Elevating Performance

BY ROBERT MISEL, AIA

Extensive glazing on the building’s north elevation provides an abundance of natural light to the open office spaces. The lobby ceiling displays canvas oil paintings by local artist Frank Samuelson. The series depict salmon migration from ocean to stream.

“The care, concern and environmental sensitivity that went into the construction of this new structure set it apart from nearly any other government building in the region, and it expresses its own statement about the people of this community.”

A steep hillside turned out to be an important part of achieving sustainable goals for a project in Kitsap County, Wash. The 54-ft change in elevation had to be eliminated to ensure the site’s sustainability. However, the building team took advantage of the natural features of the site for the county’s administration building.

The team recognized that the steep site provides not only an inherent opportunity for earth sheltering, but also for rainwater harvesting, daylighting of interior spaces and natural ventilation. The building is designed as a series of stepped terraces arranged around a central vertical circulation core. Designers incorporated a water conservation system that collects rainwater from the vegetated roofs and stores it to provide site irrigation.

The Kitsap County Administration Building creates a pedestrian link between the adjacent courthouse and public works buildings. The terraced floor plates reduce the scale of the building toward the surrounding neighborhood while maintaining a civic presence towards the county campus.

Kitsap County pursued an integrated design that incorporates sustainability into the larger design process. As a result, the building team was able to push the boundaries of conventional HVAC systems and construction methodologies, reduce energy consumption, save water and create a building that contributes positively to employee performance and comfort.

**Design Process**

The design process began with an eco-charette where primary stakeholders met for a brainstorming session to set environmental goals for the building. These goals were tracked and evaluated throughout the project.

Managing and conserving site water became a primary goal. Miller|Hull collaborated with the landscape architect and civil engineer to develop a system for the capture and reuse of rainwater. By studying the weather and rainfall patterns in the area, and comparing them with the detention requirements and likely site irrigation needs, the building team developed a rainwater collection and detention system designed to provide 100% of the required site irrigation.

Terracing the building into the hillside allows for multiple, smaller floor plates with an open office seating plan. Operable windows provide access to fresh air.

**Even Daylight Distribution**

The building is oriented along an east-west axis. Limited use of hot, south-facing windows helps reduce the energy required to cool the building. Increased use of north-facing windows provides indirect natural light. Where windows were desired in spaces that faced the sun, extensive overhangs were installed to reduce glare and solar heat loads in summer.

Daylighting studies of the office spaces were performed to ensure all occupants had access to an immediate source of natural light. Narrow floor plates combined with interior sky lights guarantee the presence of natural light even into the earth sheltered portions of the building and reduce the need for artificial lighting.

Open office lighting is designed with linear fluorescent T5HO indirect pendants with 0–10 V dimming ballasts. Daylight zones are created near glazing walls and skylights. Each fixture length in the daylight zone uses integral daylight sensors to control the light levels.

This sensor integration eliminates the need for additional ceiling drops for separate sensors in the space, allowing for a cleaner installation. It also provides tighter control of each fixture length in the zone. Occupancy sensors are integrated into the control system and are cost effective since they eliminate wasted energy by turning lights off when room occupants forget.

**KEY SUSTAINABLE FEATURES**

- Rainwater collection and vegetated roof system
- Recycled Content Materials: fly ash cast-in-place and precast concrete, carpet, gypsum wall board, synthetic flooring and acoustic ceiling tile; construction debris was recycled
- Limited use of hot, south-facing windows, and increased use of north-facing windows; extensive overhangs where windows face the sun; light sensors at window areas
- Individual Controls: operable windows, task lights at office desks, and individual airflow control in cubicles
- Tinting of floor plates and thermal mass
- Indoor air quality sensors in conference rooms; low- and no-VOC materials used in construction
- Natural Ventilation: fan-assisted natural ventilation; light illuminates in the office and an e-mail is sent asking occupants to open the office windows
- Underfloor air distribution

**The main lobby space connects all five county departments and provides an overflow area for the commissioner’s chamber.**

**ENERGY AT A GLANCE**

- Energy Use Intensity (Site) 71.1 kBtu/ft²
- Natural Gas 31.9 kBtu/ft²
- Electricity 39.2 kBtu/ft²
- Annual Source Energy 164 kBtu/ft²
- Annual Energy Cost Index (ECI) $1.40/ft²·yr
- ENERGY STAR Rating 77

**BUILDING ENVELOPE**

- **Roof**
  - Type: Modified Bitumen
  - Overall R-value: R-21
  - Reflectivity: 0.27
  - Type: Vegetated (Green)/Precast Concrete Plain
  - Overall R-value: R-23, plus thermal mass of soil/concrete
  - Reflectivity: 0.12

- **Walls**
  - Type: Limestone Clad/Concrete Masonry Unit (CMU)/Metal Stud
  - Overall R-value: R-11
  - Type: Concrete/Metal Stud
  - Overall R-value: R-15
  - Type: Cement Board/Metal Stud
  - Overall R-value: R-21
  - Building Glazing Percentage: 40% (including skylights)
  - **Basement/Foundation**
    - Basement Wall Insulation R-value: R-11
    - Basement Floor or Under Slab Insulation R-value: R-10

- **Windows**
  - U-value: 0.48
  - Solar Heat Gain Coefficient (SHGC): 0.37
  - Visual Transmittance: 61%

- **Location**
  - Latitude: 47.54°N (122.65°W)
  - Orientation: Building axis generally east-west
Thermal Mass
The concrete structure provides tremendous thermal mass, which minimizes temperature fluctuations throughout the daily cycle. Cast-in-place architectural concrete walls are exposed at the building core, and the precast floor planks are exposed at the perimeter of the office spaces, minimizing the amount of finish materials used. The thermal mass terraced floor plates and earth sheltering design help maintain a consistent temperature throughout the building. The earth cools the adjacent office space, creating an environment similar to a basement on a hot day. The consistent thermal mass contributes to the building’s energy performance; only one of the two boilers was activated during the first winter of operation.

Indoor Air Quality and Natural Ventilation
To take advantage of the mild Puget Sound climate, fan-assisted natural ventilation is incorporated into the design. The building includes four large open office areas that have a long north wall with operable windows.

“...One consistent theme in my discussions with occupants was the amount of available natural light, which they consider to be an attitude booster. I rarely turn on my office light due to the amount of natural light available in my office,” said Brian Lyman, AIA, capital projects manager, Kitsap County Department of Administrative Services.

The project’s commitment to sustainability continues outdoors. Photo sensors, in conjunction with a time clock, allow outdoor lighting to operate only when daylight is not available.

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During appropriate outdoor conditions, natural ventilation is used in these sections of the building to eliminate the need for air-handling and refrigeration equipment. Appropriate outdoor air conditions are based on a combination of the outdoor air temperature and solar/ internal building loads. In natural ventilation modes of operation, building occupants manually open the windows on the north face of the building. Air enters through the windows and is relieved through internal louvers located near the skylights, above the interior offices at the back of the floor plate. Natural ventilation modes are initiated by an e-mail to occupants notifying them that they may open their windows. Also, a red/green light signals appropriate conditions. Space temperature and carbon dioxide levels are monitored at all times, and natural ventilation mode is supplemented or terminated by forced air as ventilation is required. Indoor air quality sensors in conference rooms determine the necessary quantity of outside air delivered by the HVAC system based on the number of room occupants. Significant energy savings result from reducing the amount of outside air (which often must be heated or cooled) delivered to the spaces.

Forced air ventilation is similar to the economizer operation, but uses less energy. During normal economizer operation, air is delivered to the space by the ARUs. In the forced air mode, the operable windows throughout the building are opened and the return air fan pulls air across the space and exhausts it through relief louvers in the upper floor mechanical rooms. Fan energy is greatly reduced compared to traditional 100% economizer operation due to the much lower static pressure requirements.

**Underfloor Air Distribution**

The county did not pursue LEED certification, but was committed to a sustainable design approach. Early in the design process the building team decided to pursue an underfloor air-distribution system (UFAD). In early schematic design the energy life-cycle cost analysis (ELCCA) established a baseline UFAD and compared it to more traditional overhead variable-air-volume (VAV) and water-source heat pump systems. This analysis ensured that the building mechanical systems selected during design have the lowest costs over the expected life of the building. Several alternatives to the selected HVAC system design were analyzed to determine the estimated initial cost, energy consumption and maintenance costs. The UFAD allows for fine-tuned control by all building occupants via operable diffusers located in each open office cubicle. The UFAD approach relies on introducing slightly pressurized air in the space beneath a raised floor, instead of moderately pressurized air in an extensive ductwork system located in the ceiling space.
Water harvesting is a fundamental feature of the administration building. Almost a full acre of vegetated roofs manage site water and drainage by collecting, detaining and redirecting storm water runoff to a series of five cisterns located around the perimeter of the building. The cisterns retain the collected rainwater for site irrigation during dry months. During the rainy season, the vegetated roofs and cisterns serve as a detention system, slowly releasing the collected runoff to the city’s storm system. Costs of the cistern collection system were offset by omitting the detention facility from the project.

The vegetated roofs can be seen from every floor in the building. They help reduce storm water runoff, building mechanical costs and solar reflection. The green roofs consist of a 6 in. soil profile atop a series of collection mats, fabric and rigid insulation. The green roof system and on-grade site plantings are irrigated with a high-efficiency drip irrigation system, which helped establish the plants during the first year.

The irrigation system features water-efficient irrigation fixtures and a rain sensor. It schedules watering in the evening and early in the morning to prevent unnecessary evaporation. The plants only require water in the driest of times.

The vegetated roofs consist of drought tolerant plants, a 6 in. soil profile, 4 in. of rigid insulation and a precast concrete plank structure. Rainwater collected in cisterns irrigates the plants during dry months.

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The ELCCA results indicated that the selected UFAD system would have an estimated life-cycle cost savings of $175,000 to $330,000 versus the traditional alternatives that were considered.

Alternative 1 would replace the underfloor system with conventional overhead ducted fan-powered terminal units with hydronic heating coils. Alternative 2 would replace the underfloor system with water source heat pumps. The chiller is replaced with a cooling tower.

The ELCCA results indicated that the building was performing as was intended, despite passing through the raised floor. This was a difficult endeavor due to leakage will always occur in raised floor plenum distributions systems (as is true in all ducted systems)

The objective is to avoid “bad” leakage. Bad leakage is defined as air that leaks out of the raised floor plenum and bypasses the intended occupied space. The plenum must be properly sealed to prevent this occurrence.

“Good” leakage is classified as air that does not go through the floor diffusers into the room, but passes through electrical boxes in the raised floor, the seams in the floor tiles, etc. Leakage is considered good since it still enters the occupied space at a low level helping condition and ventilate the occupied areas. However, most of the air supply should come up through the supply diffusers as designed. It became clear that everyone owned responsibility for maintaining the integrity of the underfloor plenum.

Adjustments The first year of utility bills identified an unexpected significant increase in energy use above the anticipated baseline. Since the baseline model was not a code baseline, it’s possible the model may not have considered things such as exterior site/garage lighting and cistern irrigation pumps. The energy use may also be related to a learning curve for occupants and users of the building. For example, facilities managers originally programmed the DDC so the HVAC system to run 24 hours overall temperature on its own, and that allowing the HVAC system to run 24 hours

Overall, this mechanical system will save the county about 10% annually over an overhead ducted system and more than 40% annually over a heat pump system.

In the UFAD baseline system, air handlers are variable speed and have hydronic heating and chilled-water coils. Heating water is provided by two gas-fired condensing boilers. Chilled water is supplied by an air-cooled chiller. Air is supplied to spaces either directly from the air handlers or through underfloor terminal units with hydronic heating coils. The DDC system is the most comprehensive of all county buildings.

Making these goals a priority early in the design process made them achievable. Had these goals not been established early, they would have been too expensive to implement later because they would have required wholesale changes to the design.

The measures taken to ensure a healthy and productive working environment for Kitsap County employees has resulted in better indoor air quality and an opportunity to enjoy natural light and ventilation. Employees work in a building that is flexible and functional and uses resources wisely. They can take pride in the building, which contributes to the quality of service that county citizens receive.