Taking a pre-Civil War era building and making it “super efficient” is a unique challenge. The design team for the Wilfred Uytengsu Sr. Center was able to make this historic building useful for another 150 years and operate on 34.6 kBtu/ft²·year.

Originally constructed in 1857 on the Concordia Theological Seminary campus, the Wilfred Uytengsu, Sr. Center has been used for academic purposes continuously to the present day, and now houses the university’s administration offices. The materials used to build the original pre-Civil War structure are believed to include bricks crafted and fired on site, and timbers that originated from local forests. Indiana Institute of Technology, commonly known as Indiana Tech, acquired the campus in the 1950s and has conferred engineering and technology degrees since 1930. The building was constructed with a central core. Two side additions have different floor elevations, resulting in varying floor and window heights (Figure 1).

Envelope Improvements

In the renovation of the building, the existing exterior brick walls were repaired using salvaged brick from the demolished interior load-bearing brick walls that were no longer needed. To achieve a high R-value in the exterior walls, 1 in. to 2 in. of spray foam insulation was used on the inside face of all exterior walls; then 3 5/8 in. metal studs were offset 1 1/2 in. off the face of the interior brick. Doing this minimized thermal bridging issues through the exterior walls and helped to seal up the “leaky” brick shell. Blown-in wood fiber cellulose insulation was used within the exterior wall stud cavities and within the steel beams along the exterior walls. This isolated thermal bridging issues to only the 3 in. concrete slab floors that are connected to the inside face of the exterior brick walls. The overall exterior wall system provides an R-value of 24.

All of the existing window and door openings were maintained in an effort to retain the historic nature of the building and to bring in as much natural light as possible. Existing window assemblies were replaced with high performance double-pane, low-e metal-clad wood windows with an integral thermal break system.

All door frames were insulated to minimize air infiltration through the framing system. A whole-building blower door test and infrared imaging identified a few small infiltration areas around the building, so seals were tightened or adjusted. Seals at attic access doors were not tight, door sweeps on exterior doors needed to be adjusted, and

The renovation was completed in 2010. Salvaged brick is used in the construction of the new entry vestibules and monumental sign.

Above: Storm water runoff is used in the 1,000 ft² rain garden, which features drought-tolerant native landscaping. One hundred percent of the building’s storm water runoff is diverted from the city’s collection system. The garden serves as an alternative approach to traditional storm water management practices.

Opposite: The renovation was completed in Spring 2010. Salvaged brick is used in the construction of the new entry vestibules and monumental sign.
Wilfred Uytengsu Sr. founded the leading consumer foods company in the Philippines, Alaska Milk Corp., in 1972. Uytengsu, an alumnus of Indiana Tech, and his family donated $2 million for this project. Uytengsu died before the project was completed.

breaks were found in the weather stripping along the top of each door for the closer assembly. This test also helped identify that a large amount of air was moving through the new elevator shaft and that the attic access hatch door was not sealed at the top of the shaft.

The new roof system was constructed using a structural insulated sandwich panel system in combination with blown-in wood fiber cellulose in the attic spaces. This combined system provides an overall R-value of 40.

The acoustical impact of external equipment also had to be considered. With students and faculty walking from building to building, it was deemed important to not have any equipment on the outside of the building that would look unattractive or create noise that was disturbing to the campus.

The domestic hot water recirculation system extends down the wall to behind each lavatory to minimize the amount of water lost down the drain while waiting for warm water. A common concern with low flow faucets is that the small flow rate will delay the ability to evacuate the cold water sitting in the lines that is recirculated from the mains.

HVAC Systems

The system design for this project had many constraints due to the historic nature of the building that limited where equipment could be placed. Being on a college campus, land space is at a premium and there is no “back side of the building” to hide equipment such as chillers or a cooling tower.

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With limited space options, the design team and university looked to vertical well geothermal systems as the heating and cooling plant. The university secured a grant from the U.S. Department of Energy and partnered with a local heat pump manufacturer to connect the building to a new “community geothermal loop” that serves multiple buildings on campus.

Benefits of this system include the ability to hide the plant below ground and its energy efficiency. (The building’s geothermal field is below an adjacent yard, while the “community geothermal loop” is beneath several parking lots.) Additionally, the interior space required for this equipment was limited to a few ceiling locations and bulkheads.

The building’s HVAC system consists of eight geothermal heat pumps with a total cooling capacity of 20.6 tons, which equates to 571 ft²/ton of cooling. Each of the heat pumps is provided with an electrically commutated motor (ECM) supply fan and dehumidification control mode.

The heat pump controls use traditional methods to limit pump energy by using isolation control valves to reduce flow when the heat pump compressors are not operating. The heat pump circulation loop is supplied via a set of variable speed pumps that were configured during testing and balancing to maintain the minimum amount of pressure required to achieve design flow requirements for each heat pump.

Unlike many buildings with traditional hot water and chilled water systems, this building’s circulation pumps are programmed to shut off if no equipment is calling for water flow. This is easier to achieve in a heat pump system because maintaining a loop supply water temperature at the far reaches of a building is not important. This differs from a hot water loop system, which typically has several...
three-way valves bypassing coils to keep the loop maintained at a temperature that will not delay the response of calls for heating or cooling.

With heat pumps, as long as the loop is maintained between 45°F–90°F, there is no reason to move water when there are no units actively calling for it because they can operate with much wider loop temperatures. Based on the first year of operations, the main pumps are turned off approximately 20% of the time with no call for water flow.

**Standby Mode**

To save additional energy, the heat pumps go into standby mode when the lighting system occupancy sensors determine that a space is unoccupied for at least 20 minutes. Once this occurs, the unit’s supply fan shuts down, and the space temperature setpoints change to allow for a wider dead band in an effort to prevent the compressor from running to maintain an empty room. The typical dead band used in the building is ±2°F. However, when in standby mode, this is changed to ±4°F.

The gray area in Figure 2 indicates when the occupancy sensor detects people in the space and normal sequences are followed. The black regions indicate time periods when a 20-minute interval of no occupancy was determined, and the heat pump went into standby mode. The heat pump supply fan is shut off because a dedicated outside air supply system provides the required minimum airflow separate from the heat pumps to each space.

The fireplace in the lobby uses bricks reclaimed from the demolished interior load-bearing walls.

To minimize thermal bridging through the exterior walls and to help seal the "leaky" brick shell, 1 in. to 2 in. of spray foam insulation was used on the inside face of all exterior walls. Then, 3 5/8 in. metal studs were offset 1.5 in. off the face of the exterior brick.
Each heat pump has a dehumidify mode to assist controlling humidity. Trends show that relative humidity levels are maintained at 55% during the summer in all spaces.

The dedicated outdoor air system also has an enthalpy recovery core to limit relative humidity in the outside air to each space. The DOAS runs according to the occupancy schedule.

**Lighting**

At the time of design for this project, LED light fixtures had limited options and cost a premium compared to traditional fluorescent technologies. The decision was made to use LED fixtures in all occupied spaces, with a few fluorescent fixtures in service areas that would be used very little.

The LED fixtures consist of a combination of 2 × 2 lay-in style fixtures as well as recessed cans. All of the fixtures are dimmable and provide full user control in each space.

Typically, the time delay used before turning off the lights is based on determinations of energy use as well as lamp life for traditional fluorescent lamps. Data from Philips¹ and other lamp manufacturers show that repeated on/off cycles typically shorten the life of

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¹ Philips Lighting

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**Finding Space**

One of the challenges of renovating a historic building is finding space for new ductwork and equipment. Figure 1 shows that the side wings’ floor and ceiling elevations do not line up with the center core. Additionally, with a stair tower on one side and an elevator shaft on the other, pathways from the core to the side wings were virtually nonexistent, making duct routes tight.

In many cases, the ceiling design with decorative bulkheads was dictated by where the MEP systems had to run. One of the largest challenges in this building was where to put the central circulation pumps, water heaters, electrical panels, elevator equipment, etc. The original building from 1857 never had any of this equipment. No equipment room existed before the renovation and no space was available in the building to add one.

The residential furnaces that were put in during a past renovation were stuffed into closets and the unused third floor space. An existing crawlspace under the east wing of the building was excavated to provide a 9 ft high space and create a true equipment room for these systems. This is shown in Figure 1 as the blue shaded region in the lower left of the image.

The space was limited due to concerns that the original rubble stone foundations would be compromised. A ledge area was left to use for equipment that did not require vertical height, such as pumps and piping. The remaining area in the middle of the room is limited and is used for panelboards and as an elevator equipment room.

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**Figure 2 Standby Mode**

![Diagram of standby mode](image)

Advertisement formerly in this space.

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Northwest view of the Uytengsu Center. The building prominently sits in the center of campus. Exterior mechanical equipment was not an option due to the building’s visibility.
We used a highly sophisticated method involving a “cup on a stick” and “super-bright” flashlight to fake out the sensors to verify their operation. Doing so, we observed that the lights were in fact dimmed, and with the cup held over the sensor, the room lights came up to full output after a short delay. Again with the flashlight pointed into the sensor, the light output dropped down again. Given that none of the occupants could detect the lights were changing their output, we consider the installation a success.

Conclusion

When first contacted about improving the existing building, it was easy for the design team to see fluorescent lamps; however, this is not a concern with LED fixtures.

As a result, the control strategy is more aggressive and only allows for a two-minute delay before lights are turned off. This reduces energy for short trips to the water cooler, restroom, or co-worker’s office, most of which are within a normal time-out period of 10 or 20 minutes.

In a few cases, the sensors were turning off on staff who were deep in thought with little or no movement to keep the lights on, but as time passed, the self-adapting sensors became more accurate in detecting the occupants in the space. The control strategy extends to the hydraulic elevator that shuts down when not used. Lights in the cab also shutdown when unoccupied.

In a few of the spaces that have large amounts of natural daylight and no specific occupant to take ownership of the dimmer, daylight harvesting sensors automatically control the lighting levels. For the first several months, many questioned if the sensors actually did anything because nobody could detect if the lights actually dimmed or not.

Before the university purchased it in 1953, the campus belonged to Concordia Theological Seminary. A stained-glass window from the Concordia chapel was purchased from a private buyer and installed in the president’s new office on the formerly unoccupied third floor of the Uytengsu Center.
During the winter months the vestibule cabinet heaters were running to maintain temperature setpoints initially set too high and later adjusted to be in the low 60s. This error was partly due to the type of controller used. The adjustment knob does not have specific temperature markings, but a “colder-warmer” knob without graduated markings. This made it more difficult to set a specific temperature and required a few tries to get it set correctly.

Energy use during the first month of occupancy was higher than planned in part because the doors were propped open for several days during move-in phase and the university held a gala event over a weekend with several hundred visitors. As the building eased into fall, the loads started to match up with the models pretty well. As the winter months arrived, it took several months to realize that the vestibule heaters were not set properly, and once this was corrected, the consumption dropped quickly to follow the model more accurately.

The design team spent a day with the owner’s facilities staff to review all of the sequences to make sure that they meshed with the use and maintenance of the building. Taking the time to sit down and refine the design approach, and optimizing pipe routes, duct routes, type of motors, etc., all added a few cents here and there, but ultimately contributed to the bottom line savings.

Upon completing this project, the design team and owner now realize that the concept of just meeting energy code minimums is a good goal with renovations, but there is no reason to stop there. While it is easier to make a new building high performing, this project demonstrates that the existing building stock can significantly improve energy performance.

The team found ways to use fairly normal systems and components, but use them to the best possible advantage. Taking the dollars and focusing on a well-insulated building with high quality glazing systems and making sure that it really is a tight building was the first and most important step. Efficiency of equipment is important, but if the building leaks energy due to poor materials or construction methods, none of it will matter.

The commissioning team showed the value of repeated and persistent job site inspections to check that all of the windows were installed with the right sealants, glazing, and flashing. The use of blow door testing to identify leakage areas and address them was also part of the commissioning team’s approach to get the building as tight as possible.

The design concept of the HVAC system was simple: use energy efficient systems that physically fit in the limited building space and maximize the use of control logic to minimize the need for energy.

Simple concepts such as using occupancy sensors to control setbacks and optimizing schedules to meet actual needs rather than assuming that the design team knew the operations of the building all went into creating a design that is efficient and makes sense.

The team faced many opportunities to make a better building, but to what degree was unknown. As the owner and all of the design team members discussed options using the integrated design process, it became apparent that this more than 130-year-old building could be salvaged and operated with high performance systems to reduce its operating costs.

The original goal was to make it better and meet code, nothing more. When challenged to make it a high performance building and stay within a limited budget of $2.6 million, the team found ways to use fairly normal systems and components, but use them to the best possible advantage. Taking the dollars and focusing on a well-insulated building with high quality glazing systems and making sure that it really is a tight building was the first and most important step. Efficiency of equipment is important, but if the building leaks energy due to poor materials or construction methods, none of it will matter.

The commissioning team showed the value of repeated and persistent job site inspections to check that all of the windows were installed with the right sealants, glazing, and flashing, and repairs were made if necessary. The use of blow door testing to identify leakage areas and address them was also part of the commissioning team’s approach to getting the building as tight as possible.

The design and construction of this project provided the opportunity for the design team to challenge methods used for decades and ask “Does it have to be this way?” In many cases the team entered into a game of how to make it better without costing significantly more, seeing how far we could push the design and how far we could push the construction process. A few of the lessons learned include:

**LESSEON LEARNED**

**Outside Air Economizer.** The team was unable to include an air-side economizer in the design due to severe limitations on available duct routing space, ceiling cavities and locations for intake/relief louvers given that this was a historic building and the outside appearance was important. Because it was a historic renovation, we weighed the impact of the energy savings with an economizer against the historic cost to the building. Ultimately the energy side lost because history was more important than dropping the ceilings below the tops of the historic window elevations to fit the ductwork. We did route the ASHRAE Standard 62.1-2007 minimum outdoor air to each zone, and managed to find paths for this smaller duct in lieu of routing duct sized for 100% of the supply air volume.

**Lighting Adjustments.** After initial programming of the lighting controls and owner move-in, it was discovered that in most cases the occupants had their lights dimmed to about 70% of full output. Seeing this, the lighting controls were adjusted so that when the occupancy sensor triggered the lights to turn on, the lights would resume their prior light level and not default to 100%.

**Commissioning Is Key.** This project was fully commissioned and included the typical HVAC systems, but also included building envelope. The envelope was closely monitored during installation to make sure that flashing, sealants, tapes, etc., were all properly installed. It took several iterations from the construction team to find the best method of sealing the new windows against the 130-year-old brick openings and reducing water and air infiltration. As part of this process the building was tested with a blower door to reveal air infiltration and air leaks. The entire design and construction team went running through the building trying to find the leaks and found that exterior door sweeps were leaking due to never being adjusted after installation. The test also showed that the cut in the seals around the door closers at the top of the door were air leaks of leakage that needed attention. The building passed with flying colors. However, the team wanted to make sure the building was as tight as possible to prevent infiltration.

**References**


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