RESEARCH HIGHLIGHT

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Ardencraig: Documentation of a Vancouver Triplex and Infill Project with Sustainability Features

INTRODUCTION

When Chesterman Property Group Inc. of Vancouver undertook to redevelop Ardencraig, a single-family residence built in 1910, it incorporated a number of strategies that reflect principles of sustainability and green development. Chesterman converted the four-storey house, situated on a 5.2 x 37.2 m (50 ft x 122 ft.) lot, into three strata-titled units and added a new coach house in-fill residence in the rear yard.

Figure 1 Finished triplex south elevation

The project was granted a development permit in May 1999. Allan Diamond Architects was responsible for obtaining a building permit; Urban Ecology Design Collaborative consulted on specific environmental issues; Timberland Homes Ltd. provided project management and general contracting services; and Wave Design + Media Inc. consulted on various aspects of design and assisted Chesterman in co-researching the green aspects of the project.

CONCERNS AND STRATEGIES

Chesterman and Wave Design assembled their "Green Team" at the early concept stages of the project to set goals and priorities for redeveloping Ardencraig. The team discussed seven environmental issues that appeared to be of most concern to the community at its first meeting:

1) *forestry*—continuing use of old growth forests by the building industry

2) *land use and transportation*—continuing urban sprawl and traffic congestion

3) *landfills*—amount of solid waste going into them

4) *electricity and gas utilities*—increases in capacity and infrastructure are extremely damaging to the environment

5) *water supply*—logging of watersheds, sale of water out of province, increased population and replacement cost of obsolete infrastructure is expected to increase demand and cost of water

6) *storm water*—Vancouver's older sewer system combines storm water from roofs and parking areas with sewage, resulting in an overload capacity for its sewage treatment plant; in some areas, storm water laden with oil and debris flows into the harbour; new installations in some areas now separate storm water

7) *air quality*—poor outdoor air quality due to motor vehicles, and unhealthy indoor air quality due to moisture-related problems, dust, poor ventilation and off-gassing of materials.

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The team proposed the following strategies:

- Maximize the energy efficiency of the building envelope through higher insulation levels, high performance windows and airtightness.
- Reuse wood from the original house and salvaged timber from demolished buildings. For any new wood required, use wood certified "sustainable."
- Use energy-efficient space and domestic water heating systems.
- Incorporate central heat recovery ventilation (HRV) systems in each unit.
- Reuse existing finishes where possible, otherwise use wood fibre reinforced cement products that duplicate the appearance of the original finishes.
- Prolong building life through the use of rainscreen wall assemblies.

Based on three months of investigation into the feasibility of these strategies, the Green Team made its final decisions regarding actual steps to be taken in meeting its goals.

REDEVELOPING ARDENCRAIG

A software energy analysis program, HOT 2000, provided key information in assessing the design specifications for the building envelope to ensure the first strategy, maximizing energy efficiency, could be met. The analysis resulted in the following options being chosen:

- 38 x 38 mm (2 x 2 in) interior strapping for the main house, yielding walls of RSI 3.4 (R20)
- 38 x 39 mm (2 x 6 in) framing on the coach house, yielding walls of RSI 3.4 (R20)
- use of high-performance polyisocyanurate rigid insulation on straw board (Isobord) in the existing frame of the main house, yielding a roof of RSI 4.7 (R28).

The following criteria also helped guide these choices:

- a commitment to meeting R2000 standards for the renovation
- the contractor's belief in the constructability of the solution
- the overall room size and height constraints of working within an existing building while still providing sufficient liveable space attractive to purchasers (in a compact townhouse, a few centimetres can make an important difference to a room).

To address the second strategy regarding use of newly harvested lumber, the project retained as much of the existing structure as possible and augmented this with salvaged dimensional framing from other demolished buildings. Prior to demolition of Ardencraig, a salvage expert surveyed the house. Wood was salvaged from the structural frame, joists and sheathing lumber and accounted for approximately 95 per cent of the framing lumber used in the redevelopment.

Figure 2 Coach house with salvaged lumber

Granite from the foundation and a mantle were also salvaged for reuse in Ardencraig. Items salvaged for reuse in other projects included window and door trims, interior doors, kitchen cabinets, a furnace, bathroom fixtures and a pool table. Items recovered and sold for recycling included piping and wiring containing copper. All concrete work, including new foundations, retaining walls, exterior stairs and concrete floor topping was a special order mix containing 50 per cent fly ash. The fly ash is waste from coal burning power plants which significantly lowers the amount of embodied energy required in standard concrete mixes. Replacing Portland cement with fly ash also diverts this solid waste from going into landfills.

Figure 3 Triplex shell jacked up and new foundation underneath

After reviewing capital and operating costs of high-efficiency heating equipment, the developer decided to install a central, gas-fired, medium-efficiency boiler (82 to 84 per cent efficient), with a heat exchanger to supply hot water. The coach house has a separate gas-fired boiler (72 per cent efficient) and heat exchanger for both space heating and hot water. In retrospect, the boiler decision should have been investigated more thoroughly, as the technical issues were quite complex. Furthermore, natural gas prices rose quite suddenly after the boilers were chosen, almost doubling in price.

Two other options were considered for space and water heating, but both were rejected due to long payback periods. One was a ground source heat pump system for space heating and hot water for the four units, and the other option was solar domestic water heating.

The developer also chose a radiant in-floor heating system, primarily for air quality, comfort and space planning benefits. The system requires no ducts, which would interfere with framing, and no convectors, which would interfere with the location of furniture. An additional benefit of the system, which is embedded in a thin layer of concrete topping, is that the concrete provides improved acoustical separation between the units.

Floating floor laminates are the only products that carry a full warranty over radiant-heated concrete topping, which meant that salvaged wood could not be used. Instead, laminated bamboo was chosen, which is finished with factory cured polyurethane, so no dusty sanding and toxic finishing is required on site. The particular manufacturer chosen also did not use any formaldehyde glues in the process. Good indoor air quality was also achieved by using other low toxicity finishes, such as a "zero VOC" (volatile organic compound) line of interior paint.

The landscape plan went through many changes as the project progressed and the developer endeavoured to create a green space that met the following criteria:

- reduced water consumption
- reduced load on the storm sewer
- private outdoor space for each resident
- shared open space to create a sense of neighbourhood
- opportunity for "edible" landscaping
- attractive appearance other than the standard "grass/conifer" approach.

The developer created a small pond fed by rainwater run-off and which acts both as a retention pond and an attractive landscape feature. A perforated sump on site fills with rainwater and slowly discharges it into the soil, and rainwater is also collected in a rain barrel for watering the gardens. The developer made the site as permeable as possible by using, for example, permeable unit pavers as hard surfaces. The landscaping also features indigenous plants that require relatively little watering, and there is only a small area of grass in a shared seating area in the front yard. A shared vegetable and herb garden completes the landscaping.

Efficient use of water indoors is achieved with low-flow toilets and other water-efficient fixtures. Ultra low-flow toilets were considered, but there was no perceivable payback given their additional cost and the low cost of water in Vancouver. Composting toilets were also rejected due to low acceptance by the public and health departments.

A project website, http://chestermangroup.com/ardencraig/index.html, provides information on the choices made and the decision-making process that was followed.

One unit sold prior to completion, the developer took another unit, and the remaining units sold within several months of completion.

CONCLUSIONS

Ardencraig is a successful, small-scale redevelopment project incorporating many proven resource-efficient, energy-efficient and healthy building features which have yet to become common in the marketplace, especially in redeveloped properties. The project offers several lessons learned:

- It may be best to emphasize specific sustainable targets rather than try to do everything. The project was most successful where goals were clear.
- Basing new construction almost entirely on recycled wood is feasible and not excessively costly or slow.
- Novelty overload is a real problem in green design decisions, materials selection and construction decisions. Each avenue of research turns up possibilities that must be assessed quickly and decisively.
- Novel techniques and materials must be considered for their cost, availability, construction timing and value added to the project. Some may also raise regulatory obstacles, such as a radical grey water recycling system.
- It would have been helpful to use a rating measure like R2000 or Powersmart to substantiate energy efficiency claims, given their public recognition and acceptance.
- More novel materials such as cellulose insulation or straw board substitutes should be tried in future projects, now that the overall concept and approach has been successful.
- Additional healthy and energy-efficient features and practices could be incorporated with better scheduling and planning.
- The energy performance options for the envelope are limited when remodeling an old house. To have achieved more at Ardencraig would have been more expensive and probably used floor area and headroom.
- More efficient heating equipment might be justified, but the technical complexities of system compatibility have to be solved.
- A hydronic convector heating system would resolve the problem of limited options for flooring one encounters with radiant in-floor heating. It might also make higher efficiency combustion equipment more justifiable.

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