Main entrance of Firstenburg Community Center in Vancouver, Wash. It uses natural ventilation and other strategies to save energy.

Integrated Design For Community Center

2008 ASHRAE Technology Awards

By **Paul Anseeuw, P.Eng.,** Member ASHRAE; **Rick Grove, P.E.,** Member ASHRAE, and **Tom Marseille, P.E.,** Member ASHRAE

For the Firstenburg Community Center in Vancouver, Wash., integrated design helped the engineers, architects, and city and county leaders to use sustainable design and define energy goals related to environmental responsibility. The 76,000 ft^2 (7061 m^2) center includes fitness areas, aquatics space, community rooms, a climbing wall, multipurpose rooms, lounges, administration areas, gymnasium, elevated jogging track, and senior's areas.

Early in the design process, a full-day ecosymposium brought together leaders from the City of Vancouver, Clark County, and City of Portland, Ore., as well as experts from the design team and the community. The design team led discussions and hands-on exercises to identify opportunities for integrated green design and project goals related to environmental responsibility. Case studies and the symposium location at the Jean Vollum Natural Capital Center in Portland, Ore., showcased tangible outcomes of many sustainable concepts and approaches.

The ecosymposium was instrumental in establishing clear goals and gaining client support, and helped bring the design team together in the search for an integrated design. The adaptable modeling tool used early in the process by the

About the Authors

Paul Anseeuw, P.Eng., is a recognized expert in sustainable design with nearly 30 years experience. **Rick Grove, P.E.,** is a mechanical engineer with CDi Engineers in Lynwood, Wash. **Tom Marseille, P.E.,** is managing principal for Stantec Consulting in Seattle.

An ecosymposium was instrumental in establishing clear goals.

An elevated running track uses radiantly cooled tubing.

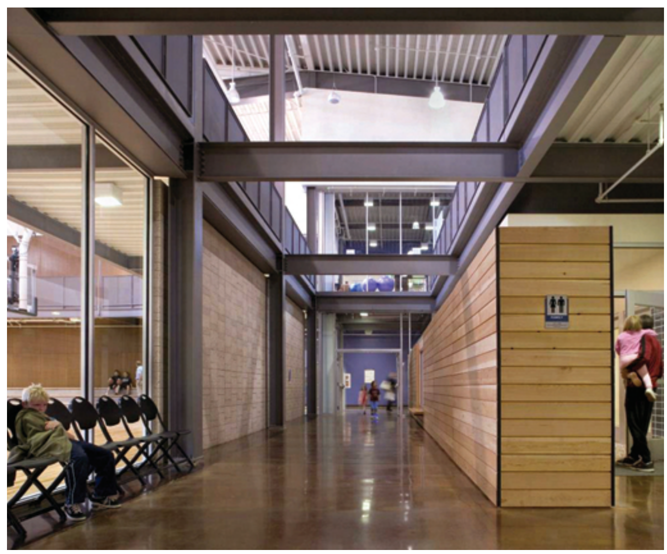
engineering firm to provide thermal modeling for the natural ventilation helped refine the design. The final shape and position of the building is a result of careful engineering analysis of the existing trees, solar orientation, prevailing wind direction, natural ventilation objectives, noise from the adjacent street, and program requirements.

Large-scale models with a variety of roof monitor and sunshade configurations were carefully evaluated for daylighting and solar performance using the BetterBricks Daylighting Lab's artificial sky and the engineering firm's three-dimensional thermal model. The engineering firm created a three-dimensional model simulating air patterns and space temperatures to inform the design and to refine the natural ventilation systems and building's final shape, siting, and orientation.

Early in the integrated design meetings, goals were identified including maximizing transparency between spaces, using daylight throughout the entire building, reinforcing opportunities for passive cooling, creating strong connections to the natural surroundings, and providing a welcoming open display of recreation and community spaces. This engineering analysis resulted in a long, thin building footprint that allows for daylight and cross ventilation, while creating a large protected south-facing courtyard. Smaller courtyards of varying scales bring daylight, fresh air for natural ventilation and nature into the interior to provide a place for casual activities and special events.

Thermal modeling and daylight modeling allowed the mechanical engineer and architect to collaborate on optimizing the amount of glazing, number of operable windows, building thermal mass, indirect lighting, and overall building envelope. This integrated design process resulted in cost analyses to determine approximate operating costs versus construction costs to select the appropriate building construction materials.

The heavy mass exposed steel structure, concrete masonry unit (CMU) walls, and concrete floors reduce the need for additional interior finishes while providing the necessary thermal mass for the natural ventilation strategies. Exposed, colored ground



A corridor offers natural light for clerestory.

face CMU piers provide thermal mass for summer cooling and a beautiful durable interior finish. Polished concrete used with heated radiant floor slabs maintain comfortable temperatures during heating season. Solar gains were eliminated through the use of overhangs, as well as exterior shading devices. Indirect lighting reduced lighting heat gains to the space.

The final building elements and design achieved a cooling and heating plant reduction of more than 50% based on a traditional design. This high performance building design reduced overall energy costs. East-facing roof monitors provide deep penetration of daylight into the building and natural stack ventilation enhancing the interior comfort and ambience.

An elevated running track has radiantly cooled tubing for extra comfort. North-facing monitors on the gymnasium provide natural stack ventilation and provide daylight well into the building for balanced, glare-free natural light. In addition to complementing the natural ventilation strategies, translucent skylights in the locker rooms bring daylight into an overlooked interior space. Energy savings are further improved by daylight sensors integrated with dimmable, energy-efficient lighting fixtures to eliminate using artificial lighting whenever possible.

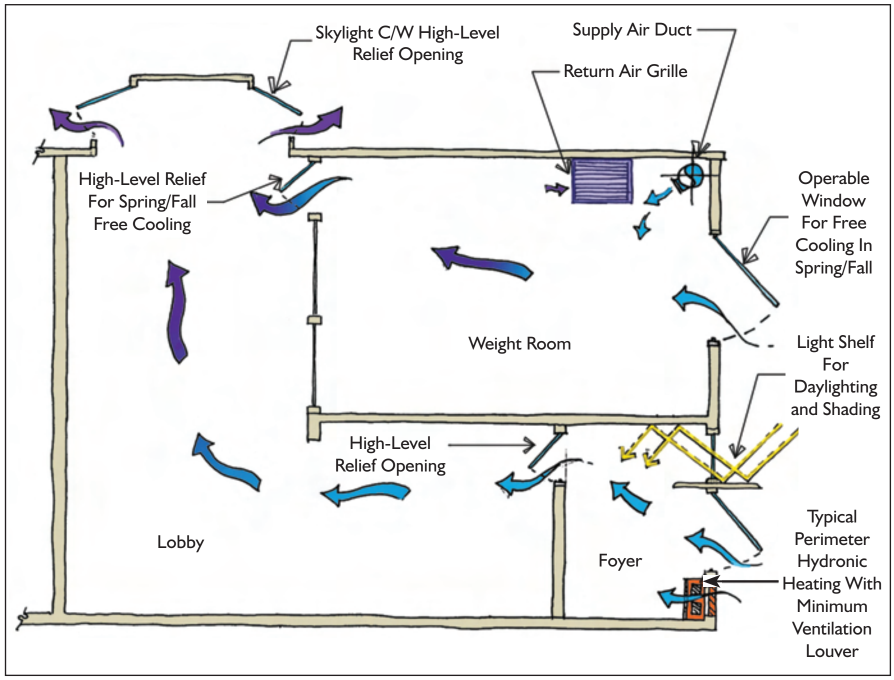
Overhangs, sunscreens, and adjacent mature fir trees minimize direct solar heat gain during the cooling season. Natural cross and stack ventilation combined with thermal mass, high performance glazing, and solar control passively maintains comfortable temperatures for most of the cooling season. Chilled radiant floor slabs provide additional cooling on only the hottest days with minimum energy consumption. Radiant heating and passive cooling eliminates substantial need for ductwork.

Most of the building has operable windows with low-level trickle vents or ducted minimum ventilation. The trickle vents or ducted ventilation provide the minimum ventilation requirements whereas the operable windows and sliding doors provide free air cooling with maximum user control. The minimum ventilation is made efficient by the use of CO_2 sensors.

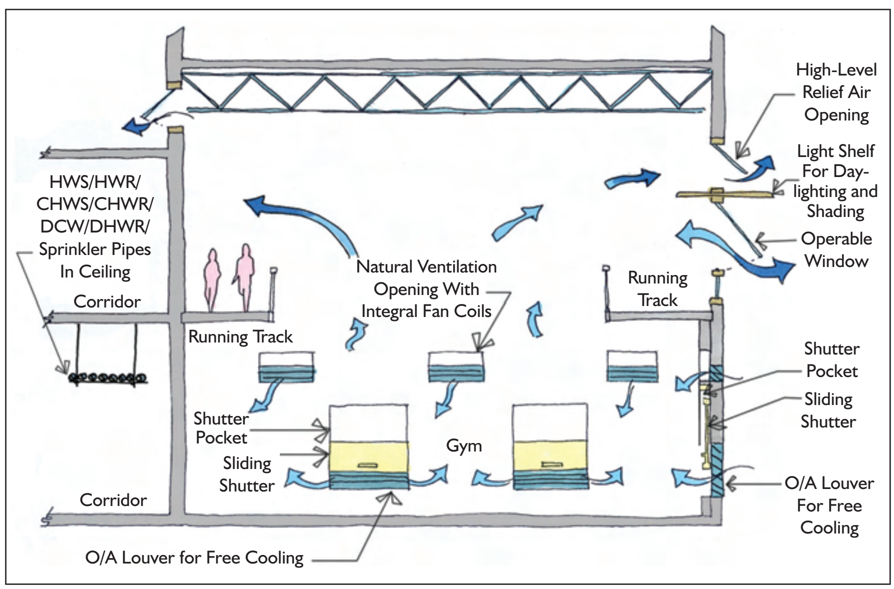
Energy targets required to achieve the USGBC's LEED® Gold rating were a prime concern. Due to the diversity of activities in the facility, the design incorporated many mechanical systems to optimize energy performance. Natural ventilation, radiant heating, radiant cooling, central heat pump, and high-efficiency boiler systems were all incorporated.

As part of this integrated design process, the engineering firm created a three-dimensional model, collaborating closely with the architect on the optimum configuration for natural ventilation strategies. The simulated air patterns and space temperatures in the multiuse areas of the building validated that the spaces would achieve sufficient ventilation and air movement to attain comfort conditions nearly year-round. Based on the model results and extensive consultation with users, the owner approved a natural ventilation system for all general public spaces, gym, community rooms, and administration areas. In the winter, manual trickle vents supply the required ventilation to theses spaces. Cold air crosses over a baseboard heater to temper it before the air reaches occupants. Radiators work with the radiant floor tubing to provide radiant heating and individual zone room temperature control.

Automatically controlled roof monitors were installed at high levels to relieve the air from the space, as well as provide daylighting. In the summer, operable windows provide cooling for the spaces as air enters into the low-level windows and is drawn across the room into the high-level roof monitor, achieving free cooling. On extremely hot days, the radiant cooling reduces the increased heat gains. The water pipe temperature is only slightly below room temperature, enabling more efficient chiller plant operation. Thermal modeling also determined that with the control strategy of night purging and heat stratification the gym's thermal mass could achieve sufficient comfort conditions throughout the summer.

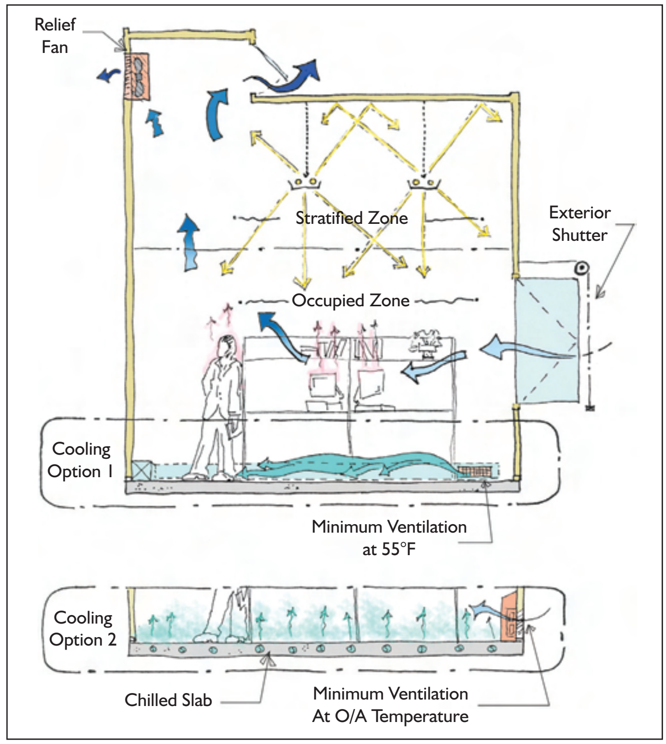


Natural ventilation schematic shows free cooling as well as a light shelf for daylighting.



Early concept sketch for fitness center's natural ventilation design.

Exterior view of natatorium. The natatorium requires ventilation.



Early concepts for hybrid HVAC systems.

In the spaces with large fluctuations in occupant levels and high impact use, the design incorporates a free cooling system, as well as a backup variable air volume cooling system. The community room, fitness, aerobics, and administration spaces use a hybrid design approach. Most of the year, natural ventilation with ceiling fans provide free cooling. However, when the room temperature exceeds the setpoint, the ventilation system provides supplemental cooling. CO_2 sensors control the ventilation air quantities.

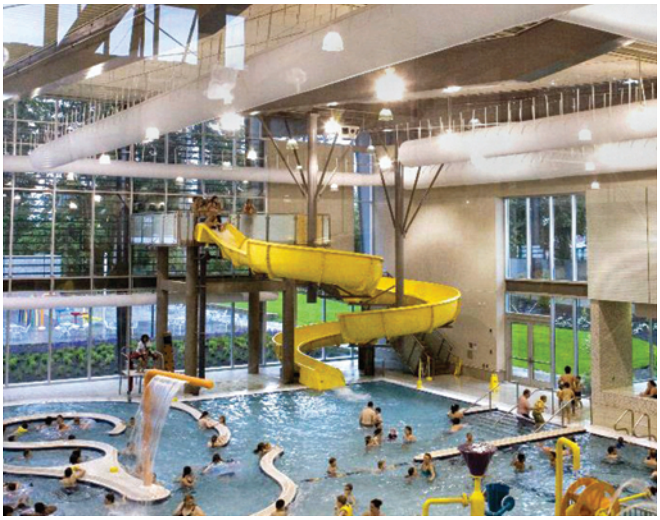
The changerooms require high ventilation rates to remove odors. The exhaust and returned air is ducted through a heat pipe coil that transfers approximately 60% of the sensible heat into the fresh air system returning to the changerooms.

The natatorium requires ventilation for dehumidification, occupant comfort, and chloramines contaminant removal. A cooling/dehumidification coil condenses moisture from the airstream, recovering the latent and sensible heat and allowing the drier air to be returned to the pool hall. The cooling coil is connected to a central heat pump, which rejects the recovered heat back into the pool, building, or domestic hot water. The natatorium uses low-level exhaust and ozone secondary water treatment to achieve proper indoor air quality. Airborne chlorine contaminants are heavier than air and capturing them at low level reduces the potential of odor spread. The natatorium ventilation system is designed to maintain a negative pressure, which also contains any chloramines from spreading into the adjacent spaces. The changerooms, washrooms, and storage rooms all have exhaust systems to prevent odors from transferring.

The building incorporated a central heat pump and condensing boiler to provide sufficient heating and cooling to the entire facility. In the summer, the heat pump provides cooling and excess heat is rejected to a cooling tower. In this facility the central heat pump can also take the waste heat and transfer it to the pool and domestic water, greatly reducing the boilers' summer run hours. In the spring and fall the cooling is provided through a cooling tower only, eliminating the need for operating the heat pump. In the winter the 96% efficient condensing boilers will provide heating for the entire facility. Energy use is anticipated to be at least 26% less than for a traditional recreation center.

Multipurpose room can be configured for many events held here.

Recreation facilities consume larger quantities of water compared to other commercial type buildings. In the Firstenburg Community Center, more than 92,000 gallons (348 258 L) of water are required to fill the pool. Health code requires everyone to shower before entering the pool. The pool decks and changerooms are hosed down with water two times per day at minimum. The design team reduced or recycled as much water as possible to cut down the city sewer loads. The ventilation



Natatorium space with overhead fabric ductwork.

Child-care area shows the natural light that enters the room.

system incorporated a dehumidification coil that removed the moisture from the airstream before exhausting the contaminated air to the outdoors. Water recycling strategies help to substantially reduce the large quantity of wastewater that would otherwise be discharged from an aquatic facility, while also reducing the quantity of potable water used for nonpotable needs. Pool filter backwash water is piped to a holding tank for use in flushing locker room toilets providing an annual water savings estimated at 500,000 gallons (1.9 million L). Ultra low-flow water conserving showerheads and lavatories combine for an annual water savings estimated at 300,000 gallons (1.13 millon L). Waterless urinals used throughout the facility provide an annual water savings estimated at 200,000 gallons (757 082 L). Total annual water savings are estimated at 1 million gallons (3.8 million L), providing an additional benefit of reducing energy for heating water and minimizing sewer discharge to public infrastructure.

The building performs as it was designed. The facility staff enjoys the simplified ventilation and sustainable aspects of the building. Local interest in the building led to a rapid selling of membership passes beyond the expectations of Vancouver. The project is so popular that the city is about to begin a new library adjacent to the Firstenburg Community Center.

One interesting post-occupancy metric collected by the City of Vancouver staff is that annual absenteeism is significantly lower for the Firstenburg Center relative to two similar community centers the city operates that were not designed with natural ventilation or to maximize daylighting.

	As Designed	Energy Code Baseline	12-Month Utility Data
Total Annual Energy Use, kBtu	13,833,000	18,915,500	12,913,953
Annual Energy Cost	$203,813	$242,806	$217,388.61

Table 1: Overall results for modeled cases and actual utility data collected over 12 months.

Is the integrated process and subsequent reduction in mechanical system costs an effective sustainable strategy? In 2003, a thermal model based on LEED bounding parameters for comfort was used to determine that the natural ventilation areas will be maintained within an acceptable thermal comfort zone. Natural ventilation substantially eliminates the need for a conventional mechanical ventilation system.

As a result of the integrated design, the building has obtained LEED-NC Gold certification. The building's design received the following points: 11 out of 15 for indoor air quality, 4 out of 5 for water efficiency, 6 out of 17 for energy and atmosphere and 4 out of 5 for innovation and design process.

In 2006, a model of this building, based on construction documents and documented operating assumptions, was used to compare energy consumption against a Washington State Energy Code baseline model using ANSI/ASHRAE/IESNA Standard 90.1-1999 methodology. The model showed 26% energy savings compared to the baseline model. Predicted overall annual energy consumption was 19.1 kBtu/ft^2 (216.9 MJ/m^2).

Exterior horizontal shading.