effective structure that embodies and demonstrates Manitoba Hydro's commitment to sustainable development. While meeting the business needs of Manitoba Hydro, the office building will have a positive impact on the future of Winnipeg's downtown and be a source of pride for Manitobans." – Client Brief, 2004

EXTREME CLIMATE

Winnipeg is one of the coldest large cities in the world with a population over 500,000. It has dominant south gusting winds and receives an abundance of sunlight in the winter months. Temperatures fluctuate from -50 ºC with the wind chill factor in the winter months to +40ºC with the humidex during the summer months.

SITE

Many sites were reviewed, and the final site, a full city block with a street address on Winnipeg's main street, Portage Avenue, was selected based its maximum connectivity to prominent downtown destinations, cultural and commercial, and pedestrian and public transit routes.

PRE-PLANNING/RESEARCH

One year prior to the selection process for the architects and engineers, a delegation from Manitoba Hydro toured Europe to visit exemplars of energy efficient design and architectural excellence. During the tour, Manitoba Hydro was introduced to Transsolar ClimateEngineering, who would later be selected as the energy/climate engineers for the project. Thomas Auer, a principal of Transsolar recalls how “unusual it was to have a client who educates himself on such a high level before looking for architects and engineers.”

BUSINESS MODEL: DESIGN/ENERGY/COST

To ensure the energy objectives were not compromised at the expense of cost and design, Tom Gouldsborough developed a unique business case model to keep Design, Energy/Sustainability and Cost in balance (Fig. 1), and anchored by goals of supportive workplace, signature design and urban design.

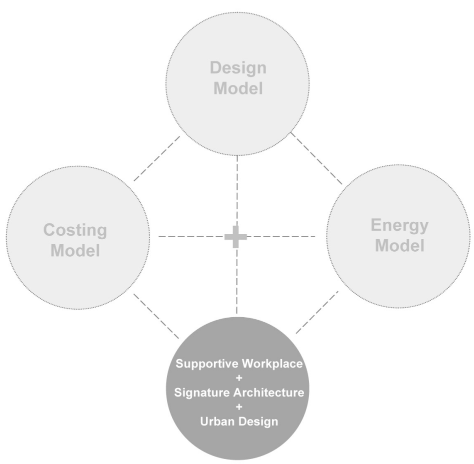

Figure 1: Balancing Goals of Energy/Cost/Design.

INTEGRATED DESIGN PROCESS (IDP)

IDP – MODEL & MANAGEMENT

Manitoba Hydro, at the recommendation of Tom Akerstream, determined the new building would be realized through an Integrated Design Process (IDP) modelled on the successful C-2000 program developed by Natural Resources Canada (NRCan) a department of the Canadian federal government. Stephen Pope representing NRCan monitored the IDP and assessed the application under the Commercial Building Incentive Programme (CBIP). Prairie Architects, under the direction of Dudley Thompson and Glen Klym (who later joined Smith Carter), was hired by Manitoba Hydro to be the Advocate Architect responsible for urban design integration and the documentation and submission under the LEED programme to achieve a Gold rating.

INTEGRATED DESIGN TEAM (IDT)

One of the first tasks in the formal IDP was to build the Integrated Design Team (IDT) comprising the corporation, design architects, architects of record, energy engineers, building system engineers, cost estimators, and project contractors. In contrast to the conventional RFP process where the architects propose the full team, Manitoba Hydro focused the first selection to the Design Architect, conducting an intensive process that included national and international candidates. KPMB Architects, under the design leadership of Bruce Kuwabara and project direction of Luigi LaRocca, was selected as Design Architect. KPMB participated in the selection of the other consultants for the IDT, including Smith Carter Architects and Engineers for Executive Architects, Transsolar ClimateEngineering for energy engineers, PCL for Construction Management, and Hanscomb as Costing/Quantity Surveyors.

INVESTING A YEAR IN DESIGN

Manitoba Hydro took the bold step of dedicating one full year to the development of the design concept, using a monthly schedule of facilitated workshops and design charettes. Year two was committed to the development of the design and involved a schedule of bi-weekly meetings to ensure all issues– architectural, structural, energy performance, cost, constructability, LEED etc. – were fully integrated in the final design solution. Key milestones included four design charettes to explore/test 16 alternatives, select 3 options for testing, leading to a final concept for development.

IDP SESSION 0 – PROJECT CHARTER

The first IDP Session was held off-site to clarify and agree on the core principle goals. These were then summarized in a three-page project charter and signed by Manitoba Hydro’s Executive and all IDT members. The charter established identification and generated a sense of ownership by all.

Supportive Workplace: healthy and effective contemporary office environment for 2000 employees adaptable to changing technology and workplace environment for present and future needs
World Class Energy Efficiency: target 60% more energy efficiency than the MNECB
Sustainability: LEED Gold Level Certification
Signature Architecture: design to celebrate the importance of Manitoba Hydro to the Province and to enhance downtown Winnipeg’s image
Urban Regeneration: strengthen and contribute to sustainable future of Winnipeg’s downtown
Cost: Cost-effective and a sound financial investment

Prairie Architects, Advocate Architects, drew on the charter throughout all phases to keep goals balanced.

The Charter proved to be a highly effective tool, and an improvement to the typical client-architect-engineer contract in which the goals are unclear and undefined.

CLIMATE ANALYSIS

In the course of the IDP, Transsolar conducted insightful analyses of Winnipeg's climate, identifying strong southerly winds and abundant winter sunlight and that the difference between the mean temperature through the year is 70 degrees Celsius (Fig. 2). Transsolar presented the extreme climate conditions as an opportunity to harness passive wind and solar energies, as well as optimize day lighting autonomy to reduce lighting loads and to create a hybrid ventilation system to allow operable windows. The tools to model alternatives and to explore the selected concepts included: CFD Wind Analysis with real model testing; computer model simulations to predict passive efficiencies; full annual daylight autonomy simulations.

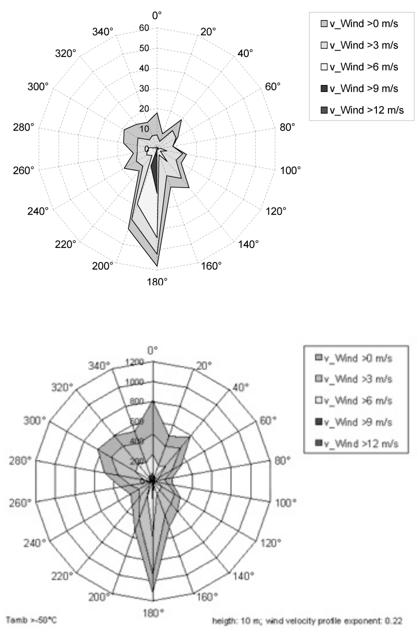

Figure 2: Wind Rose Diagrams – Temperatures Over +25ºC and Temperatures Over -25ºC.

4 DESIGN CHARETTES; 15 CONCEPTS, 3 OPTIONS

KPMB Architects led the design charettes, generating 15 concepts with related presentation materials, including models and renderings. 15 concepts were evaluated against a checklist based on the project charter goals and Transsolar modelled the concepts in terms of thermal comfort, day light and energy consumption (Fig. 3). Three options were selected for refinement (Fig. 4). Hanscomb, the quantity surveyors, cost modelled all options during Charettes 1 and 2, and during Charette 3 in parallel with the Construction Manager, PCL.

The final scheme was resolved during Charette 4 with Thomas Auer of Transsolar who rotated the model of the 'Comfort Tower' so that the stacked atria faced due south to capture Winnipeg's abundant winter sunlight and strong southerly winds (Fig. 5). In this way the 'Comfort Tower' became the preferred scheme through all levels of evaluation and review.

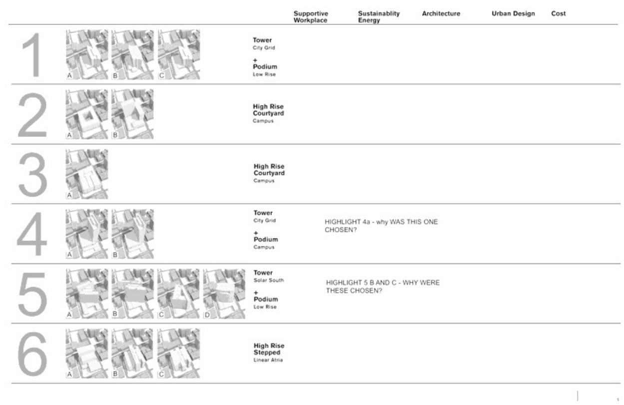

Figure 3: Charette 1: Chart showing Options 6 Building Types with 15 Options, including massing and siting.

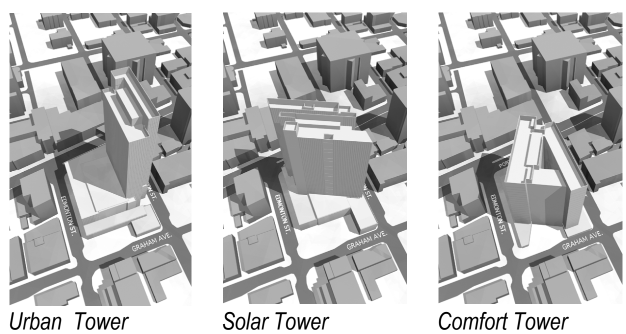

Figure 4: Charette 2: Three selected options for energy, design, cost testing.

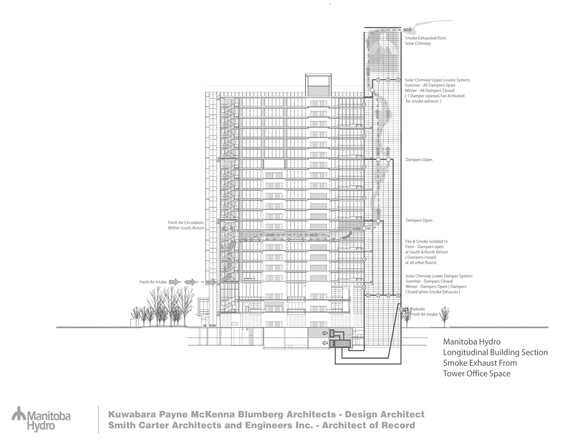

Figure 5: Charette 3: Refinement of Options: shown here the Comfort Tower Option.

'Comfort Tower' – South View with 6-storey Atria

North view with Solar Chimney

Figure 6: Charette 4: Selected Option for Development: Comfort Tower.

WORKSHOPS/COORDINATION MEETINGS

Bi-weekly, two day design development and coordination workshops were conducted in Winnipeg at the offices of Smith Carter to develop the approved 'Comfort Tower' option and to coordinate sequential packages for tender. The Construction Manager, PCL determined the scope and schedule for each sequential package. The Construction Manager presence resulted in timely answers on issues of cost and constructability, allowing the IDT to focus on development, innovation and resolution of design and energy performance issues.

IDP – BENEFITS TO IMPLEMENTATION

The IDP made it possible for Smith Carter, the Executive Architects, to coordinate bids for services and suppliers earlier compared to the conventional process of separate and distinct design, bid and build phases. This fast track process reduced the schedule by an estimated 1-2 years compared to the standard for large scale projects. It also represented significant cost savings by avoiding increases in materials and labour. Defining needs early and securing tenders and contracts avoided the spike in labour and materials costs that severely affected other projects in Western Canada at the time. It also ensured labour was available at a time when the local construction market skyrocketed due to trades people shortages.

FUSION OF PERFORMANCE AND DESIGN

The unusual form of the 'Comfort Tower' option (Fig. 7) –described by Winnipegers and the press as a "Capital A" or an "Open Book" – offered the most dynamic response to solar and wind energies as well as optimal conditions for achieving goals of supportive workplace, urban response and signature design. Two 18-storey 'towers' penetrate a three-storey, street-related podium which contains an accessible grade-level interior street, the Galleria (Fig. 8) to offer citizens a sheltered pedestrian route connecting Portage to Graham Avenues. The tower setbacks also mitigate shadow impact on Portage, the city's historic main shopping street. The siting of the south end of the building on a 45° angle also created space for a new urban park on the Graham Street transit corridor. The green roofs on the podium further the green agenda.

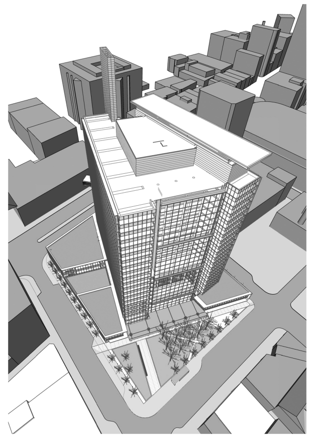

Figure 7: "Capital A" form of building.
Figure 8: Public Galleria (under construction).

The 'towers' splay open to the south to capture the abundant sunlight and southerly winds and in effect act as a double wall partitioned into a series of stacked, six-storey high atria – referred to as 'Wintergardens.' The towers fuse at the north end, which receives the least sunlight, and features a 115 metre tall Solar Chimney marks the main entrance on Portage.

6-STOREY HIGH WINTERGARDENS

The Wintergardens are an important signature element of Manitoba Hydro Place (Fig. 8). As large, not fully conditioned building volumes, they are also unique in the context of conventional hermetically-sealed North American office buildings. In combination with the solar chimney, they perform as the 'lungs' of the building passively pre-treating the air before it enters the building to provide 100% fresh air every day throughout the year, regardless of outside temperatures. Each of the three south atria feature a 24 metre tall custom-designed water curtain comprising 280 tensioned mylar ribbons which through the modulation of the recycled water humidify or de-humidify the air depending on the season.

STRUCTURE: THERMAL MASS & FLEXIBLE LOFT

The 35,600 cubic metre, concrete structure is designed to both create a thermal mass to moderate the impact of extreme temperature swings and to provide a flexible, column-free loft condition for maximum flexibility. Radiant cooling and heating systems located within the exposed concrete ceiling maintain a comfortable temperature year round.

Figure 8: Wintergarden, Rendering (left) and under construction (right).

Figure 9: Solar Chimney, Detail, under construction.

SOLAR CHIMNEY + 100% FRESH AIR

Compared to the typical North American building where as much as 80% of the air is re-circulated, the building was designed to provide 100% fresh air all year. In the winter, exhaust air from the building is drawn to the bottom of the Solar Chimney (Fig. 9) by a fan. The heat from this exhaust air is used to heat the parkade and also to pre-heat via heat exchange the incoming cold air in the south atria. The combination of pre-heating by the exhaust air and the passive solar gain in the atria bring fresh air to comfortable room temperature with minimal energy. During the shoulder seasons the majority of mechanical ventilation systems are turned off. The building is passively ventilated by fresh air which enters the building through occupant controlled operable windows at the double-skin and Wintergarden facades and is drawn through the building by the Solar Chimney (Fig. 10).

MASSIVE GEOTHERMAL SYSTEM

The foundation of the building's heating and cooling system is the geothermal system, a closed loop system consisting of 280 boreholes, six inches in diameter, 400 feet deep, interspersed between a multitude of foundation piles and caissons. Each borehole contains tubing filled with gylcol enchased in thermally enhanced grout. In summer the glycol extracts heat from the building, and returns it to the ground. The same heat is used to warm the radiant slabs during colder temperatures. The geothermal conditioned glycol passes through a complex series of heat pumps and exchangers to maximize efficiency. Conditioned water is circulated in tubes in the exposed ceiling slabs, providing 100% of the temperature conditioning. In the winter the process is reversed. Through this radiant heating system, the geothermal installation provides approximately 60% of the heating with high energy efficient condensing boilers providing the balance during the coldest months.

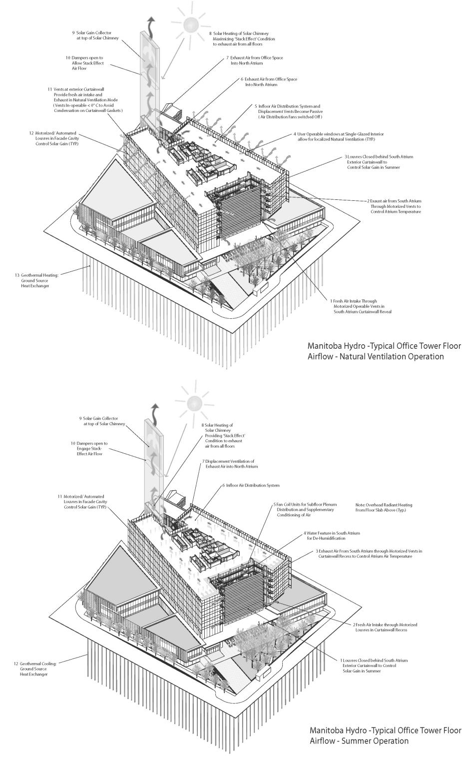

Figure 10: Ventilation schemes: natural (top) and summer (bottom).

HIGH PERFORMANCE BUILDING ENVELOPE

Ironically, a glass tower in the extreme climate proved the most effective solution: when it is extremely cold it is also very sunny, ideal for solar gains. The building is triple-glazed; the envelope delaminated into single and double glazed outside walls with a partially conditioned 1 metre wide energy efficient buffer zone in between. The east- and west facades provide operable windows for natural ventilation. The outer façade is motorized and centrally controlled, while the inner façade is manually operated. For personal control, shading devices are located in the buffer zone. Aesthetically, the transparency of glazing systems help to mitigate the overall mass and scale of the building on the streetscape (Fig. 11).

Figure 11: Detail of double-façade.

OCCUPANT COMFORT

Beyond energy conservation, critical to the success of the project was the objective to create a highly supportive, comfortable and healthy work place. Column free loft spaces are stacked and organized into vertical neighbourhoods with interconnecting stairs to catalyse face to face communication and to cultivate a culture of teamwork. Everyone has access to the façade and receives natural lighting 80% of normal office hours. Occupants control their personal environments, using operable windows, task lighting, and shading devices. Displacement ventilation is deployed via a series of occupant controlled floor grilles, allowing users control of their immediate work environment (Fig. 12).

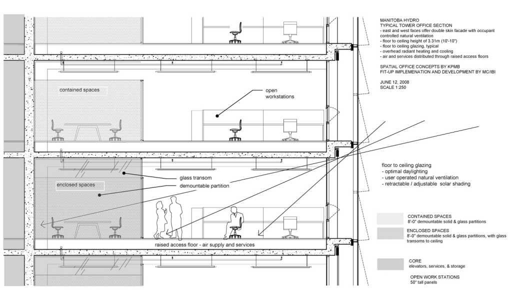

Figure 12: Typical loft sections showing daylight penetration.

POST-OCCUPANCY AND COMMISSIONING

Still ahead is the challenge to commission the building and to educate the staff, building operators and maintenance people. Manitoba Hydro is conducting a thorough workplace study to evaluate how the design impacts employee productivity. Along with their Facilities group, Transsolar has been engaged to monitor and analyze the building's performance over the next two years.

CONCLUSION

To achieve design innovation at such scale and ambition, an exceptional client is needed. Manitoba Hydro had a clear vision and understanding of the implications for design, construction, and management. The result is a testament to a committed client, an integrated design and construction team, and skilful project management. It exemplifies the IDP for achieving ambitious environmental and energy conservation objectives. The open, collaborative forum of the workshops and charettes drew out the best creative and innovative thinking and facilitated pragmatic decision-making. The project charter was critical for measuring all decisions against the goals and focusing all decisions to realize what ultimately must the goal of all architecture: the quality and comfort of the human experience. By investing in the future health of its employees and citizens of Winnipeg, Manitoba Hydro sets a precedent for environmentally responsive large scale building design and city building.

Figure 13: North elevation nearing completion.

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