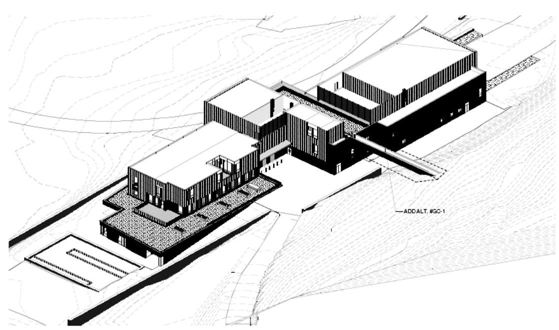
Thesis Proposal

Redesign Project

Slippery Rock University Student Union

Slippery Rock, PA



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Executive Summary

The purpose of this report is to summarize the information and conclusions found by research and calculations performed in the previous technical reports in efforts to redesign the mechanical system. This proposal will set the schedule, various systems, and techniques that will be evaluated throughout the spring semester.

The main topic of research for my overall building redesign is value engineering. My interested upon graduation include becoming a project manager for a mechanical contracting company. I therefore wish to investigate potential ways to decrease initial costs of the mechanical systems. Techniques used to do the cost analysis are included in the report.

Research to determine if a photovoltaic or solar thermal storage system can replace the green roof is also another topic related to the mechanical redesign of the building. A feasibility study is to be conducted to see benefits, if any, to this change in design.

The breadth work will be a result of the mechanical redesign. A structural analysis will be done to reduce the members further decreasing the materials needed and cost of construction. Therefore, a construction breadth will also be conducted. The purpose of the construction breadth will be to reduce construction time and implement cost savings. A tentative work schedule for the spring semester is also included at the end of the report.

Project Summary

The Slippery Rock University Student Union construction is currently underway with building completion estimated to be in late November of 2011. The 105,000 square foot building will serve many different types of activities and will house spaces such as a bookstore, kitchen, cafeteria, ballroom, theater, student lounges, and will also have numerous offices and conference rooms. The building is currently predicted to achieve a LEED Silver Rating.

The SRU Student Union will be used by students and faculty year round. The ground floor will contain the large bookstore and house all of the interior mechanical equipment. The second floor has spaces available to hold club meetings and conferences for the student organizations within the university. The faculty will also be occupying the building, with a portion on the second floor of the building dedicated into individual offices. The remaining west side of the floor will contain a full kitchen and dinning commons. A ballroom and theater room is located on the floor directly above the kitchen and dinning area on the third floor. The east side of the third floor will house the remaining meeting rooms.

The exterior landscape of the building will allow the students and faculty to have areas where outdoor seating is available. The SRU Student Union will hope to be the central meeting and gathering place of the campus.

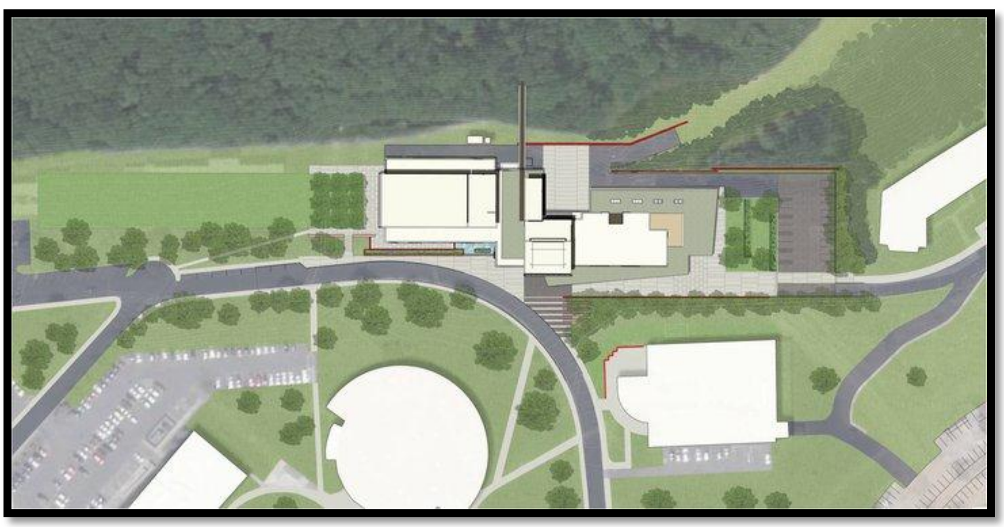

Figure 1 – Campus Site Plan

Mechanical System Description

The SRU Student union has occupational hours throughout most of each day and will be used throughout the entire year. With such a diverse environment, it is important to ensure comfort and wellbeing for the occupants throughout the long operation hours during all months of the year. In order to achieve this, careful planning was incorporated into the design to allow the occupants to have control of each space as much as possible.

In most cases, the building far exceeds minimum ventilation requirements set forth by ASHRAE Standard 62.1 and the minimum system efficiencies stated in ASHRAE Standard 90.1. The SRU Student Union is designed in order to obtain a LEED Silver Rating. To able to accomplish this achievement, efficient energy recovery units with a hot water heat transfer system are used with auxiliary back up. Both use steam from the university campus steam plant as a means to heat the water. Due to the different types of spaces in the building, simultaneous heating and cooling will be occurring, which allows for these units to run effectively.

Comfort is another major priority within the SRU Student Union. Each office, conference room, and lounge area in the building is equipped with a VAV box along with a thermostat so the individuals can have the space at their own comfort level. The nature of the building requires the larger spaces to be monitored by automatic controls to keep each space at a satisfactory temperature and humidity throughout the operational hours. When outdoor conditions are suitable, operable windows can utilize natural ventilation where applicable. With careful consideration, the SRU Student Union will be a safe and comfortable environment for the occupants.

Proposal

Overview

The Slippery Rock University Student Union is a well-designed facility using new and innovative technologies that have an expensive first cost. The purpose of my redesign will be to value engineer several systems that are contained within the building to cut down on the initial costs for the owner. Although efficiencies may be decreased resulting in a higher cost for operation, the overall savings from the value engineering hope to compensate for the increased operation costs. The building is hoping to achieve LEED Silver, with the redesign, I will investigate the possibility of still attaining a LEED rating.

Redesign Considerations

The redesign will consist of a total cost estimation of the current design. I will contact the mechanical contractor to attain a detailed cost estimate of the mechanical system. I will resize the energy recovery units to potentially less efficient air handling units to meet the minimum ventilation rates set forth in ASHRAE Standard 62.1. Currently, the ventilation rates far exceed the minimum requirements and therefore should be able to downsize the system while still maintaining indoor comfort and stability.

Next a look at the ductwork and piping runs will be analyzed. I plan to change the ductwork material to a cheaper alternative than sheet metal. I will also redesign the ductwork runs to reduce the amount of material consumed. Due to the change in the air handling units, less piping will be used from changing the hot water heat transfer system between the energy recovery units. By reducing these elements, the exhaust fans and pumps may have the opportunity to be downsized as well.

Finally, I will take an approach to determine if there is a benefit from replacing the green roof with either photovoltaic panels and or a thermal storage system. The maintenance and potential for issues with leakage into the spaces below pose the idea of replacing the green roof. Located beneath the green roof is the bookstore with vast amounts of merchandise and currently an energy recovery unit. If leakage were to occur, this could cause a great financial burden to the owner. A photovoltaic system or solar thermal storage system would decrease the mechanical construction time and also result in potential energy savings that would be lost by changing the energy recovery units to standard air handling units. A detailed cost analysis of replacing the green roof will be conducted to determine if there is any cost benefit to the owner.

Figure 2 – Photovoltaic Array

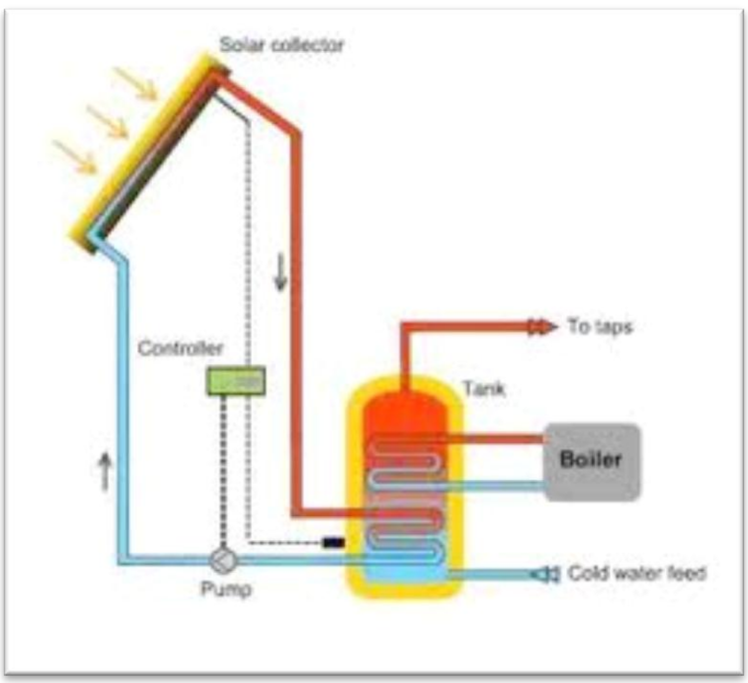

Figure 3 – Solar Thermal Storage System

Breadth Work

The breadth work portion of the proposal will be based off the redesign of the mechanical system. Because I will be investigating the system that will decrease the amount of materials used in the mechanical system, a construction breadth will be investigated. The investigation will look to decrease the construction time, cost, and installation of the project as a whole. Both the construction and mechanical redesign will have an impact on the structure of the building. Removing the green roof will result in current members to be oversized allowing for reduction in the structural system. Also, using fewer air handling units will reduce the load potentially resulting in a reduction in the structural system of the third floor to the roof. A study will be conducted to determine if a prefabricated floor system can be utilized, also decreasing construction time. Prefabricated walls panels will also be analyzed where applicable. As a result, this will tie in with the value engineering aspect to reduce initial costs of the building.

Figure 4 – Prefabricated Floor Panels

Project Methods

There will be a variety of methods used to perform the project redesign, most of which will be done by hand calculations. I will perform ductwork takeoffs by measuring the duct runs then figure out the gauge of sheet metal based on the dimensions of the ducts. Once I find the gauge, I will then be able to figure out the entire amount of sheet metal used and determine a cost estimate of the ductwork. I will then redesign the duct runs and explore different material types that could potentially replace the sheet metal at a lower cost. I will do the same with the piping in the hot water heat transfer system used between the energy recovery units. Then I will contact a vender to resize and change the energy recovery units to air handlers that are more cost effective. I will conduct a price comparison between the two types of units from the estimate received by the mechanical contractor. Once the major system equipment is finalized, I will look into potentially downsizing the fans and pumps to further decrease the total mechanical system cost.

Next, I will conduct a feasibility study of replacing the green roof with a photovoltaic array or solar thermal storage system. Using weather and solar data for the area and manufacturer data, I will determine whether or not it is worth replacing the green roof with the photovoltaic system or not. I will then do hand calculations from my solar thermal storage class to determine if enough hot water can be generated in order to be of use within the building. Space that will be saved by replacing the energy recovery unit on the first floor can be used as an area to contain the storage tank and equipment needed for the solar thermal system.

The structural analysis will be conducted by mostly hand calculations. I will perform calculations to determine the strength and deflection of the prefabricated floor slabs through the dead and live loads on the floor. The beams will be checked based on live and dead loads to ensure adequate strength and deflection. The columns will be resized based on the axial loads by using the tributary areas. In practice, the beam and column systems are typically oversized. This analysis will be able to decrease the amount of steel used resulting in lower cost.

The construction schedule will be analyzed based on the accelerated time that will be created from using the prefabricated slab panels. Microsoft project will be used to create a new schedule. A cost analysis will be computed based on the labor savings caused by the prefabricated slabs as well.

Predictions

I predict that the redesign will result in a reduced construction time and initial cost to the owner. Based on the current design, I feel I will be able to adequately reduce building materials. I believe that the efficiency may be decreased resulting in fewer points awarded for the energy and atmosphere criteria for LEED. Based on either the photovoltaic system or solar thermal water storage system, a portion of these points may be able to be retained.

Preliminary Research

The following list of resources was used to develop preliminary research. As the research progresses, more sources will be added to the list.

ASHRAE Handbook, HVAC Systems and Equipment. American Society of Heating, Refrigeration, and Air Condition Engineers, INC., Atlanta, GA 2004

ASHRAE Handbook, HVAC Fundamentals. American Society of Heating, Refrigeration, and Air Condition Engineers, INC., Atlanta, GA 2004

ASHRAE Handbook, HVAC Applications. American Society of Heating, Refrigeration, and Air Condition Engineers, INC., Atlanta, GA 2004

Beckman, Duffie (2006), Solar Engineering of Thermal Processes, John Wiley & Sons, Inc.

Tentative Work Schedule