Alice Turner Branch Library, Saskatoon, Saskatchewan

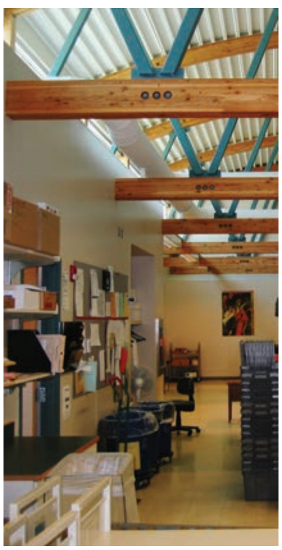
Synopsis

The Alice Turner Library features careful day lighting design to introduce sunlight deep into occupied spaces, as well as passive solar features, among others, to reduce energy use.

The Alice Turner Library was first constructed in 1998. Upon completion the building was widely heralded as a success, achieving 65% lower energy and 48% lower energy costs compared to Canada's Model National Energy Code for Buildings (MNECB), while achieving similar construction costs per m^2 to typical commercial buildings.

These energy performance levels were confirmed through a building performance evaluation shortly after the completion of the original building. In 2012 an addition to the building was completed. This addition, designed to substantially the same performance standards as the original building, increased the floor area by 15% and was incorporated into the existing HVAC system. This current evaluation considers the performance of the building since 2012.

The building is one storey and includes private offices for the public library's technical services staff , and public library spaces such as the actual library stacks, study rooms, and meeting rooms.



View of the clerestory windows bringing daylight into the back offices.

Building Data

Building Type
Addition, Public library

Climate
Continental,
Very cold winters
(5742 HDD, 125 CDD)

Age
Original building: 16+ years, constructed in 1998

Addition: 2+ years, constructed in 2012

Construction Cost
Addition: $2,900,000
($3,200/m^2)

Facilities
Library, public meeting rooms, offices

Net Conditioned Area
2070 m^2

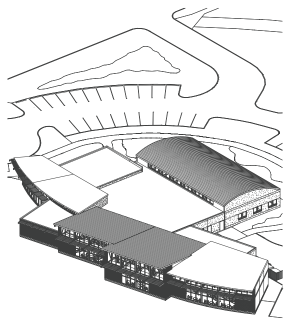
Primary Use Area
Public occupancy: 1370 m^2
Office: 700 m^2

Energy Model
DOE2.1e

Green Rating
C2000

Architect
Kindrachuk Agrey Architects Ltd.

Mechanical/Energy Engineer
Daniels Wingerak Engineering



An axonometric view of the library from the southeast.

A view of the main entrance of the Alice Turner Branch Library. Deciduous trees to the south block unwanted summer solar heat gain. Conifer trees to the north protect the building from prevailing winter winds.

Design Features

Careful building design, including passive solar strategies, resulted in reduced space conditioning requirements. This included site and material choices. Conifer trees provide a wind block to the north of the building to reduce heat loss from the prevailing winter winds. Deciduous trees to the south also provide shading in the summer months while allowing for desired solar heat gain in the winter. Wood frame construction reduces thermal bridging.

The building is insulated with a combination of batt insulation and exterior sheathing. Advanced fenestration strategies include spectrally selective double-pane argon-filled clear low-e glazing with high performance thermally-broken frames. A predominance of north and south fenestration optimizes the utility of the lighting. A mixture of full height and clerestory windows, and tall and vaulted ceilings increases day-light penetration into the building.

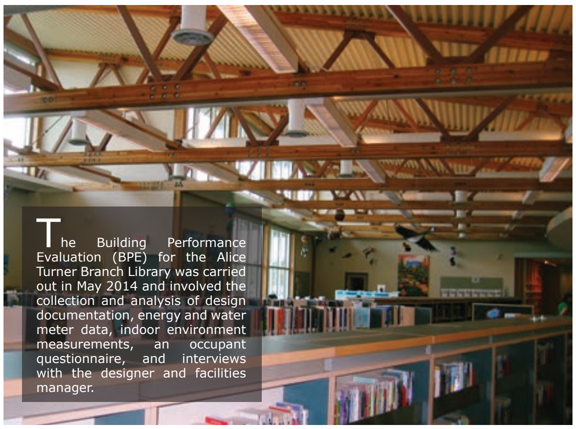
Lighting levels are also maintained through automated lighting controls including day-light sensor controlled blinds, and occupancy sensors. Indoor air quality was also considered through operable windows placed throughout the workspaces and higher levels of ventilation. Heating is provided by an underfloor hydronic system. Cooling is provided with a four pipe fan coil system (that was also designed to provide back-up heating). Ventilation is provided by an independent system, exhaust is passed through an energy recovery ventilator.

MAIN FLOOR PLAN

For more information see *iisbecanada.ca/sb-14*

Alice Turner Branch Library

Summary of Results



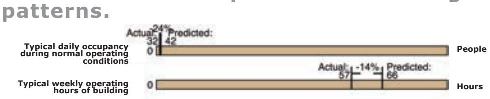
The Building Performance Evaluation (BPE) for the Alice Turner Branch Library was carried out in May 2014 and involved the collection and analysis of design documentation, energy and water meter data, indoor environment measurements, an occupant questionnaire, and interviews with the designer and facilities manager.

High ceilings and full height windows allow day light deep into the library stacks.

Occupancy Factors

KEY LESSONS:

Occupancy levels affect various aspects of building performance but are difficult to predict for buildings with changing occupancy patterns.

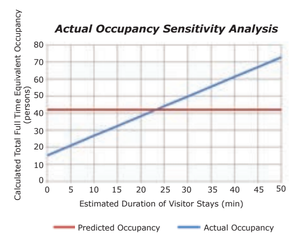


Occupancy appears to be lower than predicted. These numbers, however, should be taken with a certain degree of caution. The predicted occupancy values were taken from the occupancy schedule in the energy model, and the actual occupancy was calculated from a combination of staff schedules and detailed records of daily visitor stats.

The calculation for the actual occupancy is based on records kept by staff, and on the assumption that each visitor stays for on average 15 minutes. The actual length of stay is unclear.

The graph to the right shows a sensitivity analysis depicting the full time equivalent occupancy of the building using different durations for each visitors stay.

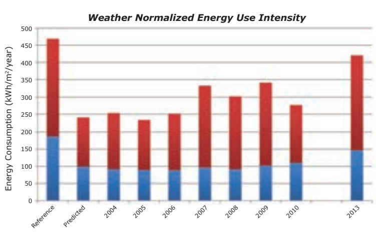
As can be seen the occupancy of the building is heavily dependent on the number of visitors (>400 daily). With only a small number of staff permanently in the building (14 full-time and 15 part-time), deviation in regards to the duration of a stay can significantly affect the "actual occupancy" of the building calculation.



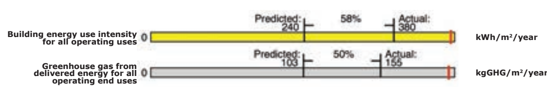
Energy & Emissions

KEY LESSONS:

As a building ages, management and maintenance issues can have a significant impact on performance. Availability of appropriate resources and continuity of institutional operational knowledge are key to ensuring persistent building performance.



Increases in energy use is can be seen to occur as the building ages. Data for 2012/2011 was excluded because energy use during construction was deemed atypical. Furthermore, net floor area was difficult to define during the duration of construction.



***RED** bar indicates typical performance for the region.*

It appears that the performance gap is connected with issues in the operation and maintenance of the mechanical system.

Reduced energy consumption in the building relies on the following strategies:

- Highly insulated envelope, including low thermal bridging due to wood frame construction.
- High performance windows.
- High levels of natural lighting to offset lighting energy use.
- Occupancy sensors to reduce lighting energy use.
- Energy recovery ventilator to minimize heat lost to exterior.
- Passive solar design to encourage solar heat gain in the heating season.
- Landscaping that reduces winter heat loads caused by predominate winter winds, and summer cooling loads caused by unwanted solar gain.

The actual energy use intensity (EUI) of 380 kWh/m²/year (for 2013) is 58% higher than predicted, although it is still better than the reference standard for typical buildings of this type and location. This is also reflected in higher GHG emission figures. The energy use soon after construction was considerably lower and close to predictions. Several interrelated issues were identified as the likely cause for the performance gap: aging HVAC equipment, problems with constructing the addition in 2012, and operational resources and information available to building managers.

Difficult to detect equipment failure resulted in hydronic flooring delivering heating to the space continuously. This was likely a result of equipment reaching the end of its normal service life.

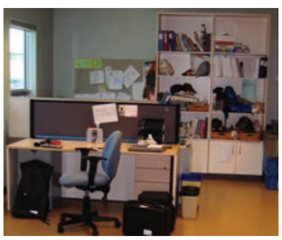
Complicating the issue of diagnosing this problem, certain manuals and diagrams of the mechanical systems were either difficult to obtain or missing. Furthermore, the building manager is unable to subsequently monitor the reports and he did not have access to the energy use figures.

For more information see *iisbecanada.ca/sb-14*

Alice Turner Branch Library

Summary of Results

Exterior view of the Alice Turner lobby.



Work stations for the Alice Turner Library branch staff.

Indoor Environmental Quality (IEQ)

KEY LESSONS:

Occupants' concerns with comfort can highlight building performance problems.

A good indoor environment is achieved by:

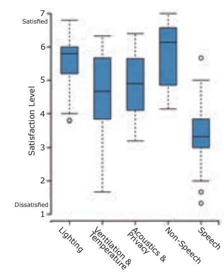
- Attention to good daylight design including predominantly north & south glazing orientation.
- Operable windows, for user control.
- Higher than usual levels of ventilation can provided and decoupled from conditioning to reduce loads during unoccupied periods.

Eighteen responses were received for the occupant survey, for a participation rate of 100% of full-time staff and 25% of part-time staff. The results indicated that respondents are most satisfied with lighting (scoring a mean of 5.6 out of 7) and non-speech acoustics issues and least satisfied with thermal comfort (mean of 4.5 out of 7) and speech acoustics issues (mean of 3.4 out of 7).

Most of the spot thermal measurements fell within the ASHRAE winter thermal comfort zones (see chart). However comments in the survey primarily cite over-cooling as an issue within the building. This appears to especially be problematic for occupants working near vents.

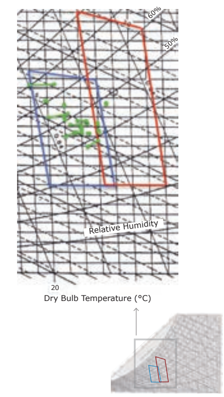
It would appear that problems with mechanical equipment continuously heating the space also cause the system to over-cool in compensation. Because of this, occupants placed near vents get a constant stream of chilled air making them uncomfortable. Furthermore HVAC zones do not always match internal partitions, exacerbating the issue.

CO_2 measurements were between 472 ppm and 627 ppm which is well below reference values, potentially indicating over-ventilation. Overall, all of the spaces measured were in the acceptable range for airborne particulates.



	Lighting	Ventilation & Temperature	Acoustics & Privacy	Non-Speech	Speech
Mean	5.6	4.5	4.9	5.8	3.4
Standard Deviation	0.83	1.34	0.95	0.99	1.14

Spot measurements of the indoor environment were taken on May 28-30, 2014 in 7 different workspaces, in the lobby, and in the library stacks. As the measurements were being taken, occupants were asked to fill out an online survey.

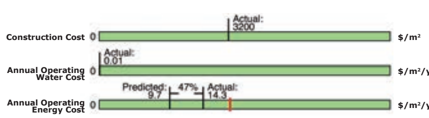


Temperature measurements (taken in May 2014), mapped onto ASHRAE 55 thermal comfort zones. The blue quadrilateral indicates winter comfort zones, while the red indicates summer comfort zones.

Economic Factors

KEY LESSONS:

Ultimately, performance issues will lead to increased operational costs.



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Higher energy operating costs reflect higher energy consumption.

While energy consumption increased 58%, costs only increased 47%. This is due to different share of consumption of natural gas and electricity as well as differences in cost of the two energy sources. The energy costs are still below typical buildings of this type.

Water

KEY LESSONS:

Water consumption patterns in libraries need further careful study but may be low.

(Above) Despite little attention given to water use in the initial design of the building, the data shows very low water use figures.

Reduced water consumption in the building relies on two strategies:

- Drought resistant and native landscaping that requires no irrigation.
- Low flow fixtures throughout the building.

The water use is extremely low. This is likely partly due to the fact that the library's many short-stay occupants do not use washroom facilities to the same extent that an occupant would use them in an office, for example.

Values for water use per occupant have been calculated based on staff and assumed visitor numbers (as discussed in the occupancy section). However, even if only staff are considered in the water per occupant calculation, water use is still extremely low (< 0.5m³/occupant/year). This may be an indication of some metering issues.

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