

*Transforming your Practice
Integrated Design Charrettes for Sustainable
Buildings*

Toronto Charrette Results



Natural Resources
Canada

Ressources naturelles
Canada



Transforming Your Practice – Integrated Design Charrettes for Sustainable Design
Toronto Charrette, Metro Hall, November 7-8, 2001

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Partners

The partners, who contributed their time and expertise over a period of months to organize, support and deliver this very successful event:

- Enbridge Consumers Gas
- Canadian Energy Efficiency Alliance
- City of Toronto's Energy Efficiency Office (Better Buildings Partnership)
- Natural Resources Canada's (NRCan) Office of Energy Efficiency and Buildings Group

Experts

The experts who acted as facilitators, simulators and resource persons for the design teams, providing valuable contributions to the management and results of the integrated design process:

- Greg Allen – Allen Kani Associates, Facilitator
- Bob Bach – Engineering Interface Ltd., Facilitator
- Kingsley Blease – Canadian Water Services, Resource person, water
- Larry Brydon – OZZ Corporation Inc., Resource person, MURB HVAC equipment
- Doug Cane – Caneta Research Inc., Facilitator
- Stephen Carpenter – Enermodal Engineering Ltd., Facilitator
- Vito Casola – OZZ Corporation Inc., Resource person, MURB HVAC equipment
- Maria Cinquino – Natural Resources Canada, Resource person, Commercial Building Incentive Program NRCan
- Per Drewes – Sol Source Engineering, Resource person, solar energy
- Heinrich Feistner – City of Toronto Energy Efficiency Office, Resource person, Toronto Better Buildings Partnership
- Brian Fountain – Energy Advantage Inc., Simulator
- Michael Hunter – MCW Consultants Ltd, Resource person, developer's mechanical engineer
- Chris Jones – EnerSys Analytics Inc., Simulator
- Ronald Mazza – RJC Ltd., Resource person, developer's structural engineer
- Gerald McCabe – Curran McCabe Ravindran Ross, Resource person, costing
- Joanne McCallum – Ontario Association of Architects, Facilitator
- Craig McIntyre – Enermodal Engineering, Simulator
- Andrew Morrison – Caneta Research Inc., Simulator
- Michel Parent – Technosim, Simulator

- Doug Pollard – CMHC, Facilitator
- Stephen Pope – CANMET, Simulator
- Andrew Pride – MintoUrban Communities, Resource person, MURB Property Management/Energy
- Farah Rahman – Architects Alliance, Resource person, developer’s architect
- Manoj Ravindran – Curran McCabe Ravindran Ross, Resource person, costing
- Peter Rowles – Energy Advantage Inc., Facilitator
- Jiri Skopek – ECD Energy and Environment, Resource person, building eco-assessment
- Alex Speigel – Context Development, Resource person, developer
- Steven Traub – Bank of Montreal, Resource person, financial implications
- Sidney Tung – Urban Development Services, City of Toronto, Resource person, municipal regulatory and planning issues

Professional Associations

The professional associations that helped to promote this event:

- American Society of Heating, Refrigerating and Air-conditioning Engineers
- Association of Energy Engineers
- Building Owners and Managers Association
- Design Exchange
- Ontario Association of Architects
- Ontario Association of Landscape Architects
- Ontario Professional Planners Institute
- Ontario Society of Professional Engineers
- Royal Architectural Institute of Canada

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1 Background

1.1 Charrette Objective – Use IDP to Implement Sustainable Practices

The *Transforming your Practice Integrated Design Charrettes for Sustainable Buildings* Toronto Charrette took place over one-and-a-half days at the City of Toronto's Metro Hall on the afternoon of November 7th and all day on November 8th, 2001.

The objective of the Toronto Charrette event was to use the integrated design process (IDP) to push the boundaries of building performance towards more sustainable practices. The sessions were intended to take a varied complement of professionals through an integrated design process in the context of a new project, so that they would “learn by doing” and be able to use IDP within their own practice.

Four partners supported Canada Mortgage and Housing Corporation (CMHC) in this event:

- Enbridge Consumers Gas,
- City of Toronto's Better Buildings Partnership (BBP),
- Natural Resources Canada's Office of Energy Efficiency, and
- Canadian Energy Efficiency Alliance (CEEA).

The goals of the partners were to:

- Establish a forum where a multi-disciplinary group of design professionals could work together on a sustainable design project,
- Gain insights into sustainable building practices, and
- Learn how to advance building performance, starting from design conception to understanding of operations issues, building on each others' unique perspectives and expertise.

1.2 Planning

The planning of *Transforming your Practice Integrated Design Charrettes for Sustainable Buildings* began in June 2001. The partnership, led by CMHC, was formed under the shared vision that “learning by doing” is a key motivator in the sustainable design process. The process of how the event unfolded is explored in greater detail in Section 1.3.

The partners selected seasoned experts with experience in the integrated design process to act as facilitators and simulators to the design teams. Resource persons were selected to provide specific areas of expertise that would

complement the composition of the design teams and enable the integrated design process in each team to become more specific and less theoretical. Appendix A contains a short biography of each expert, where provided.

A key element to the success of the charrette event was the use of a real Toronto development site as the design team site. The use of an actual Toronto site provided participants with a practical design problem, a sense of tangibility, and context in the marketplace. It gave the charrettes practical, real world issues that could not be matched using a theoretical project.

Another essential factor to the success of Toronto's *Transforming your Practice* design charrettes was the integrated focus. The charrettes required representation of the many different professions that are related to building development. To attain this multi-disciplinary design team, the Toronto Charrette event was promoted by a variety of organizations including:

- American Society of Heating, Refrigerating and Air-conditioning Engineers,
- Association of Energy Engineers,
- Building Owners and Managers Association,
- Design Exchange,
- Ontario Association of Architects,
- Ontario Association of Landscape Architects,
- Ontario Professional Planners Institute,
- Ontario Society of Professional Engineers, and
- Royal Architectural Institute of Canada.

1.2.1 The Integrated Design Process (IDP)

The team facilitators and energy simulators who led the charrette design teams have all used IDP in the design and construction of other projects. IDP can be used to develop advanced designs in any number of design areas. In the Toronto *Transforming your Practice* design charrettes, IDP was used for developing green building designs.

The keys to a successful IDP include:

- The full design team is introduced to the IDP to establish performance goals for the building at the concept stage
- Teams are multi-disciplinary and include a design facilitator and an energy simulator
- Team members share knowledge and test ideas, developing greater respect and understanding for each others' points of view, and conduct all aspects of design in a methodical manner.

For a more detailed discussion of the IDP, consult Appendix B.

1.2.2 The Project

The charrette design parameters were based on an actual proposed development in the City of Toronto. Alex Spiegel of Context Development, the developer, Farah Rahman of Architects Alliance, the developer's architect,

Michael Hunter of MCW Consultants Ltd., the developer's mechanical engineer, and Ronald Mazza of RJC Ltd., the developer's structural engineer, provided the project and related project information for the charrettes. Each charrette design team received a set of plans and data related to the proposed development.

The project site was the Radio City development on the old CBC lands in the City of Toronto. It is located in midtown Toronto between Jarvis and Mutual Streets, between Maitland and Carlton Streets. A lane runs through the site beside the National Ballet School. The Betty Oliphant Theatre sits north of the ballet school on Jarvis Street. Another school is located on the block to the south at Carlton Street. The surrounding area is residential. The CBC buildings on the site will be demolished, except for the historic buildings, which will be integrated into the ballet school. Site plans of the existing buildings and new townhouses to be built around the project site are contained in Appendix C.

Parking for the site includes 296 parking spaces for residents and 26 for visitors. Two hundred spaces of bicycle parking are provided.

Six design teams were established for the charrette – three to explore multi-unit residential building (MURB) design issues, and three to explore the office design issues of a commercial-residential mixed-use project.

The MURB project for the charrette was:

- A 25-floor, 169-suite condominium in the north tower
- To be marketed to young professionals.

The office project for the charrette was:

- A 30-storey office in the proposed south tower
- To be a rental building with parking below grade and a mechanical penthouse on the roof
- A height of 86.15m, with a mechanical penthouse of 10m
- Actually planned as a south tower condominium, not an office building, but the plans provided were used as a basis for the charrette IDP.

1.2.3 Design Challenge

Three levels of constraint and performance were proposed as the challenge to the six design teams.

- Design Teams "A" were constrained in orientation, geometry, size, and site, essentially using the building as designed. The performance goal was to design the building, subject to these constraints, to improve its energy efficiency to a minimum of 25% better than the Model National Energy Code for Buildings (MNECB).
- Design Teams "B" were constrained by the geometry and site, allowing for additions to the developed scheme, changes in orientation and materials. The performance goal, subject to these constraints, was to achieve at least 50% improvement in energy efficiency over the MNECB.

- Design Teams “C” were constrained by site only. The performance goal, subject to this constraint, was to achieve at least a 75% improvement in energy efficiency over the MNECB.

In addition, as part of the IDP, team participants were responsible for establishing their own sustainable performance goals to be achieved in order to comply with the constraints and accomplish the design performance goal of their particular design team.

1.3 The Integrated Design Charrette

This section describes how the charrette design teams were assembled, the material and resources that were available to them, and a general overview of what took place during the one-and-a-half-day charrette experience. Appendix D contains an agenda of the entire event.

1.3.1 Teams

There were a total of seventy-two attendees to the *Transforming your Practice* Toronto charrette event, including speakers, facilitators, simulators and resource persons. Of those, forty-seven participated as members of the charrette teams, and eighteen were resource persons who circulated among the teams. Appendix E contains a complete list of attendees and contact information.

Participants were placed into one of the six design teams based on their profession and their area of interest (MURB or Office). Attendees were assigned to teams in order to achieve the best possible balance of multi-disciplinary expertise available at the charrette. The preferred composition of the teams was to include professionals, who had some interest related to the building type, with the following expertise:

- Architect
- Mechanical engineer
- Structural engineer
- Envelope/Indoor air quality specialist
- Landscape architect
- Property manager
- Educator
- Developer
- Design facilitator
- Energy simulator
- Note-taker

Access to information on costing, financial implications and building envelope alternative energy systems was also very important for each team. This expertise was provided by experts that “floated” from team to team during the IDP.

When the event began it became necessary to modify the initial team compositions to try to more closely match the preferred balance of professional representation on each team. This was necessary in some cases, due to absentees, last minute registrants, and a higher representation of certain professions than others. Table 1-1 provides a complete list of team members for each team.

Other attendees chose to float among the various teams as observers of the different approaches taken by each team, rather than participate as an active member of one particular team.

Table 1-1 – Breakdown of design team participation

<p>MURB Team A Facilitator: <ul style="list-style-type: none"> • Stephen Carpenter Energy simulator: <ul style="list-style-type: none"> • Craig McIntyre Note-taker: <ul style="list-style-type: none"> • Arran Timms Team participants: <ul style="list-style-type: none"> • Cathy Capes • Michael Hunter • Doug Webber Gustav Lang</p>	<p>MURB Team B Facilitators: <ul style="list-style-type: none"> • Joanne McCallum • Doug Pollard Energy simulator: <ul style="list-style-type: none"> • Chris Jones Note-taker: <ul style="list-style-type: none"> • Don Curic Team participants: <ul style="list-style-type: none"> • Laura Rachlin • Andy Taylor • Ron Mazza • Andrew Pride • Anna Sawicki </p>
<p>MURB Team C Facilitator: <ul style="list-style-type: none"> • Greg Allen Energy simulator: <ul style="list-style-type: none"> • Stephen Pope Note-taker: <ul style="list-style-type: none"> • Kevin Watt Team participants: <ul style="list-style-type: none"> • Melissa Rocchi • Ian Sinclair • Dianne Byam Grannum • Melanie Sherwood • Marius de Bruyn </p>	<p>Office Team A Facilitator: <ul style="list-style-type: none"> • Doug Cane Energy simulator: <ul style="list-style-type: none"> • Andrew Morrison Note-taker: <ul style="list-style-type: none"> • Carlos Baruso Team participants: <ul style="list-style-type: none"> • Kay Kawagishi • Luke Bond • Robert Shute • Filippo Bondi • James Aeichele </p>
<p>Office Team B Facilitator: <ul style="list-style-type: none"> • Peter Rowles Energy simulator: <ul style="list-style-type: none"> • Brian Fountain Note-taker: <ul style="list-style-type: none"> • Emilia Mirceta Team participants: <ul style="list-style-type: none"> • Sandra Marshall • Joseph Orlov • Mark Rosen • Ruthann Symons • Judith Dimitriu </p>	<p>Office Team C Facilitator: <ul style="list-style-type: none"> • Bob Bach Energy simulator: <ul style="list-style-type: none"> • Michel Parent Note-taker: <ul style="list-style-type: none"> • Jacqueline Swaby Team participants: <ul style="list-style-type: none"> • Kevin Parent • Lalith Pereira • Rob Rosseau • Michael Pressutti </p>

Teams were able to call on the knowledge of a number of resource persons who circulated among charrette teams and responded to questions on their specific area of expertise. They provided greater context and realism to the

relevant issues that faced the teams. The resource persons, listed according to their areas of expertise, were:

Radio City project site

- Alex Speigel, Context Development, developer
- Michael Hunter, MCW Consultants Ltd., developer's mechanical engineer
- Ronald Mazza, RJC Ltd., developer's structural engineer
- Farah Rahman, Architects Alliance, developer's architect

Financial Implications

- Steven Traub, Bank of Montreal

Costing

- Gerald McCabe, Curran McCabe Ravindran Ross
- Manoj Ravindran, Curran McCabe Ravindran Ross

MURB Property Management/Energy

- Andrew Pride, MintoUrban Communities

Water Issues

- Kingsley Blease, Canadian Water Services

Solar Energy Issues

- Per Drewes, Sol Source Engineering

Ground Source Heat Pump

- Doug Cane, Caneta

Municipal Regulatory and Planning Issues

- Sidney Tung, Urban Development Services, City of Toronto

Commercial Building Incentive Program NRCan

- Maria Cinquino, NRCan

Toronto Better Buildings Partnership

- Heinrich Feistner, BBP, City of Toronto

MURB HVAC equipment

- Larry Brydon, OZZ Corporation
- Vito Casola, OZZ Corporation

Natural Gas Systems

- Terry Whitehead, Enbridge Consumers Gas

Building Eco-Assessment

- Jiri Skopek, ECD Energy and Environment

1.3.2 Resource Material

At the beginning of the charrette, team members received a kit that contained direction on the charrette process and instructional and reference material. The kit contained the following:

- *CBC Lands Official Site Plan Application* from Architects Alliance and Context Development Inc.
- Photos of CBC Lands area
- LEED Project Checklist
- An excerpt from *CMHC Ideas Challenge*, Section 3 on Technical Requirements
- *Healthy High-Rise: A Guide to Innovation in the Design and Construction of High-rise Residential Buildings – Draft* prepared for CMHC by Sheltair Group

- Office of Energy Efficiency's (OEE) EnerGuide for Equipment EnerGuide Appliance Directory 2001
- OEE's Commercial Building Incentive Program (CBIP) Technical Guide CBIP II September 2001 on business card CD
- OEE's CBIP Energy Efficient Building Design Introductory Training CD-ROM
- *Transforming your Practice* detailed information handout including charrette teams, definition of IDP, charrette goals, constraints, details of project, checklist, agenda and evaluation form
- *Transforming your Practice* website sources
- OEE's CBIP Information Kit – CBIP II
- Integrated Design Processes for Solar Building Applications by Stephen F. Pope, OAA, MRAIC, September 2001
- Construct Canada Design Charrette Solar Design Guide prepared by Enermodal Engineering
- *Design Guidelines for Green Roofs* for CMHC by Steven Peck and Monica Kuhn, B.E.S., B. Arch., O.A.A.
- *Introduction to our Integrated Design Process* by Teresa F. Coady, Bunting Coady Architects
- *Sustainable Community Planning and Development: Design Charrette Planning Guide* prepared for City of Vancouver and CMHC by Fiona S. Crofton, Principal, ORCAD Consulting Group, September 2001

The sponsors also made available additional reference material on a central display table. Teams could borrow this material during the design process on an as needed basis. Some facilitators and simulators provided their own reference material.

1.3.3 Description of Day 1

Day 1 began on the afternoon of November 7th, 2001. Attendees convened in the Council Chambers of the City of Toronto's Metro Hall for the opening plenary to hear welcomes and introductory remarks by Sandra Marshall of CMHC and by Marion Fraser of Enbridge Consumers Gas.

These introductions were followed by presentations that addressed the more in-depth charrette topics of green and energy issues in apartment and office buildings. Duncan Hill of CMHC and Andrew Pride of MintoUrban Communities provided context on various MURB issues with examples. Tom Tamblyn of Engineering Interface Ltd. spoke about office issues and also provided examples. Per Drewes of Sol Source Engineering discussed solar energy integration issues. Appendix F contains these presentations.

The opening plenary was geared to raising the awareness of attendees on the overall charrette program, stimulating their interest for what was to come, and providing them with an overview of the design goals. Following the opening plenary, the attendees broke out into their design teams to meet fellow team participants. During this time teams were able to examine the site drawings, generate discussion on the issues at hand, set specific team goals and design goals, and develop their ideas and plans for Day 2 of the charrette.

1.3.4 Description of Day 2

The charrette reconvened for Day 2 in the morning on November 8th, 2001 when the real substance of the integrated design work began. The facilitators and energy simulators led their teams through the review of background material, optional scenarios, the development of the teams' ideas and plans to achieve their design goals, and the transformation of these options and ideas into concrete results to improve the energy efficiency of the building.

The energy simulators ran simulations on the design parameters that the teams generated and explored, allowing the teams to discern how their design changes affected the overall energy consumption and efficiency of the building and how best to achieve their design goals. The simulation process and the software used for this charrette are outlined in greater detail in following sections.

During the course of the day, the resource persons (listed in Section 1.3.1) circulated among the various teams to introduce themselves and provide guidance and expertise on relevant issues of the teams' design process.

Once the teams' design work began to take shape, each team recorded its results and how the design goals were achieved. When the design was finalized, each team prepared a presentation to the plenary on the work that it had done and the results of the design process.

All the teams reconvened in the Metro Hall Council Chambers for the closing plenary where each team presented its results to all the charrette attendees. The presentations clearly demonstrated that each team was able to achieve or exceed its team goals. Section 2 of this report explains the design process that each team followed and the results achieved.

The conclusion of the team presentations (refer to Section 2 of this report for details of the team presentations) sparked a lively and engaging discussion among the participants and the developer, Alex Spiegel of Context Development. The charrette closed on a positive note with a general sentiment of accomplishment among those involved.

2 Results

This section summarizes the experiences and outcomes of the six design teams. A brief background is provided on the energy simulation software that was used by the design teams, followed by a summary of each team's results. The summary includes the following information:

- Design challenge and constraints assigned to the team
- Additional design goals set by the team (if applicable)
- Approach to the integrated design process in the team
- Design measures considered
- Final results and analysis presented to the plenary of the charrette.

2.1 Background on Energy Simulations

A simulation tool allows the user to explore and experiment with a diverse range of building design features and learn the results of using such features within the design context. These simulation variables are dependent on what type of information the simulation software tool is designed to process and calculate.

For *Transforming your Practice Integrated Design Charrettes for Sustainable Buildings*, the energy simulators used EE4 CBIP software¹, developed for Natural Resources Canada's Commercial Building Incentive Program (CBIP). Using this software enabled the teams to assess how their design considerations would influence the energy use of their proposed building designs.

EE4 CBIP is an energy assessment software tool designed to demonstrate a building's compliance with the requirements of the Commercial Building Incentive Program performance path approach. CBIP is a financial incentive program offered by Natural Resources Canada's Office of Energy Efficiency to building owners and developers for the design and construction of new commercial and institutional buildings that use 25% less energy than similar buildings built to the requirements of the Model National Energy Code for Buildings (MNECB).

The EE4 CBIP software handles:

- Detailed transmission, solar, internal and ventilation load calculations,
- A broad range of primary and secondary systems and components,
- Flexible scheduling of occupancy, lighting and equipment loads, temperature schedules, water heating loads and fans, and
- Automated generation of detailed compliance reports.

¹ Information on the EE4 CBIP software and the related background information was derived from the following sources:

<http://cbip.nrcan.gc.ca/cbip.htm>

http://www.eren.doe.gov/buildings/tools_directory/software/ee4_cbip.htm

http://buildingsgroup.nrcan.gc.ca/ee4/english/cbip_e.shtml

EE4 CBIP software can also be used to perform non-compliance energy analysis and consequently predict a building's annual energy consumption, and assess the impact of design changes to the building. Accordingly, this was how the *Transforming Your Practice* charrette teams used the EE4 software. The software can also be used to determine a building's heating and cooling loads for equipment sizing.

2.2 MURB Base-case

The main features of the base-case building design used during the charrette for the MURB follow:

- 25-storey, north tower, with 169 units
- Floor space of 14336 m²
- MURB is being marketed to young professionals
- R10 walls, with uninsulated balconies
- Double-glazed floor-to-ceiling windows
- A standard corridor make-up air unit
- A 4-pipe fan coil heating and cooling with central chiller and boiler
- All apartments are mechanically cooled
- Energy performance equal to MNECB (0% savings)

2.3 MURB Team A

2.3.1 Design Challenge and Constraints

MURB Team A was led by Stephen Carpenter as the facilitator and Craig McIntyre as the energy simulator. The team was challenged to redesign the Radio City Building in order to improve its energy efficiency to a minimum of 25% better than the Model National Energy Code for Buildings (MNECB). The team's designs were constrained by having to maintain the building's orientation, geometry, size and site – i.e. essentially having to use the building as designed. The team also decided, among themselves, to adopt the following design constraints:

- Up to 1% incremental cost for features to improve energy efficiency, indoor air quality and sustainability (i.e. \$190,000) is acceptable,
- One third of the building is rental, two thirds are condominiums, and
- Suites are individually metered for electricity and natural gas.

MURB Team A also adopted the following additional design goals:

- Improve indoor air quality,
- Minimize parking, and
- Achieve market differentiation for the building (e.g. through green and energy efficiency labels).

2.3.2 Approach to Integrated Design Process

The integrated design process for MURB Team A went very well. The developer and the developer's architect and mechanical engineer were able to spend a significant amount of time working with the team, and this was a real asset to the group. They were able to provide the design team with immediate feedback and ideas and this contributed greatly to the quality and practicality of the team's work. The design experience was more real and therefore much more valuable and enjoyable. For example, the group found it interesting to learn that it was a financial benefit to the developer to reduce the number of parking spaces, and to appreciate that this also coincided with sustainable building design opportunities.

The design team began by considering the building envelope, including the window areas and systems. The group then investigated alternatives for the HVAC system and finally dealt with the design aspects related to lighting and other green measures. This systematic approach was successful and led to a creative approach to meeting the design challenge.

2.3.3 Design Measures Considered

The design team developed a number of measures to improve the energy efficiency and environmental sustainability of the building and tested the impact of these measures using the energy simulation software. The measures that the group considered were:

Heating/cooling

- Use a water loop heat pump (WLHP) instead of the four pipe fan coil

Windows

- Use low-e argon
- Use solar control low-e coating to downsize cooling system
- Raise sill height to 600 mm

Precast panel wall

- Replace precast cladding over steel studs with precast drained and vented sandwich panel

Air tightness

- Air infiltration considered with respect to chosen wall system
- Wall system was assumed to have an air infiltration that was half that of a "typical" (MNECB) wall
- Adjust wall R-value accordingly
- Air infiltration, applying to both walls and windows, reflected in the wall adjustment

Balconies

- Precast balconies supported by steel angles
- Insulation inserts between building and balcony slab

In-suite Ventilation with HRV

- Tenant controlled ventilation
- Corridor isolated from suite

Lighting

- Two stage lighting on occupancy sensors for stairwells
- Compact fluorescent pot lights in common areas
- Potential for exterior light shelf

Green building features

- Indoor air quality package of VOC-free paint, no carpets, and upgraded filter at no cost
- Include car rental company in basement in order to minimize need for parking

2.3.4 Final Results and Analysis

The final results of MURB Team A's building design upgrades are summarized in Table 2-1. Through a combination of measures, the team managed to improve the energy efficiency of the building by over 48%, greatly exceeding the original target of a 25% improvement. The incremental cost for these measures was less than 1% of the building's capital cost. These measures are expected to produce annual energy cost savings of \$60,000.

Table 2-1 –MURB Team A – Building upgrades final results

Upgrade	Elec (MBTU)	Gas (MBTU)	Annual Energy Cost	% Energy Savings	Energy Cost Savings	Net Capital Expense	Simple Payback
Base Case	5203	7894	\$ 190,329	0.0%			
WL Heat Pump	5494	5823	\$ 182,570	13.6%	\$7,759	(\$120,159)	-15.5
low e and SHGC windows	5090	7453	\$ 183,361	4.2%	\$6,968	\$ (5,000)	-0.7
Window area from 35 to 23%	5131	7465	\$ 184,662	3.8%	\$5,667	\$ -	
Upgraded Wall	5259	6315	\$ 178,344	11.6%	\$11,985	\$ 148,440	12.4
In-suite HRV	5085	5298	\$ 165,831	20.7%	\$24,498	\$ 60,500	2.5
WLHP and condensing boiler	5494	5328	\$ 178,372	17.4%	\$ 4,198	\$ 11,300	2.7
Condensing water heater	5215	7714	\$ 189,023	1.3%	\$1,306	\$ 6,000	4.6
Lighting Reductions	5123	7915	\$ 188,729	0.5%	\$1,600	\$ 1,950	1.2
Everything	4669	2128	\$ 131,056	48.1%	\$59,273	\$ 103,031	1.7
					CBIP	\$ (60,000)	
Gas savings (HP not incl)	3695 MBTU 102721				Enbridge	\$ (10,272)	
					Net Cost	\$ 32,759	0.6

2.4 MURB Team B

2.4.1 Design Challenge and Constraints

MURB Team B was led by Joanne McCallum and Doug Pollard as the facilitators, and Christopher Jones as the energy simulator. The team was challenged to redesign the Radio City Building in order to improve its energy efficiency to a minimum of 50% better than the Model National Energy Code for Buildings. The team’s designs were only constrained by the geometry of the project site – i.e. they were permitted to include additions to the developed scheme, as well as changes in orientation and materials.

This design team determined that the original project building, as drawn, was actually 20% less energy efficient than the MNECB, and as such considered the actual target as requiring a 70% improvement in energy efficiency.

The team also decided, among themselves, to adopt the following design goals in meeting the energy efficiency performance goal:

- Make transportation to and from the building more sustainable
- Improve the ‘liveability’ of the building. e.g. indoor air quality

- Improve aesthetics
- Make the building function as a neighbourhood/community contributor
- Achieve a 50% reduction in domestic water use
- Capture 100% on-site rainwater
- Consider use of natural renewable energy systems and measures to reduce energy demand in the building (demand management)

2.4.2 Approach to Integrated Design Process

MURB Team B's integrated design process worked well. Team members had a positive attitude and this contributed to the effectiveness of the group dynamics. Throughout the IDP, the group stayed together as a team and addressed the design issues as a group. At first, the group struggled with the setting of goals for the design process. However, after discussion, the purpose of goal setting and its importance to the IDP team became clear. Team members were then able to generate clear goals and to carry out the design process to meet them. Throughout the IDP, team members were able to "think outside the box" and apply this skill effectively to the building design.

2.4.3 Design Measures Considered

The design team considered two main types of measures to improve the energy efficiency and sustainability of the building – building envelope measures and mechanical measures. A list of measures in each category that the team discussed follows:

Building envelope

- Glazing ratio/location/type
- Enclose balconies
- Increase shading (light shelf, overhangs – balconies)
- U value on solid portion – wall, roof, U/S slab
- Include green roof/trellises
- Details: thermal bridging, air tightness
- Solar wall
- PV glazing/spandrels

Mechanical

- Heat recovery grey water
- Reduction in HRV fan power/(Ductless)/DHW bypass
- Boiler resizing (92% efficiency)
- Hardwired compact fluorescent/suites
- Sprinkler pipes used for hydronic heating
- Montgomery Kone elevator (an energy efficient elevator that does not need a pit or penthouse)
- 17% heating reduction due to better envelope air tightness
- Option heat recovery – ventilation air, water loops
- 2 pipe fan coil → water loop heat pump
- Ground source heat pump
- Individual metering

- Public area lighting upgrades
- Central system

2.4.4 Final Results and Analysis

The final results of MURB Team B’s building design upgrades are summarized in Tables 2-2 and 2-3. Through a combination of measures, the team managed to improve the energy efficiency of the building by over 50%, meeting its design challenge. The team estimated that these measures would cost \$1,543,500, but would produce annual energy savings of \$60,000, representing a 20-year payback on investment at current rates. It should be noted that the team did not investigate subsequent savings that would have arisen from their design measures (i.e. downsizing or elimination of systems due to improved envelope, or savings from not building the penthouse or pit for the elevator) such that the net expenditure for the team’s design measures may actually be much lower than estimated. It is also important to note that certain measures, such as balcony enclosures, that had a high cost relative to their energy efficiency contribution, would have been rejected as energy saving options and only implemented if there was sufficient market demand for them as luxury items. Balcony enclosures, for example, represented one-third of the team’s costs but only 3% of the energy savings.

Table 2-2 – MURB Team B – Estimated cost of energy efficiency measures

Design measure	Cost (\$)
Upgrade windows & frames	280,000
Increase wall R-value	160,000
Enclose balconies	500,000
Increase roof insulation	10,000
Green roof	100,000
Reduce infiltration	50,000
4 pipe hydronic HP	262,500
High efficiency fan systems	15,000
Heat recovery & central exhaust	75,000
Better quality boiler (15% improvement)	10,000
Grey water recovery	75,000
Building automation – heat set point relaxation	125,000
TOTAL	1,543,500

Table 2-3 – MURB Team B – Energy savings from measures

Measure	% Energy savings
Raise wall R value to 20	4.3
Change window U value from .5 to .4	4.3
Increase shading coefficient by 50%	0.4
Enclose north balconies	1.3
Enclose east balconies	3.3
Reduce infiltration by 50%	3.9
Set back heating point 1°C	2
Set back heating point 2°C	4
Increase roof R value from R11 to R20 (e.g. by using green roof)	0.6
Replace 4 pipe F/C with Water source (hydronic) HP	9.5
Separate/resize makeup air	3.2
Gas fired heating efficiency	6.1
Domestic hot water boiler (efficiency improvement and brown water)	4
Heat recovery (60% eff.) all make-up air	16.2
Grey water heat recovery	1.4
Common areas lighting upgrade	0.5
Building automation – heat set point relaxation (2°C)	6
Total % energy savings – compared to base case	~ 71%
TOTAL % energy savings over MNECB	52.7%

2.5 MURB Team C

2.5.1 Design Challenge and Constraints

MURB Team C was led by Greg Allen as the facilitator and Stephen Pope as the energy simulator. The team’s challenge was to redesign the Radio City Building in order to improve its energy efficiency to a minimum of 75% better than the Model National Energy Code for Buildings. The team’s designs were only constrained by the project site – i.e. they were permitted to make entire changes to the developed scheme, as well as changes in orientation and materials.

The design team looked at three building options:

- A. Townhomes and a tower (i.e. the existing scheme)
- B. Stacked and staggered townhomes and a lower tower
- C. Stacked townhomes covering the full lot with eight levels. The levels are designed on a diagonal so that the unit spans the full building width but has two floor levels. Units stand by being on consecutive floors that are interconnected over top of the hallway.

It should be noted that during the integrated design process, MURB team C encountered problems accessing the simulation software. The team’s results

are therefore based on approximations and what numbers they were able to use to make appropriate simulations.

2.5.2 Approach to Integrated Design Process

MURB Team C remained united and focussed despite several challenges, including:

- Being "understaffed" – the team lacked a mechanical engineer, and also felt that it would have benefited by having the developer or appropriate representative on hand throughout their charrette process;
- Setting the course – the team immediately rejected the status quo model from the outset, and had to start from scratch;
- Encountering problems reconciling the energy issues with the social issues; and
- Experiencing technical difficulties – the team was unable to access the simulation software and could not evaluate its goals and results.

The team began its process on Day 1 by reviewing its full set of project goals. When the IDP work began on Day 2, the team decided to restructure the building form to adhere with the social goals of green design, losing the ability to do detailed simulations in the process. Because the new building form was settled mid-way through the second day and the team was unable to run simulations, the team's IDP took a primarily theoretical approach. As a result, MURB Team C had to scramble with the theoretical components of the goals to assemble them into concrete results. Although their measures were not costed, the team dispensed with many building features in order to ensure that costs were addressed on some level. The team felt confident in the approximations of its goal setting, as they were based on sound theory and expertise.

Despite the missing components in its team composition, MURB Team C did have numerous experts circulate in during the course of Day 2 to provide guidance on certain areas. One expert (Terry Whitehead) who spent time with the group commented that he was surprised to learn that there were so many issues involved in the whole scope of sustainable building design, well beyond the operating energy costs of the building. The group learned during the course of the IDP that operating energy costs were only one factor in a grand scheme of sustainable design issues. The team dynamic remained strong throughout the IDP.

2.5.3 Design Measures Considered

The design team considered a number of different measures in approaching the development site. The process was as follows:

Zone Area

The following zone area measures were considered to determine how to make the best use of the site area:

- Finding total site areas
- Finding total units
- Determining single room occupancy

- Changing unit mix
- Developing areas of unit mixes
- Changing perimeter area and surface area
- Assessing direction for shading
- Developing storm water to water vegetation and other features
- Parking – as is – 50% (1 level)
- Mixing commercial and residential
- Establishing height of building to 7-8 floors – 118 units

Building

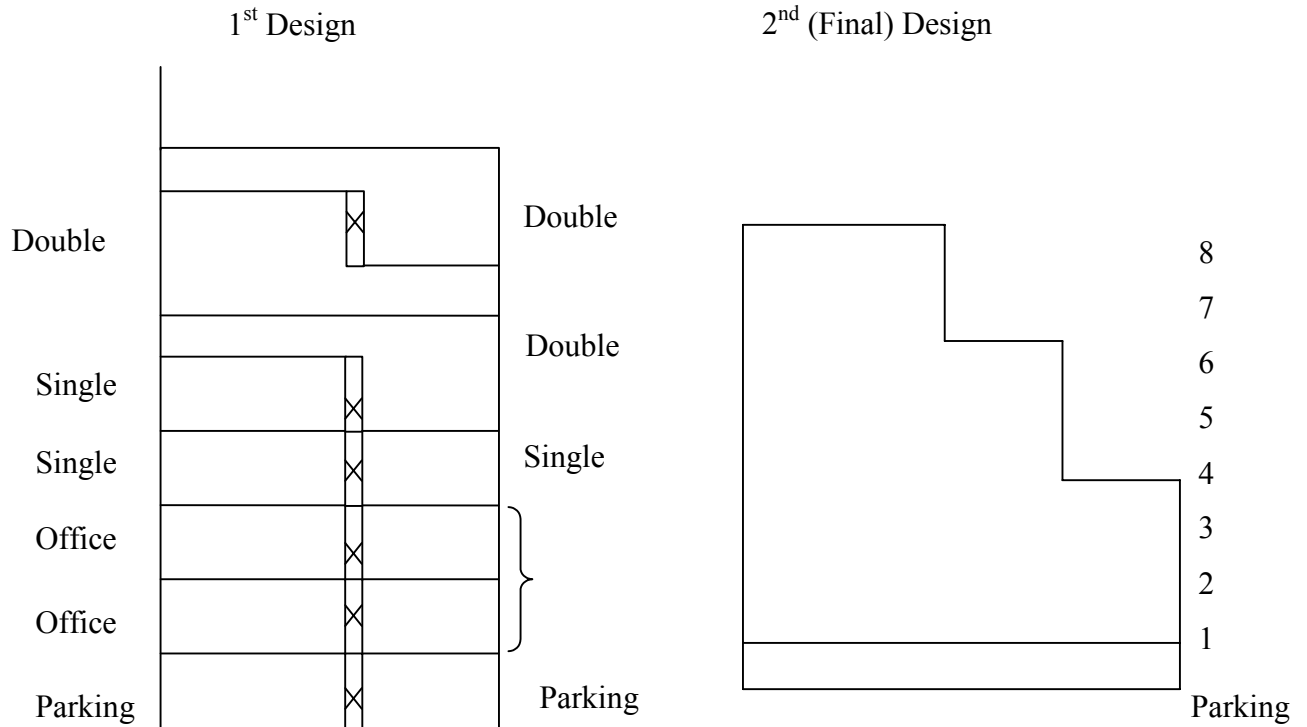
The building measures that the team explored were:

- Making changes to the configuration of the building but retaining the same number of units
- Considering corridor design (double loading corridor)
- Covering terraces with vines and other plants
- Adding bay windows with gardens on top
- Providing cross ventilation features
- Achieving a solar gain – with daylighting or green roof
- Providing shared laundry rooms, dispersed throughout building
- Determining ease of central metering
- Eliminating need for water pressurization due to lower number of floors
- Lowering skin area
- Providing bike parking at ground level
- Developing floor plate area at a smaller size to allow for a finer grid of apartment units

Design

Figure 2-1 represents renderings of the team's design process to demonstrate the considerations that were made to develop the design of the building with respect to the zone area measures considered earlier.

Figure 2-1—MURB Team C – Design process



Sustainability

The following issues were considered by the team to make the building a sustainable entity:

- Providing an Internet mailbox
- Providing a receiving area on the ground floor
- Collecting car wash water for use as grey water
- Collecting grey water for flushing toilets
- Establishing a car sharing program for the building that could use hybrid cars (electric)
- Incorporating a food co-op
- Setting up a restaurant/bar
- Providing high efficiency appliances

Landscape

The following landscape features were considered in the design for MURB Team C:

- Establishing green terraces
- Creating a green roof
- Developing a grey water irrigation system
- Having parcels of garden on the rooftop available for sale
- Designing the balconies to have vines coming down the walls

Ventilation/HVAC

In addressing the ventilation and HVAC measures, the design team considered the following items:

- Implementing a district energy system
- Employing a residential/commercial system since the team could combine both as a mixed-use development
- Obtaining heat recovery from grey water
- Providing solar water heating
- Establishing a co-generation system using waste heat
- Using desiccant based enthalpy recovery on ventilation air

Green Building Issues

The green building issues that MURB Team C considered are outlined in the following Table 2-4.

Table 2-4–MURB Team C – Green building issues

Item	Issues
Energy	<ul style="list-style-type: none"> • Operating • Embodied • Transport
Water	<ul style="list-style-type: none"> • Supply • Distribution • Treatment • Landscaping/xeriscaping • Non potable irrigation • Storage under parking lots for storm water
Sites	<ul style="list-style-type: none"> • 75% of units have parking • Savings \$18-20 K per parking space • Car lease facility • Storm water • Heat islands/avian impact
Materials	<ul style="list-style-type: none"> • Locally sourced materials • Rapidly renewable materials • Certified eco-materials
IEQ	<ul style="list-style-type: none"> • Valuing design/social
Solid waste	<ul style="list-style-type: none"> • Recyclables • Compostables • Reusable components of existing buildings • Materials diversion from landfill for existing materials
Reduce space requirements by program	
Multiple use of program elements	<ul style="list-style-type: none"> • Communication vs. exit stairs

2.5.4 Final Results and Analysis

Of the three design options that the team originally looked at, Option C was chosen as the preferred design – the stacked townhomes covering the full lot with eight levels designed as double height units with one level extending from front to rear allowing through-unit ventilation from front to back (described earlier in Section 2.5.1). The selection was based on the following benefits:

- Each unit has a view of the street
- There is cross flow ventilation
- Reduced corridor space
- Easier access to individual utilities
- Reduced exterior skin area
- Lowered height (to maintain a strong street relationship that could not otherwise be achieved as a tower)
- Angled balconies to gain solar (passive) – faces of the balconies were not parallel to building – the outside edges of the balconies were angled toward the sun
- Commercial facilities on lower floor (i.e. car rental; food depot; office – live/work; health club and fitness area; laundry; bar; game room)
- Reduced parking to 1 level due to car rental agency

Figures 2-2 and 2-3 below show detailed sketches of Option C, the building design chosen by MURB Team C.

Figure 2-2—MURB Team C – Detailed sketch of chosen building design (top view)

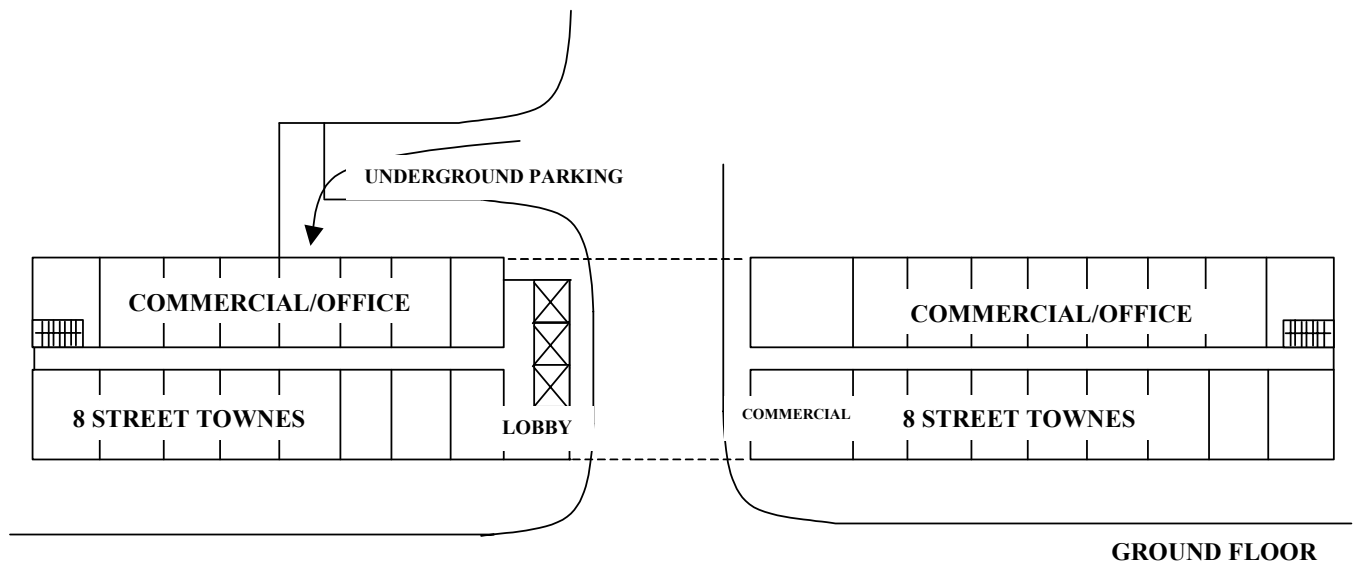
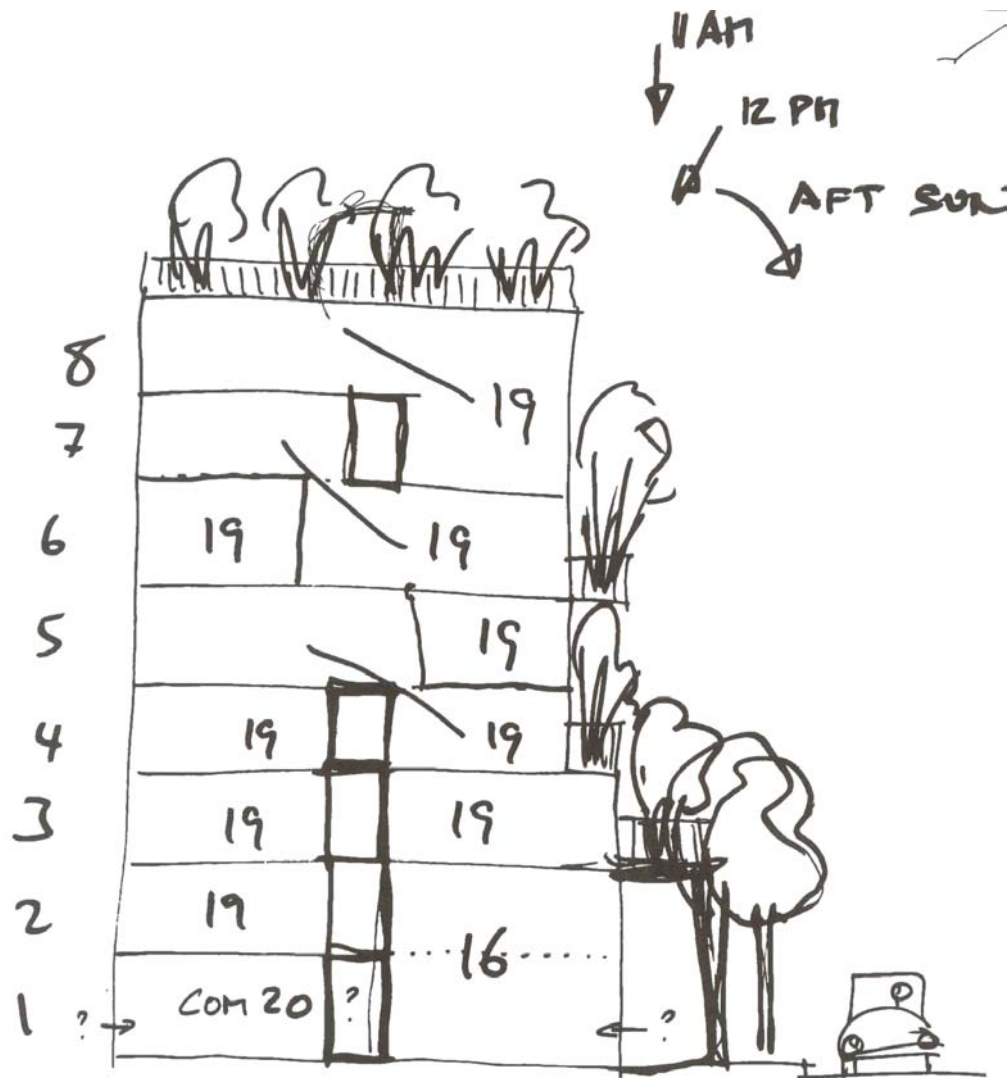


Figure 2-3—MURB Team C – Detailed sketch of chosen building design (side view)



The final results of MURB Team C's building design are summarized in Table 2-5. Through the implementation of the combination of measures described in Table 2-5, the team improved the energy efficiency of the building by approximately 75%, meeting its design challenge.

Table 2-5–MURB Team C – Building design final results

Design measure	Energy savings (%)
Less exposed wall <ul style="list-style-type: none"> • Increased wall insulation • Increased window insulation • Increased building air sealing • Heat recovery 	≈45
Domestic hot water <ul style="list-style-type: none"> • Heat recovery from grey water • Solar water heating 	≈5 ≈10
HVAC – hydronic heat delivery, slab thermal storage	≈8
Lighting – common area – daylighting	≈2
High efficiency appliances <ul style="list-style-type: none"> • Provided switched disconnects to avoid phantom electrical loads (i.e. clocks, pre-heats, etc.) 	≈5
Co-generation	Not calculated
TOTAL	≈75

2.6 Office Base-case

The base-case features of the office building design used for the charrette are as follows:

- 30-storey, south tower
- Floor space of 17412m²
- Open plan office building
- A retail store and restaurant are located at the ground level with their own HVAC system
- The office space is modeled with a VAV system
- The zoning for the open plan offices uses a core/perimeter scheme
- The ground floor has a lobby (between the restaurant and retail store) to access the office elevators
- The retail store has small storage section with unit heaters
- Lighting levels have been matched as closely as possible to those in the MNECB using (2) 4 ft Fluorescent T12 ES
- Underground parking is being considered as unconditioned space therefore it is not modeled.

2.7 Office Team A

2.7.1 Design Challenge and Constraints

Office Team A was led by Doug Cane as the facilitator and Andrew Morrison as the energy simulator. The team was challenged to redesign the Radio City Building in order to improve its energy efficiency to a minimum of 25% better

than the Model National Energy Code for Buildings. The team’s designs were constrained by having to maintain the building’s orientation, geometry, size and site – i.e. essentially having to use the building as designed.

The team identified the following two dominant constraints:

- Floor to floor height of 3m
- Location (B+ site)

Office Team A also adopted the following additional design goals:

- Good indoor air quality
- Reduce greenhouse gas/pollutant emissions

2.7.2 Approach to Integrated Design Process

Doug Cane gave the team members an introduction to the integrated design process, explaining that it can be used to overcome some of the problems or ‘missed opportunities’ associated with traditional design processes. The team used the following aspects of the integrated design process approach:

- Greater design team interaction in the early stages of design – looking at the building as an integrated set of systems
- The use of sophisticated modeling tools to examine energy efficiency options (design assistance with energy simulator)
- The use of experts in other areas (i.e. advanced technologies, indoor air quality, material selection, commissioning etc.)

2.7.3 Design Measures Considered

Prior to the charrette, Andrew Morrison identified a number of energy efficiency measures and compared them to the base case using the energy simulation software DOE 2.1E (see Table 2-6).

Table 2-6–Office Team A –Energy measure results

Measure #	Description	% Energy consumption savings (vs. base case)
0	Base-case	0
1	Lighting power density of 11.5 W/m ² (base was 17.5W/m ²)	4.93
2	Daylighting sensors	1.29
3	Occupancy light sensors	4.96
4	Low-E coated windows	6.13
5	Low-E coated and argon filled windows	8.13
6	Low-E coated, argon filled and triple glazed windows	13.33
7	Increase wall insulation by RSI 2.72	2.45
8	Condensing boiler (thermal efficiency 95%)	5.45
9	Low flow faucets	2.96
10	Low-energy office equipment	6.62
11	Increase roof insulation by RSI = 3.0	0.28
12	600mm overhang S & W windows	0.05
13	Sequenced boilers	3.00

At the charrette, the team was charged with the task of considering how to best combine these individual measures to meet the performance goal as well as to identify additional measures, if necessary. The additional measures, and their related energy savings where available, that were discussed by the team were:

- Lighting power density of 8.8 W/m² (9.4%)
- Variable speed fans and pumps
- Underfloor supply air (5.0%)
- Waste heat (heat rejection) for humidification (7.0%)
- Light shelf (2%)
- Green roof
- Heat pump water heater added to surface hot water (SHW) storage units (2.5%)
- “Dynamic” sizing of chillers/boiler
- A “breathing wall” for recirculation of air in areas to improve IAQ
- Add PV to external shading surfaces on south wall

2.7.4 Final Results and Analysis

Office Team A presented two final building design options to the plenary – a “SPEC” scenario and a “Purpose Built” scenario. The measures included in the SPEC scenario were:

- Increased wall insulation to RSI 2.72
- Lighting power density of 8.8 W/m² (because of constraints in the floor-to-floor height, the team did not have a drop ceiling, so lights were hung in the space – reflectance from the ceiling allowed use of lower power density which provided direct/indirect lighting)
- Low E coated windows
- Variable speed fans and pumps
- Condensing boiler
- Proximity sensor faucets
- Underfloor supply air (floor-to-floor height constraint)
- Waste heat (from chiller) used for humidification

The overall energy efficiency performance of the SPEC scenario was 43% better than the MNECB, thereby exceeding the team’s target of a 25% improvement. The cost implications of the SPEC measures are shown in Table 2-7. There was an estimated overall cost savings of \$1.05 per square foot calculated for the SPEC scenario.

Table 2-7–Office Team A – Cost implication of SPEC scenario

Design measure	Cost increment (\$/ft²)
Condensing boiler	+0.37
Proximity faucets	+0.33
Suspended lights	+1.00
Delete ceiling system	-2.75
Overhead slab finish	+0.50
Access floor, wood core	+5.00
Concrete slab finish	-0.50

Electrical Dist.	-1.50
Mech-system (from conv. VAV)	-0.50
HVAC plant (Capacity reductions)	-2.40
Elect. SHW from Central gas SHW	-0.60
TOTAL	-1.05

The “Purpose Built Scenario” included all of the SPEC measures as well as the following additional measures:

- Overhang/Light shelf
- Green roof
- Tenant commitment to low energy office equipment
- Heat pump water heater added to SHW storage units

The team estimated the overall energy saving of the “Purpose Built Scenario” was 53%, compared to the MNECB, thereby also exceeding the team’s original target of 25% improvement of MNECB.

2.8 Office Team B

2.8.1 Design Challenge and Constraints

Office Team B was led by Peter Rowles as the facilitator and Brian Fountain as the energy simulator. The team was challenged to redesign the 30-storey south tower of the Radio City Building in order to improve its energy efficiency to a minimum of 50% better than the Model National Energy Code for Buildings. The team’s designs were only constrained by the geometry and the project site – i.e. the team was permitted to make additions to the developed scheme, as well as changes in orientation and materials.

2.8.2 Approach to Integrated Design Process

Office Team B approached the integrated design process by initially addressing issues such as the occupancy, hours of operation based on tenant type, and level of energy consumption of the office building, and the building owner’s concerns regarding the operation of the building. The team assumed that there would be three types of occupants and estimated their energy consumption needs.

Tenant #1 – Hi-tech company

- Occupies 40% of office space
- Operation hours are approximately 5 x 16 hours a week
- Energy consumption requirements indicate high computer load

Tenant #2 – Government agency

- Occupies 40% of office space
- Operation hours are approximately 5 x 10 hours a week
- Energy consumption requirements indicate basic office load

Tenant #3 – Miscellaneous companies

- Occupies 20% of the space
- Operation hours are approximately 5.5 x 13 hours a week
- Energy consumption requirements indicate moderate class load

Based on the occupancy, the building owner's concerns are energy costs and low turnover.

From this model, the design team determined their objectives to be:

- Long term investment
- Low turnover
- Less than 10 year pay back
- Durability – targeted at \$140/ft²
- Power quality
- Power reliability

2.8.3 Design Measures Considered

The design team considered a number of different measures in approaching the development site. Their process was to take a broad assessment of the geometry and lighting measures for consideration and then take a more detailed assessment of the more technical central plant mechanical measures for consideration as they went further on in their IDP. The broad assessment included:

Geometry

Geometry was the first feature that the team explored. The specific items the team looked at were:

- Determining whether the building should be square or rectangle cross-section
- Determining shading
- Establishing orientation
- Establish optimal location for building core (elevator and duct risers) on floor plate
- Developing an atrium between the office and the MURB towers to make an enhanced space and to build on the synergies between the two buildings.

Lighting

Office Team B identified the following lighting considerations:

- Upgrading lighting by moving to more efficient technologies T12-T8-T5 with possibility of trichromatic LED's
- Factoring daylight
- Implementing a continuous dimming feature
- Establishing light shelves to allow daylighting further into the floorplate
- Establishing use of occupancy sensors

Central Plant

Table 2-8, below, presents the central plant factors and technical measures that were explored in greater depth by Office Team B and provides costs, including replacement costs, where available.

Table 2-8–Office Team B – Central plant factors

Item	Specifications
Restaurant and retail features	<ul style="list-style-type: none"> • Include in central plant
Variable Frequency Drive (VFD)	
Floor by floor ventilation	
Increasing the walls' R values	
Boiler – existing Recommend condensing boiler with combined heating & DHW plant 92% efficiency	<ul style="list-style-type: none"> • 3.8 Mbtu, 80% efficiency • \$20,000 replacement cost
Chiller Recommend COP of over 6.5	<ul style="list-style-type: none"> • 5.2 COP • 512 ton • \$250,000 replacement cost
Cooling tower	<ul style="list-style-type: none"> • 622 ton • \$51,000 replacement cost
Lighting fixtures	<ul style="list-style-type: none"> • T12 • About 3,000 T12, 2 lamp, 4' • \$220 per fixture material • \$690 replacement cost per fixture
Fans & pumps	<ul style="list-style-type: none"> • 240,000 cfm • 1.2 cfm/sq ft. (max. for cooling VAV) • \$800,000 fans & mech • \$150,000 boxes • ≈\$1,000,000
Windows	<ul style="list-style-type: none"> • 59,000 sq. ft. brick • 39,000 sq. ft. window • 98,000 sq. ft. total window and wall area • Standard double-glaze window \$40/sq. ft. cost • \$16,000 cost
Insulation	<ul style="list-style-type: none"> • Wall – brick • Insulation • Vapour barrier • 6" block • ms + dw • = \$1.75 million cost for walls and insulation

Cogeneration system

Office Team B explored the use of a cogeneration system in their building design, and two cogeneration unit types were considered as options for use. Option 1 was a 650 kW unit and Option 2 was a larger 800 kW unit generation set. Vito Casola of OZZ Corporation conducted an analysis to determine the practicality of incorporating a cogeneration system.

Appendix G contains several worksheets from the analysis. These worksheets only include an analysis of Option 1, because it was more favourable than Option 2. The results of this very preliminary work concluded that a cogeneration system was not a viable option for such facilities under the current market conditions.

Moreover, the load profile data that were provided to all the teams for the charrette process were based on monthly profiles. However, in order to accurately assess whether the loads will vary between facilities enough to favour a cogeneration system, hourly profiles are required for weekdays, weekends and for different times of the year. Thus, the results of the analysis should not be considered accurate because they were based on the limited input data that were available and the short time frame allotted to complete the analysis.

Lacking the adequate information (namely the hourly profile data) and the time required to conduct a precise analysis, it was necessary to make many assumptions in order to complete the analysis. These assumptions were based on experience gained on similar projects over the past ten years and on current market conditions, including commercially available equipment, estimated capital cost, current and projected prices for electricity and gas, standby charges, operating and maintenance costs, inflation indices, etc.

Further study would have made the analysis more accurate and thus more conclusive, however the analysis is indicative of what can be expected of a cogeneration system at such a facility under the current market conditions.

2.8.4 Final Results and Analysis

The final results of Office Team B's building design are summarized in Table 2-9. Through a combination of measures, the team improved the energy efficiency of the building by 79.6%, thereby meeting and exceeding their design challenge of a 50% improvement.

Table 2-9–Office Team B – Building design final results

Design measure	Cost (\$)	Energy savings (%)
Change geometry to 40' x 150' (measure was not retained)	0	-5
Rotate building 45°	0	-0.1
Orient office and MURB to connect with atrium	276,427	3.2
Lighting	235,553	6.3
• Change T12 to T8 fixtures	230,515	0.5
• Dimmable ballasts added		
Envelope	217,931	7.2
• Improve wall sections and upgrade windows		
• Upgrade roof		
Central plant mechanical upgrades	188,692	13.5
• Condensing boiler		
• High efficiency chiller		
• Modulating cooling tower		
HVAC improvements VFDs on supply fans, include retail in central plant	163,515	6.2
Underfloor ventilation system	161,931	0.2
Air to air heat recovery on ventilation	155,698	4.8
Add central heat pump	138,755	22.8
Add co-generation system	124,953	20.0
TOTAL	1,893,970	79.6

2.9 Office Team C

2.9.1 Design Challenge and Constraints

Office Team C was led by Bob Bach as the facilitator and Michel Parent as the energy simulator. The team was challenged to redesign the 30-storey south tower of the Radio City Building in order to improve its energy efficiency to a minimum of 75% better than the Model National Energy Code for Buildings. The team's designs were only constrained by the project site – i.e. they were permitted to make entire changes to the developed scheme, as well as changes in orientation and materials.

2.9.2 Approach to Integrated Design Process

There was good communication and teamwork among the group. Most people in the group were very active participants. Because of time constraints there was not much opportunity for debate within the group. It took a little time before the team started focusing on the actual work at hand, defining an efficient building. The team was composed of people with different profiles,

which was very useful. Participants on the team found the "floaters" quite handy, especially the costing experts.

The team began the integrated design process by establishing a set of goals for the IDP. The team identified a comprehensive set of objectives to be factored into the selection of the specific measures for the building design to achieve those goals. The objectives included providing a space that would result in increased employee productivity. A specific set of design measure considerations that covered the building exterior, materials, water use, indoor air quality, noise, and alternative energy supply were considered. A set of preferred design features was then adopted, costed and the percentage of energy savings achieved was calculated for each measure and summed to generate the total energy savings and dollar cost of the design. The steps in the IDP are presented below.

Setting goals

The team established the following goals for their IDP:

- Maximize usable space
- Minimize core common areas
- Maximize density of property – could have building issues
- Determine adaptability of space
- Determine flexibility of leasing
- Break up user space
- Implement high level of energy/environmental performance
- Expand our “horizons”
- Increase productivity
- Improve lighting
- Decrease waste stream (high level objective)

2.9.3 Design Measures Considered

The team identified the following comprehensive set of considerations to be factored into the selection of the specific measures for the building design:

Overview considerations

- What is the shape and height of the building? – May have to decrease building size
- Must establish benchmarks – What constitutes a building? Is it efficient, not efficient, etc?
- Must improve heat loss, etc.
- Space should be designed to improve productivity
- Building could be for single tenant/owner
- Owner could state that it must meet program criteria – e.g. encourage bicycle parking, roof top gardens
- Design team would have input including design of building
- Could use existing building as benchmark but not as finite descriptions
- High level of community integration, e.g. daycare, public transportation

Building Exterior

- Design the building with an inset back to maximize natural vegetation – xeriscaped
- Install rain/storm water capture and a water feature to retain some captured water for use on the green roof
- Provide bicycle foot paths in shared common space
- Provide a loading space
- Recycle any cafeteria food waste
- Provide disability access and daycare – sunken courtyard inset back with ramp and amenity space for bicycle, daycare and disability access
- Provide storage for recycling materials and truck access for disposal – same as delivery system
- Provide grey water collection and reuse with storm water (while also considering appropriate treatment for grey water before and after delivery- e.g. soaps, post treatment, best management practice for treatment collection)
- Design a green roof with a grey water filtering system
- Design a photovoltaic path and night lighting

Materials

- Computer systems – use ultra efficient computers with a defined schedule
- Original building materials – reuse all possible original building materials and recycle remainder
- Construction materials – use eco-certified materials, use local materials over imports, and use fly-ash concrete
- Office systems – use natural materials, reused modular, remanufactured and upgradeable, renewable resource materials for office systems
- Material finishes – use non-toxic paints and ceiling material
- Piping and ducting materials – use recycled products
- Appliances – use Energy Star and EU energy efficient products

Water

- General water use
 - Potentially use non-potable toilet water
 - Install ultra-low water usage fixtures (i.e. shower heads, faucets)
 - Address the load management for potable water (i.e. collection during off-peak in designated storage area)
- Seasonal water use
 - Summer
 - Grey water to toilet fixture
 - Atrium collection for external water
 - Excess green roof collection
 - Interior water feature
 - Recirculation
 - Excess in CR to exterior
 - Winter
 - Grey water to toilet fixture
 - Atrium collection to indoor
 - Excess CR to indoor

→ Recirculation – losses to humidity

Indoor Air Quality

- Integrate indoor air quality measures with the green wall water feature (with back up from heat pump storage)

Noise

- Alternative materials for sound absorption and attenuation

Alternative Energy Supply

- Alternative energy supply measures to be incorporated into a flexible office system using modularity

2.9.4 Final Results and Analysis

Office Team C calculated the total energy savings and costs for the proposed design using an energy performance model. As well, the team prepared design renderings of the proposed design. Figure 2-4 depicts a side-view rendering and Figure 2-5, a rooftop view rendering. Due to time constraints, not all of the design features shown in the renderings were incorporated into the energy savings and cost analysis (e.g. shades were not added).

The energy savings and corresponding costs for the proposed design are summarized in Table 2-10. Through a combination of lighting, equipment, heating and cooling, ventilation, and water measures, the team improved the energy efficiency of the building by 74.7%, close to their design team challenge of 75%.

Figure 2-4—Office Team C – Side view rendering of building design

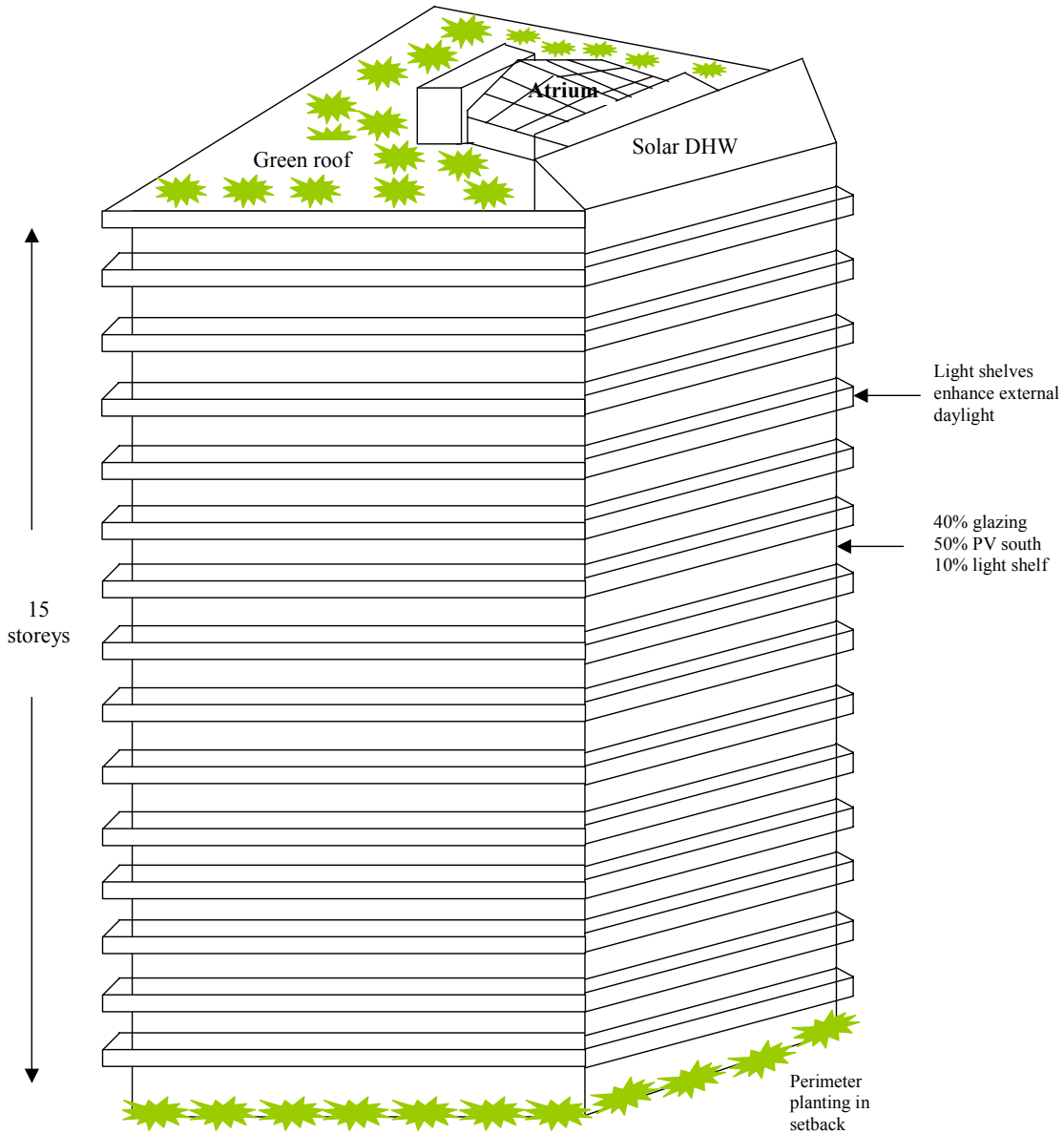


Figure 2-5—Office Team C – Roof top view rendering of building design

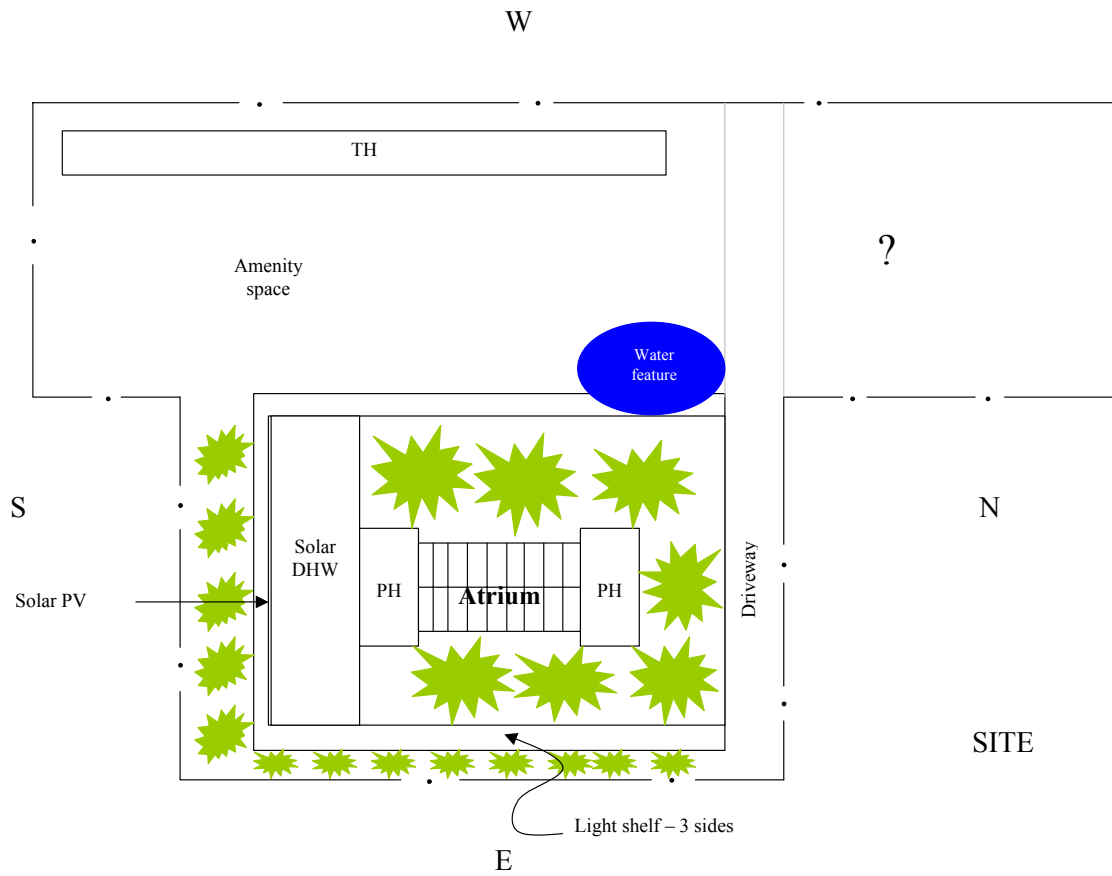


Table 2-10–Office Team C – Building design final results

Design measure	Cost	Energy savings %
Central atrium	164,095	6.6
Efficient lighting system at 0.5 W/ft ² and efficient office equipment, higher temperature-differential heating coils and lower static pressure ventilation	115,488	10.5
Optimal use of the energy efficient office equipment incorporated in the design (operated according to the occupant load)	112,065	5.9
Advanced lighting design with daylight sensors and continuous dimming for most of the offices	102,706	1.1
Added an R-40 roof	102,169	0.9
Added R-20 walls	100,323	3.6
Added low-e/argon windows	95,656	5.1
Modified the humidification system from steam injection to water mist injection (for internal gain reuse)	92,207	1.3
Modified the low-e/argon windows to clear triple-glazed to increase solar gains	92,335	3.1
Modified the VAV system to a distributed ground source heat pump system	77,623	25.9
Modified the VAV system to a centralized ground source heat pump system	72,164	0.7
Added a solar domestic hot water system	69,968	3.7
Reduced infiltration levels to 0.1 L/s/m ²	69,119	1.2
Reduced the skylight on the atrium to 65% of the roof area and replaced the skylight glazing from low-e/argon to triple-glazed	68,888	0.2
Reduced the fan energy use with opening windows allowing natural circulation through the central atrium	66,475	2.3
Used high efficiency motors on the ventilators	66,249	0.1
Incorporated a PV array on the building	3,814.7	2.0
Reduced the atrium temperature during the heating season from 71.6°F to 68°F in heating and 75°F to 80°F in cooling	65,181	0.3
Incorporated low flow faucets (demand activated)	65,032	0.2
TOTAL	1,601,557.7	74.7 ≈ 75

3 Participant Feedback

All charrette attendees were given a questionnaire in their participant kit to fill out at the end of the sessions. In total, 24 completed questionnaires were received, representing a response rate of approximately 33%. A blank copy of the questionnaire is provided in Appendix H.

The questionnaire gauged the participants' previous knowledge of IDP and green design, their previous level of experience with various design tools, guides and processes, their feedback on the charrette, and their intentions to use the integrated design process and/or whole building energy simulation in the future.

A summary of the responses, in each of these main areas, follows.

3.1 Previous Knowledge of IDP and Green Design

Participants were asked to rate their knowledge of Integrated Design Process and Green Design prior to attending the charrette. Table 3-1 presents a summary of responses. Given the open-ended nature of the original question, there were a variety of terms used in the responses. For the purpose of analysis, the responses were categorized as indicating either a 'low', 'medium' or 'high' rating of previous knowledge. Responses such as 'nil', 'minimal' or 'limited' were considered to be low, whereas responses such as 'fair', 'good' or 'some knowledge' were considered to be a medium rating. A high rating was given to responses such as 'excellent' or 'advanced'.

Table 3-1 – Respondents' self-assessed previous knowledge of Integrated Design Process and Green Design

	Low	Medium	High	No response
Knowledge of Integrated Design Process prior to charrette	42%	25%	8%	25%
Knowledge of Green Design prior to charrette	21%	67%	8%	4%

3.2 Previous Experience with Design Tools

Participants were asked to indicate the extent to which they use, or have used, a variety of design tools, guidelines, and processes in their projects. Table 3-2 presents a summary of responses.

Table 3-2 –Participants’ previous experience with green design tools

	Yes	No	No response
Do you have experience or expertise with LEED, Breeam/Greenleaf or other green design guidelines or tools?	25%	71%	4%
Have you ever participated in an integrated design charrette previously?	17%	83%	0%
Do you use integrated design techniques in your regular practices?	46%	46%	8%
Have you ever used whole building energy simulation in building design?	38%	50%	12%
Have you ever used whole building energy simulation in building performance audits?	33%	50%	17%
Have you submitted any projects for the Commercial Buildings Incentive Program (CBIP) grants?	21%	62%	17%
Have you ever used the CBIP Screening Tool?	12%	71%	17%
Have you ever used the ASHRAE 90.1 Energy Cost Budget approach for compliance with that standard?	33%	50%	17%
Have you ever done detailed energy simulations for a project using the following: ²			
Carrier HAP	25%	75%	
Trane TRACE	8%	92%	
DOE-2.1 PowerDOE, VisualDOE, PC DOE	12%	88%	
Merriweather	4%	96%	
BLAST	0%	100%	
TRNSYS	4%	96%	
Other	4%	96%	
Have you ever done whole building energy simulations using EE4.CBIP?	12%	71%	17%
Do your consultants do EE4.CBIP whole building energy simulations?	21%	42%	37%
Who does design and document coordination in your office:			
Principal in charge?	25%	21%	54%
Project Architect/Engineer?	46%	4%	50%
Job Captain/Sr. Technologist?	29%	13%	58%
Do you have quality assurance processes to demonstrate consultant design and document coordination?	21%	50%	29%

² The questionnaire only asked participants to circle those simulations which they *had* used. As a result, it was not possible to differentiate between a ‘negative response’ and a ‘non-response’ and therefore only one number is given.

3.3 Charrette Feedback

Participants were asked to rate the extent to which the Toronto Charrette event met their expectations, based on a scale of 1 to 5. As shown in Table 3-3, the majority of respondents (67%) indicated that the event either met or exceeded their expectations. Approximately 79% of respondents also indicated that they had gained some insight from the charrette that would be useful in their work.

When asked to describe their experiences in their charrette teams, nearly all of participants that responded answered very positively.

Respondents suggested two main areas for improvement of the charrette teams in future events – group size and group composition. A few respondents suggested that there were too many ‘floaters’ (i.e. experts) and not enough core teams members. A number of participants also commented that the composition or balance of the teams could be improved by ensuring that each team has at least one representative from each major discipline (architect, engineer, developer etc.). Other suggested improvements for future events included: more detailed reporting from each group; a longer event; more representation from the design community and city planners and OBC; and better defined base building and materials.

Table 3-3 – Participants’ overall evaluation of the charrette

No response	1– “poor”	2 – “met some expectations”	3 – “met most expectations”	4 – “met my expectations”	5 – “went beyond expectations”
4%	0%	8%	21%	50%	17%

3.4 Future Use of IDP and Whole Building Energy Simulation

Over 70% of respondents indicated that they intend to use Integrated Design Process (IDP) in their next design projects. However only 8% (2 individuals) of respondents indicated that they did NOT intend to use IDP. The remaining respondents expressed that either (1) they would discuss the possibility of using IDP with their clients/coworkers; or (2) that they were not directly involved with design work and therefore IDP was not applicable to their situation. One half of the respondents also indicated that they intend to use whole building energy simulation in their future projects.

3.5 Written Testimonials and Other Feedback

Subsequent to the event, CMHC received written feedback on the charrettes from the developer of the project site (Alex Spiegel of Context Development) as well as from one of the energy consultants (Larry Brydon of OZZ Corporation) and one of the note-takers (Arran Timms). Copies of this correspondence are provided in Appendix I. These individuals praised the great success of the event and offered suggestions for improving future events as well as ideas for new projects and endeavours based on the success of the charrettes. Highlights of these comments follow.

3.5.1 Developer: Alex Spiegel, Context Development Inc.

Alex Spiegel commended the concept, design and outcomes of the integrated design charrettes. As a developer with strong interests in green design, he acknowledged that while there are a number of barriers to green design,

developers must still take the lead in encouraging sustainable buildings and considering green design strategies. Spiegel felt strongly that the charrette was an ideal mechanism for developing such strategies, as shown by the following statement:

“What could be better than to have a group of committed and creative professionals from diverse disciplines focusing on a real project on a real site, offering their collaborative design skills to improve the quality of the project design?”

Spiegel also offered praise for the format and design of the entire event. He found the approach of having three levels of constraints and performance goals (A, B and C) for the different design teams very useful given that, as the developer of the project site, he also faces a number of design restrictions. He also commended the fact that there were energy simulators present in each design team, as this allowed the teams to see the impacts of their design options as they discussed them.

Spiegel was very pleased with overall results of the charrette, as indicated by the following comment:

“In directing the green agenda to a very practical level, the charrette has provided me with “do-able” solutions for the Radio City project as well as with innovative suggestions for other projects in the immediate future.”

3.5.2 Energy/HVAC Specialist: Larry Brydon, OZZ Corporation

Larry Brydon highly commended the ‘real world’ approach to the charrette that included the use of an actual project site and drawing participants from a variety of disciplines. He also applauded the fact that many of the participants had relatively low levels of understanding and/or interest in integrated design, prior to the charrette, such that the event was not another case of “preaching to the converted”.

According to Brydon, the charrette created a ‘win-win-win’ situation. The experts and resource people had an opportunity to network while the design teams got to see the “simulated, real-time impact of the various changes one discipline can have on the other, and the substantial impact an integrated design process can have on overall energy efficiency and social impact.” The developer received valuable design options and strategies from design experts and the marketing representatives had the opportunity to understand how “improved occupant comfort, individual control and productivity are just as ‘sellable’ as a panoramic view”.

3.5.3 Note-taker: Arran Timms

Subsequent to the charrette, Arran Timms, who was the note-taker for MURB Team A, provided feedback on the charrette to CMHC. Timms applauded several aspects of the event, such as focusing on a real project development site and having the actual building developer present at the event to provide

comments. Timms also suggested that the charrette benefited greatly from the knowledge base of the team members and expert resource people, as well as from skilled facilitators. His suggestions for improving similar events in the future included: facilitating the use of audio-visual equipment in final team presentations; and including a keynote address by an architect or developer of a successful 'green building' in the agenda.

3.5.4 Other Feedback

In preparing this charrette report, IndEco contacted specific facilitators and energy simulators to obtain clarification on certain IDP processes as well as on the analysis and the results. In the course of these discussions, these individuals provided additional feedback on the charrettes and this feedback is provided below.

It was pointed out that, normally in the design process costs are calculated as each measure is considered. However, in the charrette design teams, the cost analysis and calculations were done at the end of the design process. For future charrettes, being able to do the costing as measures are identified would be advantageous. As well, for future charrettes that deal with MURBs, it would be very helpful to have a marketing resource person available to provide feedback on the saleability of proposed measures (e.g. saleability of grey water recycling). Both of these suggestions would enhance the "real world" nature of the training session.

In addition, it was pointed out that design teams require a minimum of one-and-a-half days to conduct their IDP, gather results and present them. As such, a full two-day event format should be considered for future charrettes.

4 Conclusions

Transforming your Practice Integrated Design Charrettes for Sustainable Buildings was a very successful event. Seventy-two people attended the charrettes (including speakers, facilitators, simulators and resource people).

The design teams were given specific design constraints and energy performance goals as a challenge. All teams met their performance targets and some teams far exceeded them. The charrette as a whole demonstrated the success of the integrated design process, including the use of energy simulation software. The charrette allowed the teams to deal with a complex set of issues in a very quick manner and to reach their performance goals with the use of relatively few measures.

Most participants found that the charrettes met or exceeded their expectations and that they gained some insight that will be useful in their work. Participants provided valuable feedback on how to improve future charrettes. The architects who participated were able to earn 15 points towards OAA continuing education requirements.

Not only did the charrettes provide an opportunity to participate in an integrated design team, but they also provided the opportunity to design modifications to an actual proposed development in the City of Toronto. The developer as well as his mechanical engineer, structural engineer, and architect were on hand at the charrettes to provide valuable feedback on and insights into suggested designs for the MURB component. This made the design experience more practical and rewarding.

For those groups that were able to calculate the costs of their design measures as they progressed, this capacity was another component of the charrette process that was considered very advantageous.

The composition of the teams also helped in making the process more realistic. In particular, the combined involvement of the developer, architects, engineers, energy simulators, property managers and costing experts gave the charrettes more depth.

CMHC intends to offer charrettes in the future that will build on the strengths of these charrettes and make improvements based on the feedback obtained and the lessons learned. This will enhance the utility as well as the enjoyment of future charrette events.

As a follow up to these charrettes, CMHC intends to contact participants early in the new year to assess the long-term value of the experience. For example, CMHC may canvas participants on whether they are making use of the resources contained in the participant kits; determine if participants are

becoming involved in IDP processes; and if they are using EE4 or other simulation software to evaluate potential energy savings.

The City of Toronto's Energy Efficiency Office is very pleased with the success of the charrette event. The EEO is now examining how to build a similar charrette type model into its proposed New Construction Program, planned for launch in 2002 to help fulfil the requirements of the City of Toronto's approved Environmental Plan.

Natural Resources Canada's Office of Energy Efficiency will be looking closely at the results of the measures the charrette design teams chose to meet their energy performance goals. NRCan intends to make potential CBIP applicants aware of energy efficient measures for commercial or multi-unit residential buildings that would help to meet the CBIP requirement of achieving an energy savings of 25% beyond the Model National Energy Code for Buildings.

The Canadian Energy Efficiency Alliance (CEEA) found the charrettes to be very successful. They are consistent with the aims and activities of CEEA in relation to promoting energy efficiency at the design stage. After having participated in a few similar charrettes, CEEA believes that this approach should be continued and intends to be encouraging potential supporters and funders to participate in future charrettes.

Enbridge Consumers Gas concluded that partnering with organizations like CEEA, City of Toronto, NRCan and CMHC is an effective way to help promote market transformation towards energy efficient building design.

Overall, the partners are pleased with the results of the charrettes and look forward to future collaboration.