## Senior Thesis Capstone Project
## Treado

### Thesis Proposal

# Interdisciplinary Science and Engineering Building

University of Delaware
Newark, DE 19716

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## Executive Summary

The fallowing proposal is for the redesign of the University of Delaware's newly designed Interdisciplinary Science and Engineering building (ISEB). The building will be built on university property, will be approximately 194,000 square feet, and is scheduled for completion in Fall 2013. The building will facilitate both research labs and educational/office spaces.

The presence of labs in buildings is synonymous with energy consumption. High outdoor-air rates, possibly large process heat loads, and continuous hours of operation, all contribute to make the average laboratory space an energy hog. These energy concerns also offer the opportunity for innovative design.

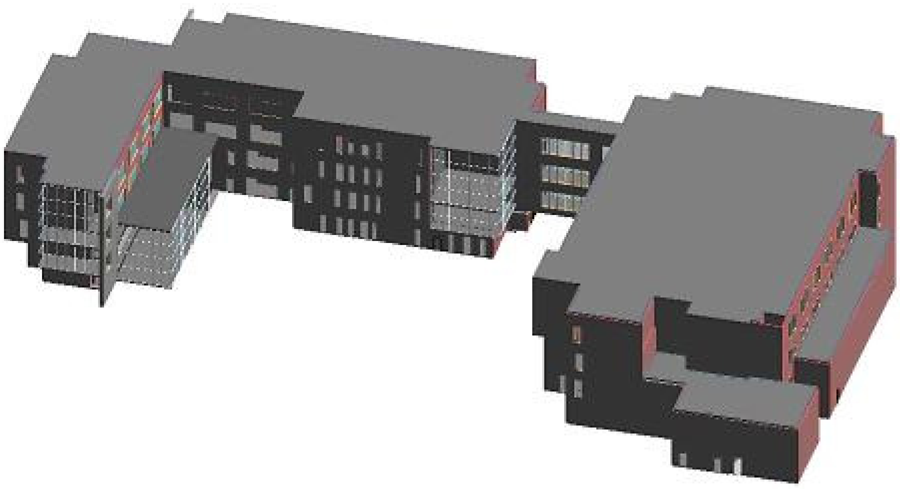
The current air side system of ISEB consists of two AHU types, 100% outdoor air and re-circulation. The re-circulation type systems consist of VAV AHU's that re-circulate air through the spaces, bringing in outdoor air to meet ventilation requirements or if running in economizer mode. These systems supply conditioned air to zone terminal boxes that are equipped with hot water reheat coils. The 100% outdoor air AHUs supply VAV zone terminal boxes equipped with hot water reheat. Each lab contains variable volume fume hoods that exhaust 6-12 ACH/hr and feed "high-plume", constant flow, exhaust fans on the roof. These units are equipped with either enthalpy wheel or heat pipe energy recovery from exhaust air, depending on contamination requirements.

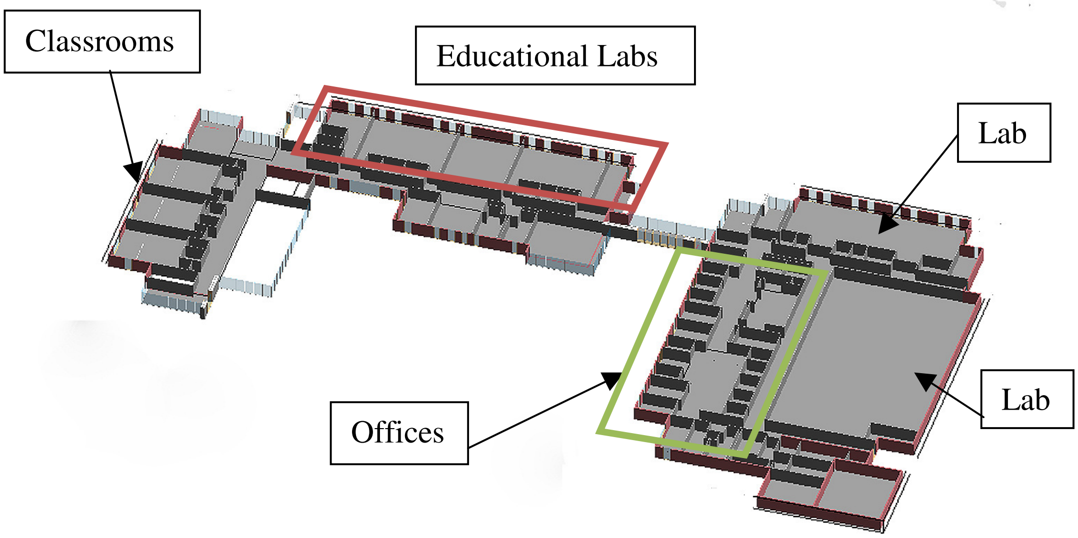
The proposed redesign presented in this document will aim at reducing the energy consumption of ISEB on a holistic basis. First, two different methods of handling the exhaust air to the labs will be compared to the current design. A large portion of the heating/cooling load on the building is due to the large amounts of ventilation air required by the labs, so reducing the amount of and implementing ways of conserving the ventilation air could result in large energy savings.

This report will also look at how these proposed methods of handling the building's ventilation will affect other building systems. The sections of the electrical system that are affected by the changes made to the mechanical system will be examined and redesigned as necessary. Also, any new mechanical ductwork and equipment will be carefully coordinated into the current building layout in order to not inhibit the current architectural interior design.

## Building Overview

ISEB is a unique building due to its mixed use. It contains strictly controlled laboratory spaces with stringent environmental requirements, as well as classrooms and office areas that deal with large occupant fluctuations. All of the educational related spaces, as well as the office spaces, are supplied by any one of the three recirculating type AHU's. The lab and lab support spaces require 100% outdoor air and are supplied by any one of the seven 100% outdoor air AHU's. Each wing of the building contains both lab and non-lab spaces. (Typical floor shown below)





## Mechanical Redesign

### Lab Exhaust Redesign

### Method 1:

One area that has been identified as wasting energy is in the non-lab spaces that are served by 100% outdoor air units. This method will implement chilled beams in these spaces along with any lab space that has a cooling load that dictates, in order to reduce the air change rate, and in turn reducing the amount of conditioned air that is thrown away. This method will also implement Aircuity's Optinet air sensor controls in order to control the amount of outdoor air brought into the air handling units based on current air conditions, not a set schedule. Bringing in outdoor air based on demand and not on preset accepted lab ACH/hr. values should reduce the amount of ventilation air brought into the building.

### Method 2:

The multi use of ISEB results in some tricky design situations from a ventilation standpoint, but if addressed carefully can result in some energy conservation solutions as well. In many hours of the year the non-lab spaces require ventilation air that is in excess of the amount needed to pressurize the building. When this occurs, this excess ventilation air can be ducted as "return air" to the lab AHU's for reuse. This transfer air system is possible because although it is often thought that lab air requirements call for 100% outdoor air, the actual requirement is no re-circulation of lab air. The current design of AHU's 5 and 9 implement heat pipe energy recovery because they serve clean rooms that have high contamination restrictions. This redesign method will replace these heat pipes with 3 angstrom enthalpy wheels to improve energy recovery.

## Electrical Breadth

**Redesigning all electrical systems impacted by the mechanical redesign**

The mechanical depth redesign proposed in this report will directly affect the building's electrical system. Loads must be recalculated, wires must be resize, panel boards must be reconfigured, and any other electrical equipment that served the original mechanical equipment must be examined. This provides a great opportunity to address system integration. This breadth will also fully analyze all of the costs associated with any and all changes that must be made to the electrical system due to the changes proposed in the mechanical depth.

## Architectural Breadth

**Master Coordination**

Both method's proposed for the ventilation system redesign will require the addition/rerouting of ductwork, addition of chilled beams, and changes in ceiling layouts. Once again, in order to address total system integration a coordination model will be made from the perspective of an architect to insure that the changes made to the building mechanical system will integrate into the current interior design of the building. This will require a 3D model of any space above and below the ceiling, where ductwork is added or rerouted. Also, a revised ceiling plan will be made for the addition of the chilled beams in method 2.

## MAE Connection

The redesign of the exhaust system will incorporate hydronic cooling systems. This will include chilled water pumping to the chilled beams along with fan energy needed for the ventilation systems. These topics will make use of material covered in master level courses AE 557 and AE558, central cooling/heating systems.

## Tools for Analysis

### Mechanical System Redesign

In order to compare the different alternative methods suggested in this report to the current design energy simulation software must be used. Trane's TRACE 700 software will be used to conduct load calculations and run energy simulations. For the design of the Aircuity's Optinet system, a control writing software will be required. Automated Logic's Control Spec Builder will be used to show how this system will be implemented and how it will communicate with the building's ALC system.

### Electrical Breadth

Excel spreadsheets will be used in to represent panel board layouts and list electrical loads. Autocad will be used to draw any schematics or plans needed. Revit MEP 2011 and Navisworks will be used to coordinate electrical wiring with other mechanical equipment.

### Architectural Breadth

Revit Architecure and MEP 2011 will be used to coordinate the addition and/or rerouting of any ventilation ductwork. This model will then be taken into Navisworks so that further coordination may be implemented and a walkthrough representation may result. Reflected ceiling plans will be made with Revit Architecture and/or Autocad 2011

## Preliminary Research

1. Johnson, Gregory R. "HVAC Design for Sustainable Labs." *ASHRAE* 50 (2008): 24-34. Print.

This article was used to get ideas for energy saving areas present in labs. This is where the preliminary research was done for the transfer exhaust and ventilation reduction methods.

2. "Energy Savings Turbine over Prv." *Steam Turbines*. Web. 09 Dec. 2010. <http://www.nestco1.com/energy_savings_turbine_over_prv.htm>.

This website was used to do the preliminary research for the steam powered turbine in lieu of a pressure reducing station.

3. "Aircuity OptiNet Components Evaluate Indoor Environmental Quality | Aircuity." *Aircuity - Indoor Environmental Quality Solutions (IEQ)*. Web. 09 Dec. 2010. <http://www.aircuity.com/technology/optinet-components/>.

This is the site for the manufacturer of the ventilation control method presented in this report. Preliminary feasibility research was done by visiting this site.

4. Poirazis, Harris. *Double Skin Façades for Office Buildings*. Rep. Lund University, 2004. Print.

This article reviews several other articles and journals on double skin facades. It gives a description of different types of double skin systems, the history of this type of façade, and how they work.

5. Hock, Lindsay. "Airing Out Laboratory HVAC." *R&D* 10 Aug. 2010: 20-24. Print.

This article was used to get an idea of how different laboratory exhaust and ventilation systems work. It also inspired further research into lab energy conservation.

6. Loudermilk, P.E., Ken. "Designing Chilled Beams For Thermal Comfort." *ASHRAE October* (2009): 58-62. Print.

This article lays out design guidelines for the use of chilled beams in many situations in order to provide adequate thermal comfort. It is in reference to both sensible comfort and humidity control.

7. Barnet, P.E., Barry M. "Chilled Beams for Labs." *ASHRAE December* (2008): 28-37. Print.

This article focuses on the use of chilled beams in a laboratory space. It discusses the use of chilled beams for sensible load with the use of energy recovery for the exhaust of the lab.

## Work Plan

| Senior Thesis Final 3/15/2011 | | 1/29/2011 Milestone 1 | | | 2/17/11 Milestone 2 | | | 3/5/2011 Milestone 3 | Spring Break | | | 3/24/2011 Milestone 4 | | | | Johnathan Peno Mechanical Option |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Thesis Semester Schedule (January 2011-April 2011) | | | | | | | | | | | | | | | | |
| 10-Jan-10 | 17-Jan-10 | 24-Jan-10 | 31-Jan-10 | 7-Feb-10 | 14-Feb-10 | 21-Feb-10 | 28-Feb-10 | 7-Mar-10 | 14-Mar-10 | 21-Mar-10 | 28-Mar-10 | 4-Apr-10 | 11-Apr-10 | 18-Apr-10 | 25-Apr-10 | |
| Evaluate/Firm Current Load Simulation | | | | | | | | | | | | Final Report Due | Faculty Jury Presentations | ABET | Senior Banquet | |
| | Determine Sensible loads for Chilled Beam | | | | | | | | | | | | | | | |
| | Determine min. vent rate for pressurization & hrs excess vent | | | | | | | | | | | | | | | |
| | | | Size New Equip. | | Run Energy Analysis For both proposed methods | | | | | | | | | | | |
| | | | | | | Research Acuity, Control Spec Builder, 3 angstrom wheel | | | | | | | | | | |
| | | | | | | Input Acuity into control spec bider | | Compare Alternatives | | | | | | | | |
| | | | | | | | | Calculate Cost/energy savings | | | | | | | | |
| | | | Detemine Elec. New Elec. Loads for Equip. | | | | | | Start Final Report | | | | | | | |
| | | | | | Adjust/Rezise Elec. Equipement | | | | | Organize Final Report | | | | | | |
| | | Layout Ductwork | | | | | Rezise Wire | | | Arrange Final Report | | | | | | |
| | | | | Size Ductwork & Layout Ceiling(C.B.'s) | | | | Calc Costs Associated with Elec. Changes | | | | | | | | |
| | | | | | | Input Ductwork/Ceiling Into Revit | | | | | | | | | | |
| | | | | | | | | | Navisworks Walk Through | | | | | | | |

| Milestones | | | |
|---|---|---|---|
| 1 | Solid Energy Model, Sensible Loads for C.B., Vent Rates for transfer spaces | (yellow) | Mechanical |
| 2 | All new systems have been laid out, New equipment has been sized | (orange) | Electrical Breadth |
| 3 | All info needed to compare alternatives should be obtained, | (green) | Architectural Breadth |
| 4 | Final Presentation/Report Done | (gold) | Overall Project |

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| Orange | Electrical Breadth |
| Green | Architectural Breadth |
| Gold | Overall Project |