Interdisciplinary Science & Engineering Building (ISEB)
Newark, DE

Johnathan Peno
Mechanical Option

Final Thesis Presentation

Johnathan Peno

Mechanical Option
Spring 2011

Advisor: Dr. Treado

Presentation Outline

- Introduction
  - ➢ Building Overview
  - Existing Conditions
  - System Evaluation
- Ventilation Load Reduction
- Electrical System Integration
- Conclusions

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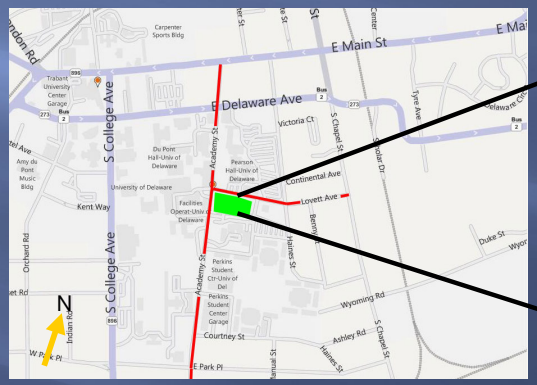

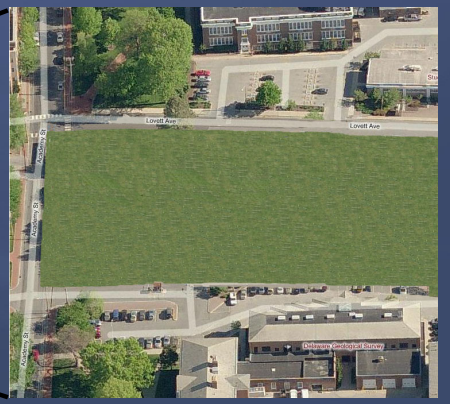

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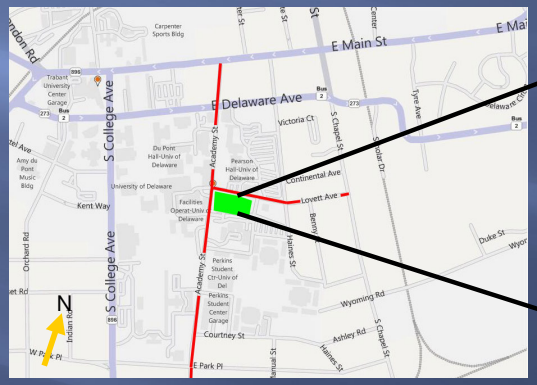

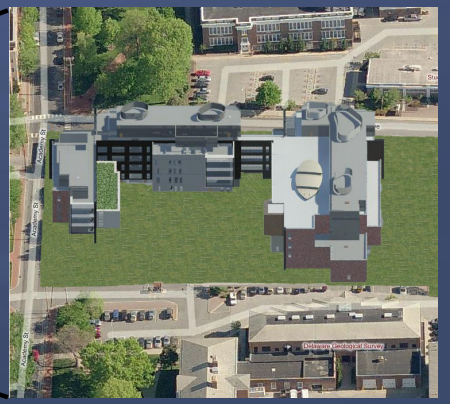

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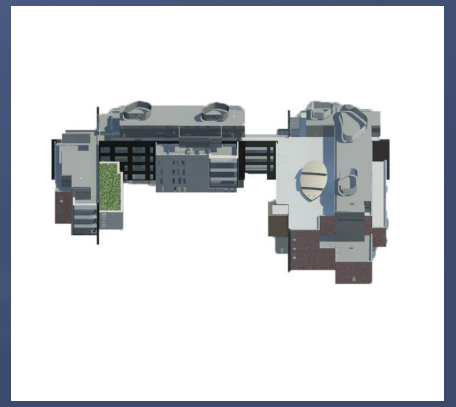
Size:	**194,000 SF**
Construction Period:	**Spring 2011 - Fall 2013**
Occupancy Type:	**Lab, Education, Office**
Project Budget:	**$140M**
Construction Budget:	**$105M**
Project Delivery Method:	**Design-Bid-Build**
Architect:	**Ayers Saint Gross**
Mechanical Engineer:	**Mueller Associates**
Owner:	**The University of Delaware**



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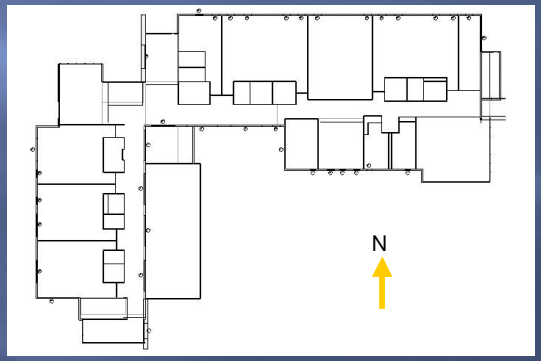

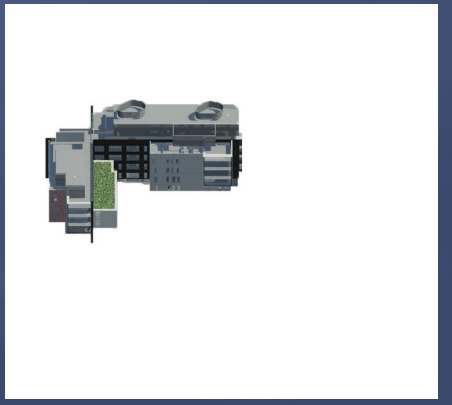

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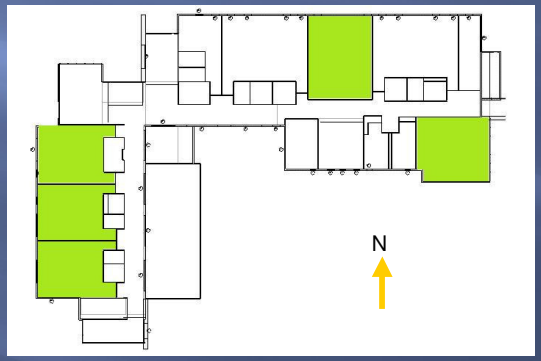

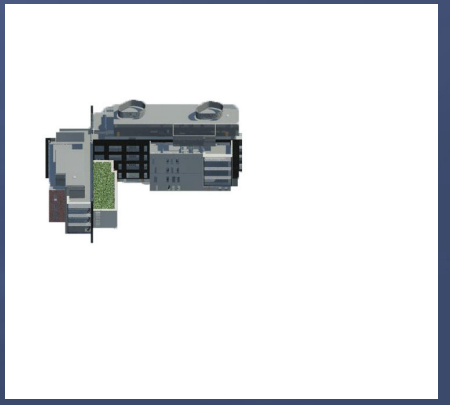

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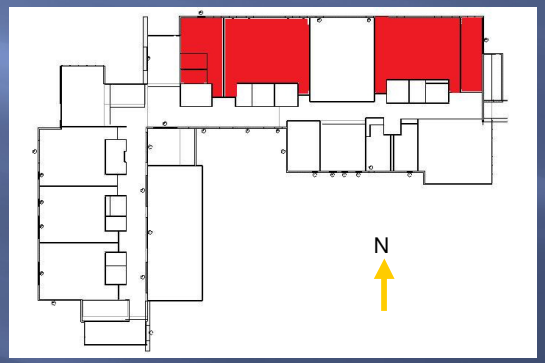

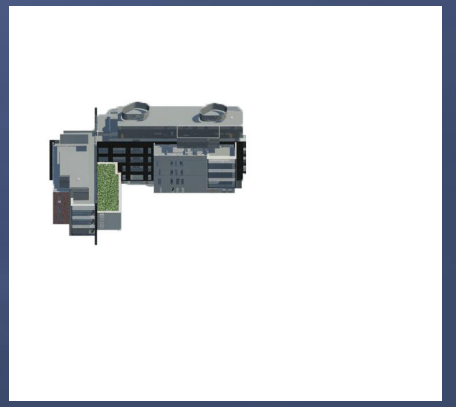

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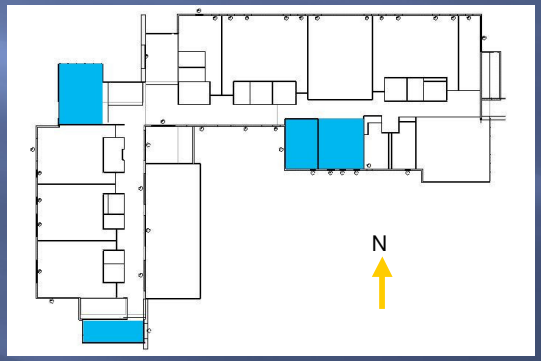

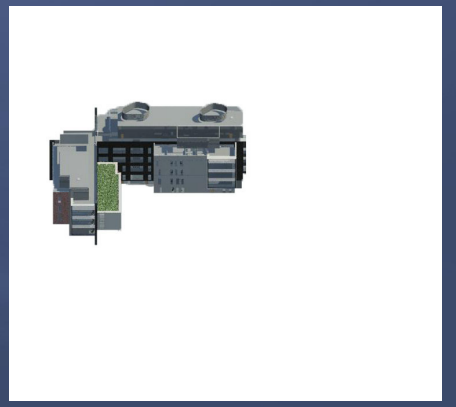

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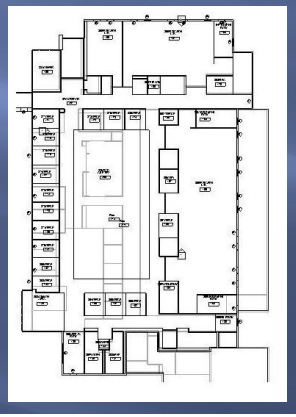

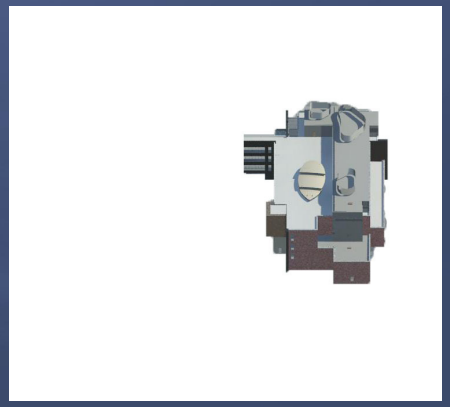

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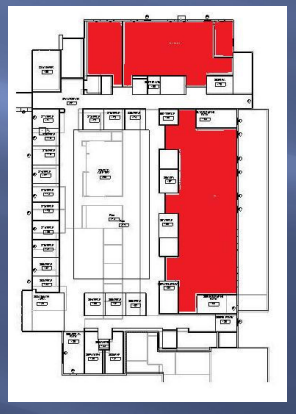

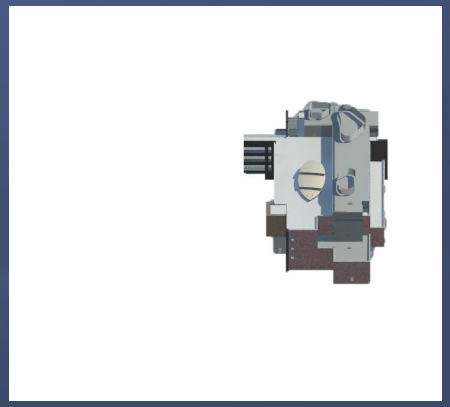

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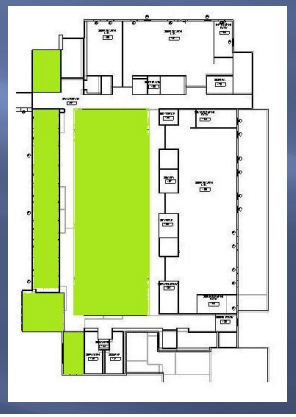

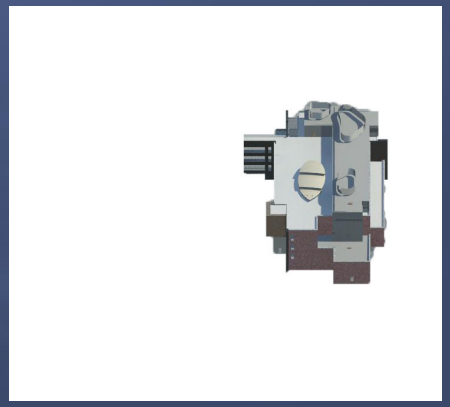

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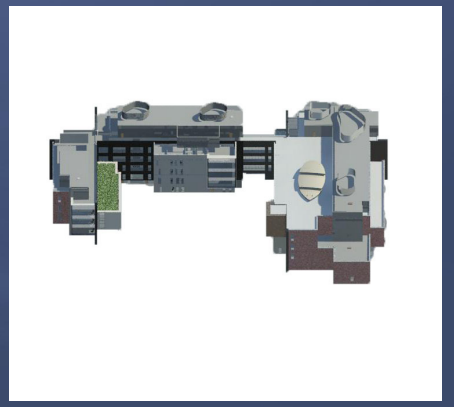
Water/Steam Side

- **CHW to Building from ECUP (1350 tons)**
  - Building Cooling
  - HX to Lab Process CHW
- **Steam-Water HX Fed by Campus Steam Loop (19,000 PPH)**
  - Heat/Preheat Needs
  - Domestic HW
- **Electric Standby Chiller for Critical Spaces**
  - Condenser Heat in Preheat/Reheat Loop
  - Fluid Coolers on Roof



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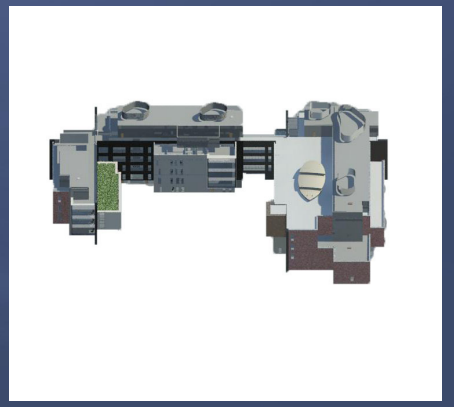
Air Side

10 Total Air Handling Units

- AHU 1, 2 & 10 = Recirculating
- Rest = 100% Outdoor Air
  - Enthalpy Wheel/Heat Pipe
- VAV with terminal reheat (HW coils)
- Building Direct Digital Control System



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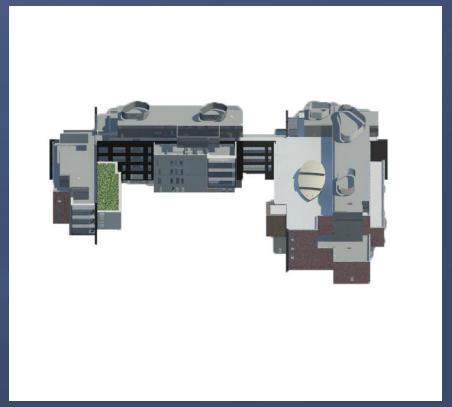
System Evaluation

- Lab Buildings = High Ventilation Loads
- Instructional Laboratories
  - Less Stringent Environmental Constraints
  - Labs & Non-Labs on Same AHUs (3 & 4)
- Goals:
  - Reduce Ventilation Energy Consumption
  - Maintain Occupant Safety



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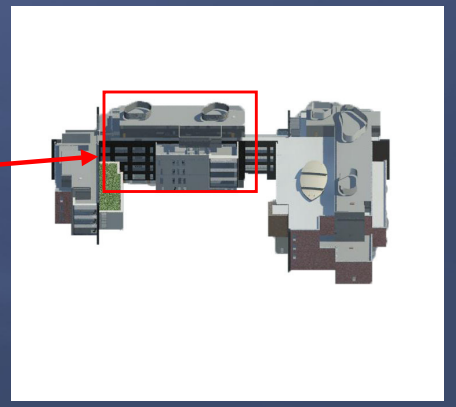
System Evaluation

- Lab Buildings = High Ventilation Loads
- Instructional Laboratories
  - Lower Hood Densities
  - Less Stringent Environmental Constraints
  - Labs & Non-Labs on Same AHUs (3 & 4)
- Goals:
  - Reduce Ventilation Energy Consumption
  - Maintain Occupant Safety



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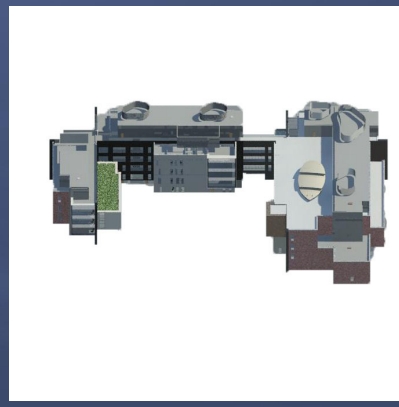
Redesign Approach 1

3 Step Process to Reduce Building Ventilation Loads

- Separate Lab and Non-Lab Spaces
- Lower Air Change Rates
- Implement Chilled Beam System



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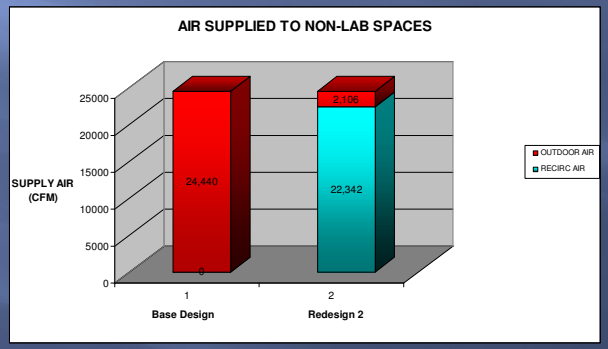
Step 1) Separate Lab & Non-Labs



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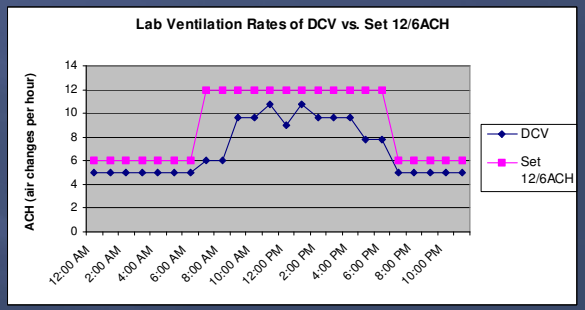
Lab Occupant Safety:

Minimum Air Change Rates In Labs

Current Design: 12/6 ACH (Occ/UnOcc)

Redesign: Adjust ACH Rate Based on Demand

Approximate Hourly ACH Reduction



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Step 2) Implement Demand Based ACH Control System

- Room Sensors
- Data Routers
- Sensor Suite
- DDC System

System Diagram

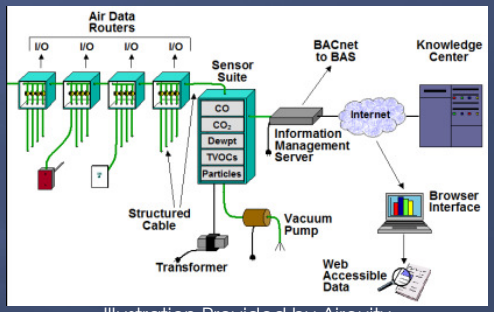

Illustration Provided by Aircuity

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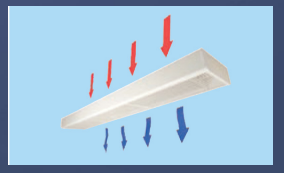
Step 3) Lab Passive Chilled Beam System

- 12ACH → Ventilation Load Dictates
- Lower ACH → Cooling Load May Dictate
- Implement Parallel Cooling System instead of bringing in excess OA

Passive Chilled Beam

Photo: Halton Passive Chilled Beam



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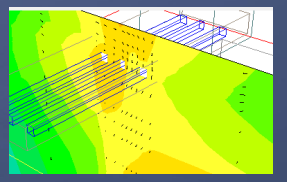
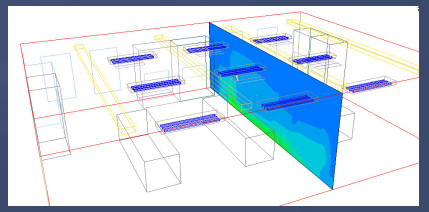
CFD Analysis

Goal:
Feasibility of Passive Chilled Beam System

Design Variables:
- Diffuser Pattern
- Chilled Beam Layout

Model:
Turbulence Model: Standard K-e
Differencing Scheme: Hybrid





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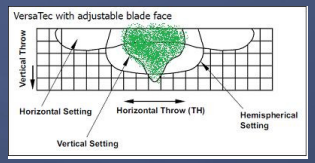
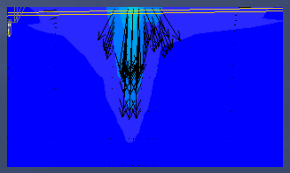
Diffuser Pattern

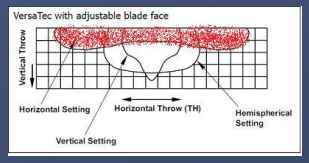
Vertical vs. Horizontal

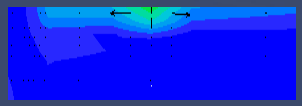
Vertical Patterns





Horizontal Patterns





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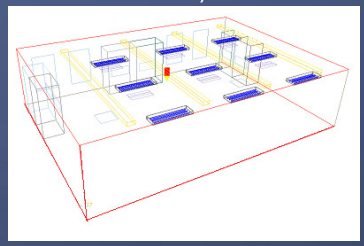
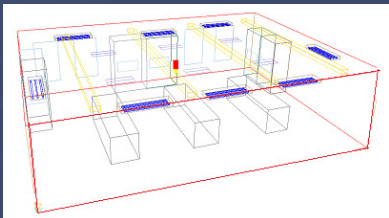
Chilled Beam Layout

Row vs. Perimeter

Row Layout



Perimeter Layout



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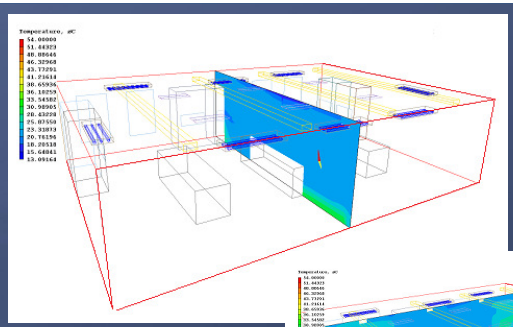
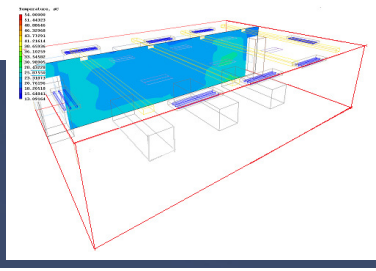
CFD Analysis Conclusion

Perimeter Beam + Horizontal Pattern

- Effectively Cooled Room to Design 72F
- Acceptable Temp. Gradient (Standard 55 +/- 3°C)





Ave. Room Temp=71.78°F

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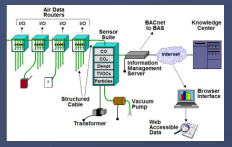
Approach 1 Conclusions

	Approach 1	
Chilled Water	-2%	
Steam	-15%	
Electricity	-1%	
Payback Period	4.1	w/ Chilled Beams
	1.2	w/o Chilled Beams

✓



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    - ➢Design
    - Savings
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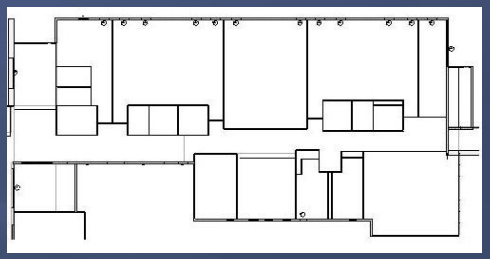
Approach 2

- Transfer air from Non-Labs to Labs as Make-Up Air In lieu of O.A.



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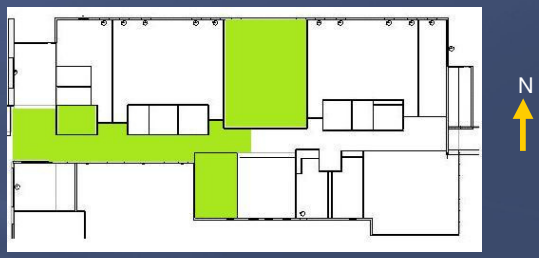
    - ➢Design
    - Savings
- Electrical System Integration
- Conclusions

Approach 2

- Transfer air from Non-Labs to Labs as Make-Up Air In lieu of O.A.



Presentation Outline

- Introduction
- Ventilation Load Reduction
  - Approach 1
  - Approach 2
    - ➢Design
    - Savings
- Electrical System Integration
- Conclusions

Approach 2

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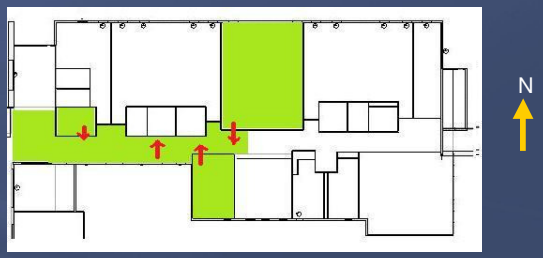

Presentation Outline

- Introduction
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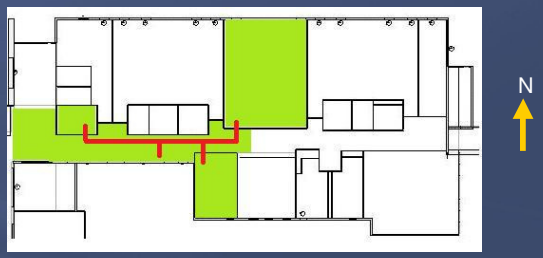

Presentation Outline

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GreenHeck Low Profile Cabinet Centrifugal Fan

Presentation Outline

- Introduction
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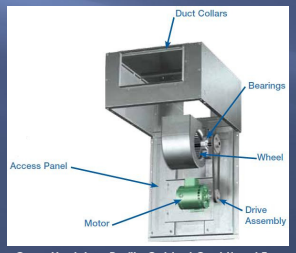


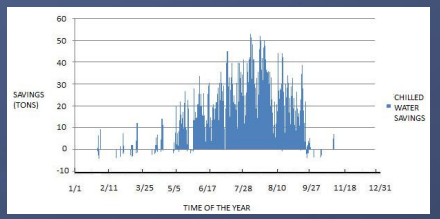
GreenHeck Low Profile Cabinet Centrifugal Fan

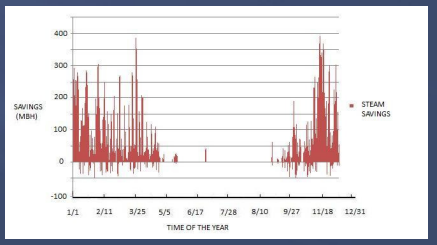
Presentation Outline

- Introduction
- Ventilation Load Reduction
  - Approach 1
  - Approach 2
    - Design
    - ➢Savings
- Electrical System Integration
- Conclusions

	Savings
Chilled Water	24,898 ton-hrs
Steam	256 Mbtu

	Approach 2
Chilled Water	-2%
Steam	-5%
Electricity	0%
Payback Period	3.3





Presentation Outline

- Introduction
- Ventilation Load Reduction
- Electrical System Integration
  - ➢ Existing Conditions
    - Approach 1
    - Approach 2
- Conclusions

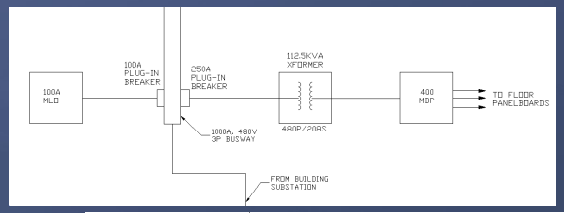
Interdisciplinary Science & Engineering Building (ISEB)
Newark, DE

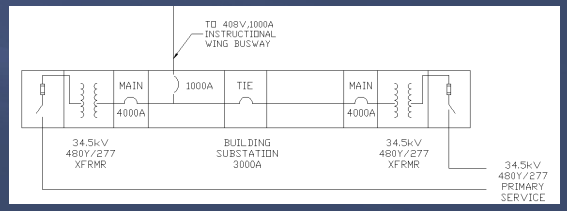
Johnathan Peno
Mechanical Option

Existing Electrical

- 34.5 kV service entrance feeders
- Dual primary-secondary doubled ended unit substation
- (2) medium voltage fused switches, Indoor substation
- Transformers Step 34.5 kV → 480Y/277 V
- 3000A main-tie-main distribution section.

Existing Conditions





Presentation Outline

- Introduction
- Ventilation Load Reduction
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  - ➢ Existing Conditions
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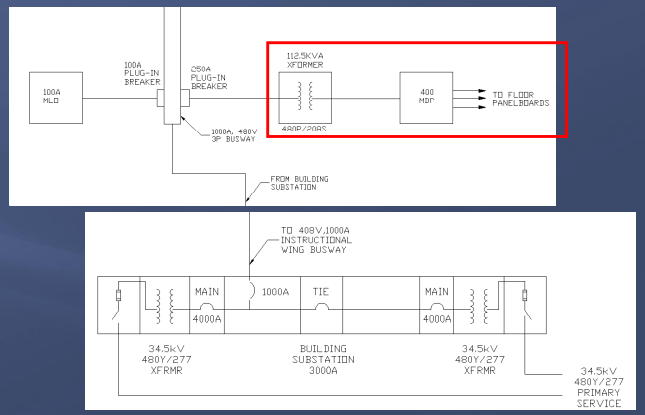
Interdisciplinary Science & Engineering Building (ISEB)
Newark, DE

Johnathan Peno
Mechanical Option

Electrical Integration

- 1000A Busway serving Instructional Wing
- 480/277 → 208/120 Xformer
- 400A MDP (Ground Floor)
- New 100A , 32 pole Equipment Panels

Existing Conditions



Presentation Outline

- Introduction
- Ventilation Load Reduction
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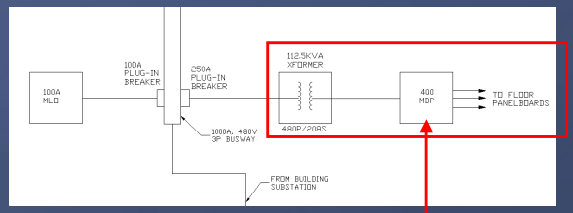
  - Existing Conditions
  - ➢ Approach 1
  - Approach 2
- Conclusions

Approach 1 Additions

Fan Coil Unit
- Blower Motors
- Electric Heaters

	MDP
	DRGC
Location	Elec Rm 115
Size	400 Amps
Previous Load	110,082 VA
Added Load	26,704
New Amp Draw	379 Amps
Okay?	Yes
Future Growth	5%

Electrical Equipment Affected



Presentation Outline

- Introduction
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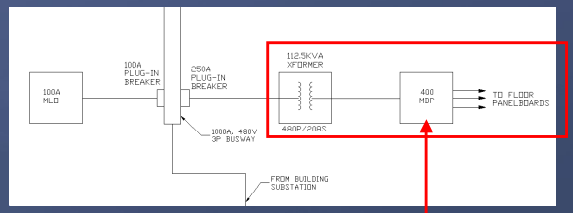
  - Existing Conditions
  - Approach 1
  - ➢ Approach 2
- Conclusions

Approach 2 Additions

Transfer Fan Motors
Fan Coil Units
- Blower Motors
- Electric Heaters

	MDP
	DRGC
Location	Elec Rm 115
Size	400 Amps
Previous Load	110,082 VA
Added Load	29,767
New Amp Draw	388 Amps
Okay?	Yes
Future Growth	3%

Electrical Equipment Affected



Presentation Outline

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  - ➢ Recommendations
  - Acknowledgements
  - Questions

Recommendations

Approach 1 (minus Chilled Beams)

- Most Economical (1.2 years)
- Highest Level of Occupant Safety (IEQ)
  - Thanks to Room Sensors

Presentation Outline

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  - Questions

Acknowledgements

Family

Friends

AE Department

Mueller Associates

AIG Architects

University of Delaware

Presentation Outline

- Introduction
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- Electrical System Integration
- Conclusions
  - Recommendations
  - Acknowledgements
  - ➢ Questions

Questions?