People love their libraries and nearly 50 years after the Oak Forest Neighborhood Library opened, nostalgia remained for the mid-century architecture. But, the brick and glass building was undersized, inefficient and inaccessible, no longer meeting the Houston Public Library system’s standards or the needs of the neighborhood residents. The decision to save the Oak Forest Neighborhood Library due to the historic significance of its mid-20th century design was the first important step in its sustainable redesign.

Oak Forest Neighborhood Library, which first opened in 1961, was originally designed by Goleman & Rolfe Architects to focus on a tree-filled site with an open plan and custom modern furnishings. This facility, dubbed a “modern milestone” in recognition of its architectural style, was also the proud recipient of the half-millionth book of the Houston Public Library (HPL) system upon the library’s opening, according to Houston Chronicle archives.

However, a half-century later, the library’s original layout was no longer ideal for users. All age groups shared a single space for stacks, reading and computer access. Public entry on the north was completely disconnected from the shaded lawn and neighborhood on the west, and the single large reading room windows overlooked unattractive strip center parking.

The renovation design team tackled these problems by adding new wings and a second entrance while preserving the facility’s architectural style.

### Integrating Old and New

The library today includes a 4,500 ft² addition and the completely renovated 7,500 ft² original structure. New adult and teen wings define the public service zone to the south, giving the children’s access to nature and reuniting the two entries.

When Built: 2011

Total Renovation Cost: $3.6 million

Expected (Design) Occupancy: 12,000 visits per month

Percent Occupied: 100%

Conditioned Square Footage: 12,000

AIA/ALA Library Building Award, 2013; LEED Gold NC v2.2, 2011

When Built: 1961

Major Renovation 2011

Renovation Scope: Renovation of 7,500 ft² and addition of 4,500 ft² including HVAC, envelope, bathrooms, lighting

Total Renovation Cost: $3.6 million

Cost per Square Foot: $300

Includes site work
second entry and outdoor reading room framed by new dedicated adult and teen areas on the west. Each age group now has appropriate facilities, furnishings and technology, ranging from early-literacy computers for toddlers to video game consoles for teens to quiet space with contemplative garden views for adults.

**Site**
The site, which was remediated during the renovation to address asbestos in the building, is located in a dense development with access to area services, businesses and four bus routes within one-quarter mile of the building. Bicycle racks and shower facilities for employees help reduce reliance on automobiles.

No new parking was added, open space was maximized, and the project includes a roof with a Solar Reflectance Index (SRI) value of 95; each helped reduce the overall heat island effect. The SRI value is a measure of a surface’s ability to reflect solar radiation; a standard black roof would have an SRI of 0 and a standard white roof would have an SRI of 100.

**Innovation**
The project received several LEED Innovation in Design credits that helped propel the project to exceed City of Houston sustainability goals, which specify LEED Silver certification for all its major new and renovated buildings. One Innovation in Design credit was received for exemplary tree preservation. The project saved 14 existing trees from removal. The mature existing trees are integral to the project design, providing shading and surrounding an outdoor garden and reading deck that the lobby, teen reading room, and adult areas all overlook.

Other Innovation in Design credits were received for educational outreach, exemplary performance for water use reduction and exemplary performance for green power. The design team provided a case study and tour guide so visitors could learn about the sustainable aspects of the building. Low flow shower heads and lavatories with a 10 second operating cycle, dual flush water closets, and low flow urinals account for a calculated 40.9% water use reduction from baseline.

The electricity for this building comes from the City of Houston, which has a two-year contract to purchase 140 MW of renewable energy, making Houston the largest municipal buyer of renewable power in the country. The city negotiates the fixed price for a citywide bulk energy, landfill gas and coal refuse, and has a contract with Reliant Energy, which owns or purchases power from generation assets that use renewable energy sources including wind, solar energy, landfill gas and coal refuse.

The double height lobby allows librarians to have good visual connection to all of the library areas and both entries. The interior and exterior of the upper walls are wrapped in ipe, a weather-resistant hardwood from Central or South America. A custom circulation desk mimics the shape of the exterior reading deck.

**Renovation Savings**
One way municipal building owners can be environmentally responsible is to maintain and renovate existing buildings to both save the embodied energy in the building materials and maintain the cultural memory of important civic buildings.

Perhaps the most sustainable aspect of this project is the building reclamata. Renovating the existing building shell allowed 1,314,000 MJ of embodied energy to be saved by reusing the existing concrete foundation, clay tile walls, brick cladding and steel structure. In addition, 212,000 lb of building materials were kept out of the landfill. In fact, 88.6% of the existing wall, floor, and roof elements were maintained in the new facility, which reduced the overall construction cost compared to a similarly sized newly constructed facility. The estimated cost savings resulting from renovating the existing structure rather than building an all new building was between $1 million and $1.5 million (savings calculated after construction was complete).

**Energy at a Glance**

- **Annual Energy Use Intensity (EUI)** 40.9% predicted improvement over LEED v2.2 baseline
- **Annual Source Energy** 233 kBtu/ft²
- **Annual Energy Cost Index (ECI)** $1.81/ft²
- **Annual Load Factor** 47.24%
- **Percentage of Power Represented by Renewable Energy Certificates** 100%
- **Number of Years Contracted to Purchase RECs** Two years
- **Heating Degree Days (Base 65°F)** 2,338
- **Cooling Degree Days (Base 65°F)** 3,449
- **Annual Hours Occupied** Approx. 1,750 hours

**Water at a Glance**

- **Annual Water Use** 390,000 gallons; 40.9% predicted improvement over LEED v2.2 baseline
efficiently than the original building). It is not clear if this lower than expected building performance is due to occupant activities or operation. Annual Energy Use Intensity (EUI) is 69.66 kBtu/ft².

**HVAC**

The existing HVAC system was removed and a completely new system, using high efficiency units with air pretreatment and dehumidification, was installed to serve the new and renovated space. The new HVAC system serving the 12,000 ft² library includes a 15,400 cfm Texas north and is oriented along an east/west axis. This orientation was maintained, though the building now opens to the largely shaded west garden.

The building is designed to save 29.2% in energy cost savings relative to California Title 24-2005 baseline building. Even though the building was commissioned, actual building performance has not kept pace with that model (though it is still operating about 25% more efficiently than the original building).

**KEY SUSTAINABLE FEATURES**

- **Water Conservation**: Low flow fixtures used throughout. The building uses 40.5% less water from calculated baseline.
- **Recycled Materials**: Recycled rubber flooring throughout. Reused existing building foundation, structure and shell. Reused bricks from exterior wall removed to make way for the new addition.
- **Daylighting**: 75% of occupied spaces; daylight harvesting system installed in open areas.
- **Individual Controls**: Workstations in office areas provided with LED task lighting with occupancy sensors.
- **Transportation Mitigation Strategies**: The library is located on a previously developed site that is well connected to area services and served by four public transportation bus lines. Bicycle racks and shower facilities are available for employees.
- **Other Major Sustainable Features**: Building reclamation, green power sourcing and regional and recycled materials.

**SITE LAYOUT**

The light gray area indicates the existing building. The yellow rectangle is the new double height lobby, and the two blue rectangles are the new reading rooms for adults and teens.
with a direct expansion cooling coil, 40-ton condensing unit, and electric duct heaters. Outside air brought into the building is pretreated and dehumidified, cooled or heated by a 100% outside air unit.

Moisture is removed from the outside air before it enters the building. This effectively controls the humidity in the building. Any moisture generated in the building is removed by the cooling coil in the air-handling unit.

The return air flows through face and bypass dampers, which direct the air over the cooling coil, or bypasses the cooling coil, and is mixed back together with outside air, then delivered to the spaces. A constant air temperature leaving the coil ensures that the coil is dehumidifying at any load condition. When the outside air temperature drops and cooling is no longer required, electric heaters in the ductwork downstream of the air-handling unit are energized.

The system in the original 7,500 ft² building was a single zone, constant volume air-handling unit, which used chilled water cooling to chill the air and boiler heat to reheat the air to maintain room temperature. Before the renovation, the chilled water system had been changed to direct expansion cooling with air-cooled condensing units. The original system was efficient for the early 1960s, but is not efficient by today’s standards. The new system serves energy by delivering constant volume airflow at a low pressure. The mixed air temperature is closer to the room temperature, which allows for better air mixing and better comfort control.

The dehumidification unit uses a desiccant to remove moisture from the air. The desiccant is recharged by the condenser heat from the cooling cycle in the unit. The energy used for cooling the outside air is also the energy used to dehumidify the outside air. This is a very efficient way of conditioning 100% outside air.

Envelope

The original thermal envelope also needed enhancement. The original single glazed window wall was removed. The new window wall system uses thermally insulated clear glass with a ceramic frit panel on the upper levels to reduce heat gain.

LESSONS LEARNED

Early Investigations of Existing Conditions Can Help Control Costs. During construction, the building envelope was found to be deteriorated and in need of repair. This led to some time delays and change orders. The City of Houston’s General Services Division and the Houston Public Library (HPL) conducted a thorough investigation, including coring the roof of existing buildings during the early design phases, so any replacement can be part of the original construction documents and contract.

Protecting Existing Trees Can Require Extra Care. The project team saved 14 existing trees, exceeding the City of Houston’s requirements for tree preservation. The design team provided a detailed tree preservation plan, which made the requirements clear. The plan aimed to keep construction away from the root systems of the existing trees.

Hand digging for utilities and foundation was required to prevent harming the root systems of the trees. The project team saved 14 existing trees, exceeding the City of Houston’s requirements for tree preservation. The design team provided a detailed tree preservation plan, which made the requirements clear. The plan aimed to keep construction away from the root systems of the existing trees.

The percentage of glazing is 34%, with full height glass walls facing the public entries and largely solid brick walls facing the nearby adjacent structures. The new window wall system has 64% visual transmittance, a solar heat gain coefficient of 0.27 and an effective U-factor of 0.28.

The original building exterior walls did not contain thermal insulation. As part of the renovation, insulation was added to all exterior walls, placed in a new metal stud wall that lines the interior. Additional insulation was added to the roof to increase thermal performance and to help with roof drainage. A fully adhered white thermoplastic polyolefin (TPO) roof, 60 mil, was placed over tapered polysioxyanurate insulation over 2 in. of polysioxyanurate insulation (4 in. at new construction) to create an R-25 assembly at new roofs and an R-19 assembly at existing roof areas. Limiting the thickness of the insulation at the existing roof was required to replicate the building’s original details and fascia profile.

Materials

Regional and recycled materials and low-emitting adhesives, sealants, paints, and composite wood are used throughout. Of the total value of building materials used in the project, 12.8% was manufactured within 500 miles of the site and 18.9% was manufactured with...
construction indoor air quality plan was also used during construction. MERV 8 and MERV 13 filters were used during construction, and MERV 13 filters were installed at the end of construction. Baseline testing, flushing with outdoor air and retesting was completed, bringing indoor air quality into compliance with the concentration limits before occupancy. Indoor air quality is further enhanced with carbon dioxide monitoring and heavy-duty stainless steel recessed walk-off mats that run wall to wall inside the vestibule at each entryway.

**Indoor Air Quality**

Even though low emitting products were used in the project, recycled content. In addition, 100% of the wood used in the project was harvested from Forest Stewardship Council certified forests.

**Lighting**

The new organization of the building also allows natural daylighting for 75% of occupied spaces, and the artificial lighting system has automatic controls, helping conserve energy when additional lighting is not required. The design team provided energy modeling on the daylight harvesting system for the direct/indirect lighting, which includes T5 and T8 fluorescent fixtures. The modeled system convinced the client to invest in the controls, which had a short-term payback period.

**Response**

The renovated library is very well attended, with about 12,000 visits by library customers per month; visits increased 32% after the renovation. The building also is a favorite for librarians to work in due to its light filled open spaces with views to the exterior.

Customers are happy the original building was saved and enjoy the new usefulness of the renovated facility. Roselyn Ford, an Oak Forest Neighborhood Library customer, told the Houston Chronicle before it reopened, “I love the fact that the library system listened to our suggestion to preserve the original look of the library, so when we’re able to start using the library again, it will still feel like home.”

**Conclusion**

The Oak Forest Neighborhood Library demonstrates that preserving and modifying older buildings can reap financial, environmental and cultural benefits. The renovated library now uses energy and water more efficiently while serving customers more effectively. While renovating older buildings sometimes requires additional measures to maintain site or architectural features, the end result for this library and the response by visitors easily justifies the extra attention required during the project.