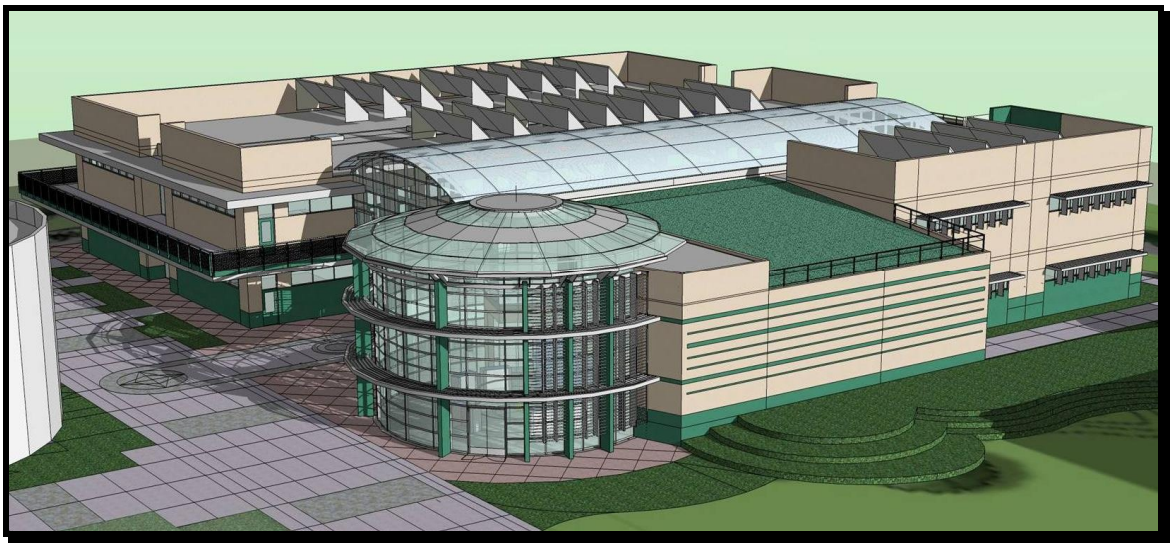
Thesis Proposal

Mechanical Systems Redesign



The Harker School - Science and Technology Building
San Jose, CA

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Mechanical Option

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Executive Summary

The Harker School is one of the top K-12 schools in the state of California located in San Jose, CA. The new Science and Technology Building is a two story, 50,000 ft^2 located on the upper school campus (grades 9-12).

The current designed mechanical system is an innovative direct/indirect evaporative cooling system with a traditional two pipe boiler. There are only a few systems of its kind currently in use in the San Francisco Bay Area.

In the November ASHRAE meeting, Donald Wulfinghoff gave a presentation which advocated the use of single zone systems in all buildings. This project offers an ideal chance to research and implement many of the ideas he talked about in his presentation, so a single zone system concept is proposed for use.

With the increase in number of air handling units needed to serve all the spaces, that means that there will be much more of a load due to equipment located on the roof. A study on the subject will be necessary. The current structural system will be analyzed and any changes that are needed will be researched further and the changes will be made.

Since most of the spaces have a main usage involving public speaking and lecturing, acoustical quality is a primary concern. Various spaces throughout the building will be analyzed acoustically to determine if any adjustment is required. If so, the proper alterations will be researched and completed.

Building Design Overview

The Harker School Science and Technology Building is located in San Jose, California on the school's upper campus (high school). It is a two story 50,000 square foot building which has a variety of offices, classrooms, and laboratories located in an East and a West wing. The two wings are separated by a double height open forum which is heated by a radiant floor system. Along with the previously mentioned spaces, the West wing also has a 192 seat lecture room, and a rotunda which has a large glass façade and roof.

Access to the East wing of the building is located all around the perimeter on the ground level as well as the second level via a cantilevered walkway that encompasses the whole wing including inside the rotunda. Sandwiched in between the classrooms and offices of both floors of the East wing are prep offices for the biology, technology, chemistry, and biology departments.

LEED Certification was a primary goal in the design process. Pending a formal review, there are enough points to achieve this. The Silver rating is possibly only a couple points away, however it is unknown at this time whether or not a higher rating will be pursued. There are also plans for a solar power system, but no timetable is currently set for its implementation.

Another goal was to minimize energy use and save on operation costs as much as possible. That is why a new cutting edge direct/indirect evaporative cooling system was selected for use in this project. There are only a few systems of its kind currently in use in the greater San Francisco Bay Area. It

has the potential to cut operating costs down to a fraction of what more traditional systems costs are.

Existing Mechanical System

Overview

The building is conditioned by three 100% OA air handling units which feed VAV boxes throughout the building. As previously mentioned, the forum connecting the two wings is heated by a radiant flooring system. Two gravity ventilators are used to cool the space as it is not conditioned by any of the AHUs.

The radiant flooring system is served by a single boiler which also serves the heating coils and reheat coils in the AHUs and VAV boxes respectively. Two pumps circulate the hot water through the system. One moves it throughout the building, and a second one moves it though the radiant flooring system.

Equipment

AHUs

There are a total of three AHUs in the building. They use a direct/indirect evaporative cooling system to condition the air along with a traditional 2-pipe boiler. They serve the classrooms, laboratories, and offices in the two wings of the building. AHU-1 serves the West wing, and AHU-2 and 3 serve the East wing

VAV Boxes

There are 33 VAV boxes serving the main rooms in the building. Located in the ceiling plenum, there are several types of VAVs depending on the CFM required for the space being served.

Boiler

There is only one boiler in the building. It is used to supply hot water for building heating to the VAV boxes, AHUs, and the radiant flooring in the forum.

Pumps

There are two pumps used to distribute the hot water from the boiler. The first one is located on the roof with the boiler which distributes the water throughout the buildling. The second pump is located on the first floor in the forum, and it supplies the radiant flooring system with hot water.

Gravity Ventilators

There are two gravity ventilators located above the doors at the South entrance to the forum for cooling purposes.

Proposal Objectives

The main purpose of the AE Senior Thesis is to analyze an existing building's system, and develop an in-depth redesign of the system based on the results of the analysis. The goal in this specific redesign is to try to obtain a lower first cost for the system while keeping the operating costs at or below the current system's operating cost.

One issue that arose in the first technical report is the requirements outlined by ASHRAE Standard 62.1 is that none of the three AHUs were compliant. The redesign will take place with this in mind, to ensure that all of the spaces are properly ventilated per the ASHRAE Standards.

Another purpose is to see the difference between a more traditional system and a newer system. The system currently designed for The Harker School Science and Technology Building is a direct/indirect evaporative cooling system. This kind of system is going to be one of only a few in the San Francisco Bay Area. This thesis project will be a good opportunity to compare its effectiveness with that of another system.

Proposed System Redesign

In the November ASHRAE meeting, Donald Wulfinghoff gave a presentation which advocated the use of single zone systems in all buildings. This project offers an ideal chance to research and implement many of the ideas he talked about in his presentation.

If done correctly, a single zone system will do a better job of meeting the demands of each zone than a multi-zone system would do since each zone will have its own dedicated air handling unit. The issue of under-ventilation in the spaces will be easily fixed as well.

Another positive aspect of utilizing a single zone system is that air will not be distributed from one room to another. Between labs, offices, and classrooms, there is a lot of potential for contaminants to enter the air. In a

high school, illness is passed around pretty easily. While a single zone system won't solve that problem completely, it can help to lessen it by keeping any contaminants that may be around isolated in one space.

Breadth Topics

Structural

With the increase in number of air handling units needed to serve all the spaces, that means that there will be much more of a load due to equipment located on the roof. A study on the subject will be necessary. The current structural system will be analyzed and any changes that are needed will be researched further and the changes will be made.

Acoustical

Whenever public speaking or lecturing is the focal point of spaces, acoustical quality always becomes a primary concern. Various spaces throughout the building will be analyzed acoustically to determine if any adjustment is required. If so, the proper alterations will be researched and completed.

Tools and Methods

As with the second technical report, Carrier's Hourly Analysis Program (HAP) will be used to model the building in its entirety. It will be able to simulate the loads and energy consumption of the building based on the various design elements.

In order to complete the structural breadth study, a structural computer program will be needed. It is unclear as to what program will be used, but the Penn State AE computer labs are host to a wide variety of programs including those which specialize in structural analysis.

In the acoustical breadth study, a computer program may or may not be necessary. If, however, one is needed then the Enhanced Acoustic Simulator for Engineers (EASE) will most likely be used to analyze the spaces that were used in the study.

References

ASHRAE Standard 62.1-2007: Ventilation for Acceptable Indoor Air Quality. American Society of Heating Refrigeration and Air Conditioning Engineers, Inc. Atlanta, GA. 2007

ASHRAE 90.1–2004: Energy Standard for Buildings Except Low-Rise Residential Buildings. American Society of Heating Refrigeration and Air Conditioning Engineers, Inc., Atlanta, GA. 2004.

Davis, Scott. *Technical Assignment 1: ASHRAE Standard 62.1 Ventilation Compliance Evaluation*. October 5, 2007

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Davis, Scott. *Technical Assignment 3:* Mechanical Systems Existing Conditions Report. December 13, 2007