CHAPTER/REGIONAL TECHNOLOGY AWARD - SHORT FORM

1. Category - Check one and indicate New, Existing, or Existing Building Commissioning (EBCx)

☒ Commercial Buildings	☐ New	☒ Existing or	☐ EBCx
Institutional Buildings:			
☐ Educational Facilities	☐ New	☐ Existing or	☐ EBCx
☐ Other Institutional	☐ New	☐ Existing or	☐ EBCx
☐ Health Care Facilities	☐ New	☐ Existing or	☐ EBCx
☐ Industrial Facilities or Processes	☐ New	☐ Existing or	☐ EBCx
☐ Public Assembly	☐ New	☐ Existing or	☐ EBCx
☐ Residential (Single and Multi-Family)			

2. Name of building or project: Indian Trails Public Library - Renovation and Addition

City/State: Wheeling, IL

3. Project Description: Renovation and Addition

Project Study/Design Period: 01/2015 (Begin date (mm/yyyy)) to 08/2017 (End date (mm/yyyy))

Percent Occupancy at time of submission: 100%

4. Entrant (ASHRAE member with significant role in project):

a. Name: Maze, Steve D. (Last) St. Mary, Robert N. (First Middle)

Membership Number: 5055868 (SDM) 5057609 (RSM)

Chapter: Illinois

Region: VI

b. Address (including country): 30 N. Wolf Road, Second Floor

Hillside (City) IL (State) 60162 (Zip) USA (Country)

c. Telephone: (O) (708) 236-0300 Email: bstmary@elaraeng.com

e. Member's Role in Project: Principal (SDM), Project Engineer (RSM)

f. Member's Signature: Robert N. St. Mary

5. Engineer of Record: Donald J. McLauchlan Donald J McLauchlan

By affixing my signature above, I certify that the information contained in this application is accurate to the best of my knowledge. In addition, I certify that I have discussed this entry with the owner and have received permission from the owner to submit this project to the ASHRAE Technology Awards Competition.

Indian Trails Public Library
Renovation and Addition

By Elara Engineering

Project Statement

Indian Trails Public Library, located in Wheeling, IL, is a two-story building originally constructed in the early 1980s with a two-story addition completed in the late 1990s, totaling approximately 41,085 sq. ft prior to this project. As part of this project, an interior renovation was performed on much of the existing library and a 15,200 sq. ft. two-story addition was constructed. At present, the building occupies approximately 56,285 sq. ft. and is comprised of large, open spaces for bookshelves, a maker space, several workrooms and offices, and training spaces.

In April of 2013, Elara Engineering was called upon to complete a mechanical evaluation of the existing Indian Trails Public Library systems, including identifying opportunities to improve performance and reduce energy consumption. It was observed that most of the building's equipment was approaching or had already exceeded its anticipated useful service life. Additionally, the entire facility utilized electric resistant heating and direct expansion cooling (DX), causing the building to incur substantial energy costs. During the evaluation, it was identified that the equipment installed as part of the original construction lacked reheat capabilities and as a result, outside ventilation air was only being provided in the summer. In the winter, the dampers were closed, and the building was receiving little to no mechanical or natural ventilation. Additionally, all original VAV boxes were cooling only with no means of reheat and had not been reconfigured to accommodate modified room layouts when the building addition in the 1990s was constructed.

Approximately one year later, Elara was enlisted as the mechanical, electrical, plumbing and fire protection design engineer for renovation of the existing library including the substantial new addition referenced above. The new heating, ventilation and air conditioning systems installed to serve the renovated library were designed to decouple the ventilation and space heating and cooling loads to maximize the operating efficiency of these systems and also ensure ventilation would be delivered to the spaces year-round.

A custom, dedicated outside air supply (DOAS) unit is responsible for providing ventilation air to fan coil units located in the ceilings of perimeter spaces based on demand (code required ventilation based on space usage and occupancy) and uses dual temperature water produced by water-to-water heat pumps for tempering the ventilation air before delivering it to the spaces. Dual temperature water is also supplied to the fan coil units for the heating and cooling of the perimeter spaces. The DOAS unit is equipped with a variable frequency drive (VFD) and utilizes carbon dioxide sensors within the building spaces to determine the ventilation requirements of the building and operate only to meet the required demand at a given time. Additionally, the DOAS unit employs an energy recovery wheel to recover energy from the exhaust air stream to preheat incoming outside air for improved efficiency and freeze protection.

Space heating and cooling for the interior zones is accomplished via a rooftop variable air volume (VAV) air handling unit that utilizes natural gas for heating and direct expansion cooling that operates based on the needs of the spaces. The VAV air handling unit supplies the interior zones of the library utilizing VAV boxes equipped with hot water reheat for individual zones.

The renovated library utilizes a geothermal well field consisting of 28 vertical wells at a depth of 450 feet each on 20-foot centers as its primary source of heating and cooling for space conditioning. The geothermal well field is situated northeast of the building in an existing storm detention area. A 20% propylene glycol water solution is distributed throughout the geothermal well field and piped to central water-to-water heat pumps located within the building's second floor mechanical room that produce dual temperature water for space heating and cooling via air handling units, fan coil units, VAV boxes and miscellaneous terminal devices located throughout the library.

Finally, the building's major mechanical equipment is controlled via a web-based, open protocol direct digital control (DDC) central building automation system with remote monitoring. In addition to providing enhanced maintenance, new DDC systems control equipment to operate more efficiently, resulting in improved

performance and energy savings. By operating the major heating, ventilation and air conditioning systems variably, the systems only operate to meet the requirements of individual zones based on occupancy rather than operating continuously regardless of how the space is being used. As a result, the energy that would otherwise be used during times of low or no occupancy is saved without compromising indoor air quality or comfort.

Justification for Claim of Excellence

Energy Efficiency: The use of high-efficiency equipment coupled with sustainable design, including the use of a geothermal heat pump system, and smart control contributes to a highly efficient building design. Significant energy savings were achieved by replacing electric heat with hot water reheat coils on the interior spaces and hot/chilled water coils on the perimeter spaces, all served by centralized water-to-water heat pumps tied to the geothermal well-field. The new systems resulted in an approximate decrease of 30% in energy consumption for the facility, despite an increase of 30% in square footage, totaling approximately 40-50% less energy usage than a typical library building. This significant reduction in energy resulted in a site energy use intensity (EUI) of 32.4 kBtu/ft^2/yr based on the performance energy model. Geothermal systems are one of the most energy efficient and environmentally clean systems widely used for space conditioning today since a majority of the energy used for the system is obtained from the ground as renewable energy.

Indoor Air Quality: Prior to this project, Indian Trails Public Library was subjected to poor indoor air quality due insufficient outside air ventilation during certain times of the year, inadequate VAV zoning, and poor temperature control due to the use of direct expansion cooling. Through the utilization of CO_2 sensors controlling the DOAS unit, demand-controlled ventilation is provided to all spaces and also significantly improves comfort. Additionally, as part of this renovation, the building spaces were completely rezoned to adequately accommodate both the existing spaces and newly constructed spaces. By converting the building from direct expansion cooling and electric heating to chilled water cooling and hydronic heating supplied by a centralized geothermal heat pump system, more consistent leaving air temperatures are provided off the coils, leading to a significant improvement in space comfort.

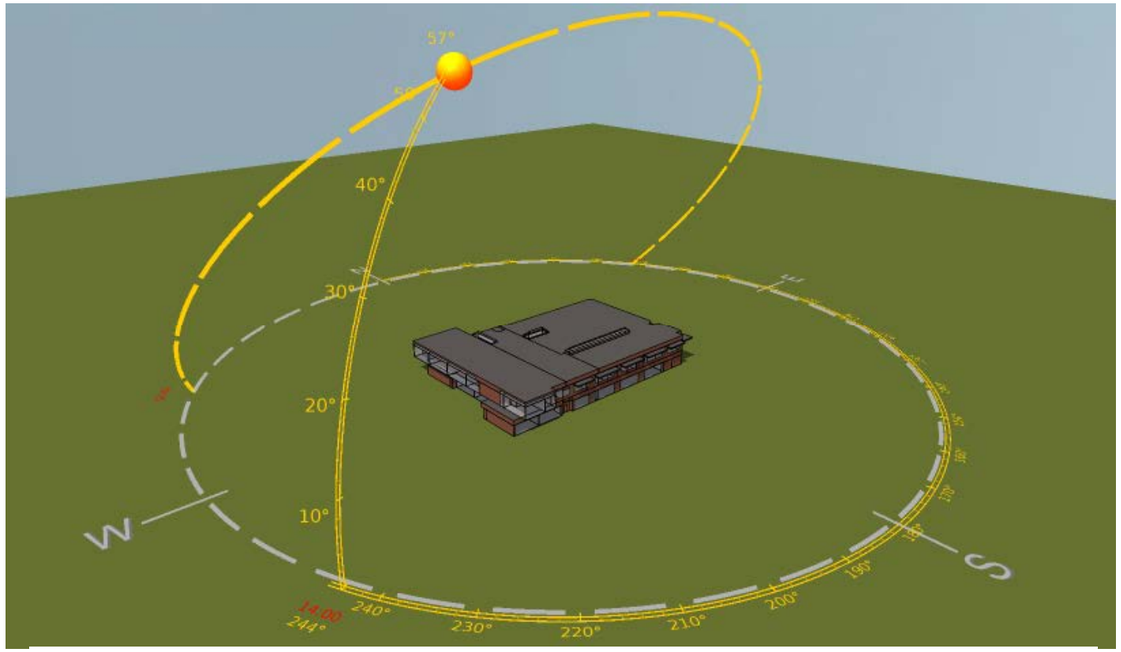
Innovation: The project used innovative sustainable design methods, including a geothermal heat pump system, to both transform existing spaces as well as new spaces where a high level of occupant comfort is achieved while operating efficiently.

Operation and Maintenance: The installation of energy efficient equipment with automated controls and proper service clearances improves overall operation, maintenance and reliability. The remote BAS monitoring system provides the ability to monitor and vary the output of systems in real-time. The implementation of web-based, open protocol DDC allows the end users to remotely modify, adjust, and correct problems with greater control of the system as a whole. Additionally, the geothermal heat pump system was designed in a way that optimizes serviceability and decreases future inherent maintenance by utilizing (2) centrally located water-to-water ground sourced heat pumps in lieu of distributed equipment throughout the building.

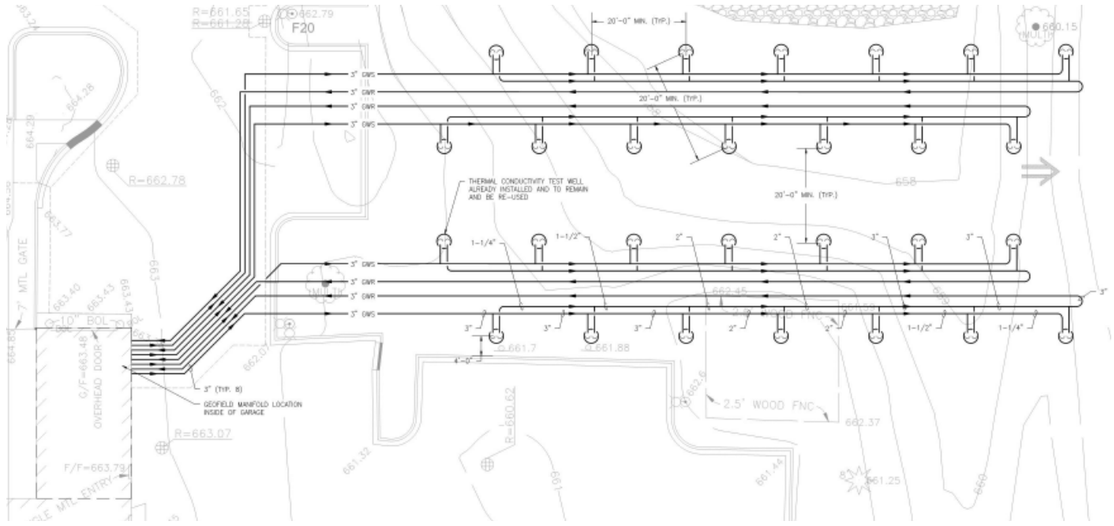
Cost Effectiveness: When the original building was constructed in the 1980s, Indian Trails Public Library was designed to utilize electric heat and pneumatic controls to keep initial construction costs down, which has greatly contributed to increased energy costs over the life of the facility. Through the conversion from electric to hydronic heating and cooling and implementation of smart controls, significant energy savings are realized, resulting in significant cost savings.

Environmental Impact: The selection of high efficiency equipment and sustainable systems minimized the overall utility input to the building. The operational abilities of the discussed mechanical systems significantly minimized energy costs that would otherwise be present in a conventional HVAC system. This translated into a clear reduction in the amount of harmful emissions expelled into the atmosphere. Additionally, geothermal systems do not burn fossil fuels and thus emit fewer greenhouse gases as well as eliminate the potential for carbon monoxide within occupied spaces. Due to the conversion of electric to gas heating, electricity savings are also a result of the project, thereby reducing overall carbon emissions. Using the energy model that was prepared as a basis for the renovation project, the project team was able to apply for and successfully received an EBSCO Solar Grant that will nearly fully fund installation costs of photovoltaic panels, further reducing the library's annual electricity expenditures upon construction completion in 2018.

Energy Model - Shading

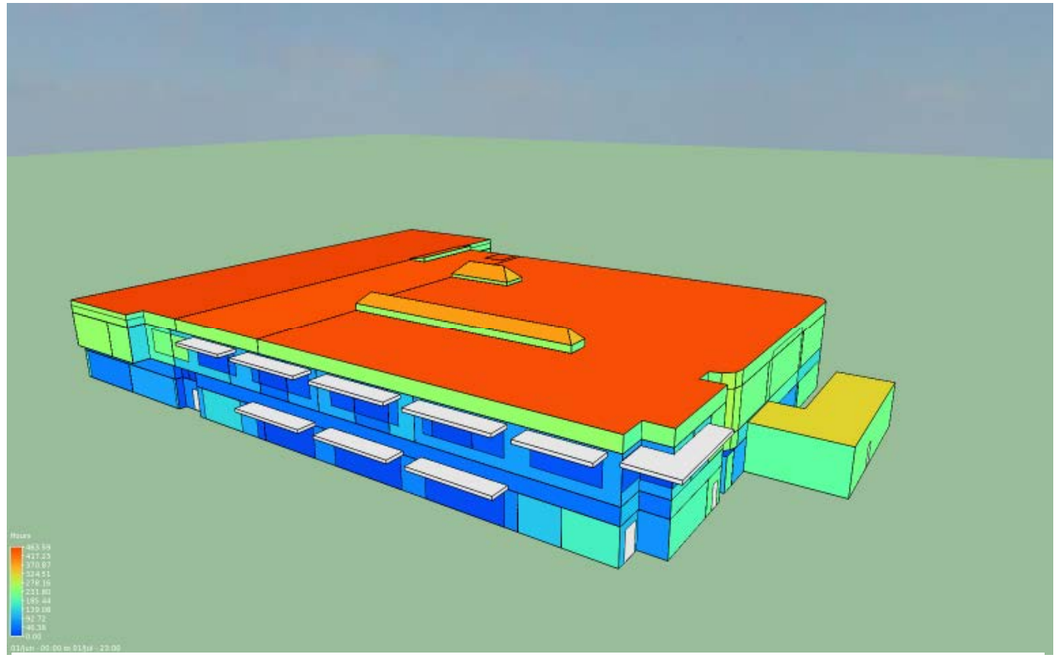


A 3-dimensional buiding model was constructed in the IESVE buiding analysis software, incorporating all building elements and thermal properties



Geothermal Well-Field Layout

Energy Model – Solar Loads



Solar analysis of the building was conducted, taking into account the impacts of window overhangs and the building's self-shading features. As evident in the figure above depicting annual hours of solar exposure, window overhangs decrease the amount of solar expsoure compared to nearby surfaces, reducing solar gains and cooling energy.