

# CEE 243 - Predicting and Measuring Building Energy Use

Agenda: May 26

## Original class overview

- Introductions
- Motivating problem
- Course overview / roadmap
- Today's lecture: intro to HVAC systems
- Wednesday: Building performance database introduction

# Q8

1. For each assigned system and a few associated points for each:

- System or component description, e.g., AHU1 or Hot Water Supply Temperature
- ID, e.g., 1127
- Point source, i.e., one of: Control, Sensor measurement
- On one or a small set of SEE IT graphs of 2011 measured

# Q8

2. Re Query 7 ... elaborate your analysis of significance.

- Estimate the *CO2 abatement potential* of some change that you suggest that might make the predicted data either better or worse: Plot  $\Delta\$$  vs.  $\Delta\text{CO}_2$
- Assume:
  - Change: ~ \$1000, \$10,000, \$100,000
  - 1.3 lbs CO<sub>2</sub> to generate 1 kWh electricity;
  - 125,000 pounds CO<sub>2</sub> to generate 1 billion Btu;
  - 12,000 Btu for 1 ton of heating or cooling.
- Annotate business significance in plot.

# Q8

3. SEE IT graphs that represent system performance from the perspective of one or a small set of related points. Identify the important features and implications of each graph and of comparisons between related graphs
4. Add a title for each section of your wiki w/ **green/ yellow/ red** light status.
5. Add a *Guide for users* page to your wiki that explains how to: Browse, ...
6. PowerPoint deck for final presentation

# Lingo

- Enthalpy:
  - total energy of a thermodynamic system [joule; Btu, calorie]
- Heat – Latent and sensible:
  - Sensible heat changes temperature
  - Latent heat changes state, e.g., gas ,  $\leftrightarrow$  liquid
  - In air conditioning, sensible capacity lowers temperature; latent capacity removes moisture from air

# Lingo

## ■ Infiltration:

- air leaking into or out of a building through cracks, frames, outlets, walls, floors, roof, etc. [Air Changes per Hour (ACH)]

## ■ Units – IP vs SI:

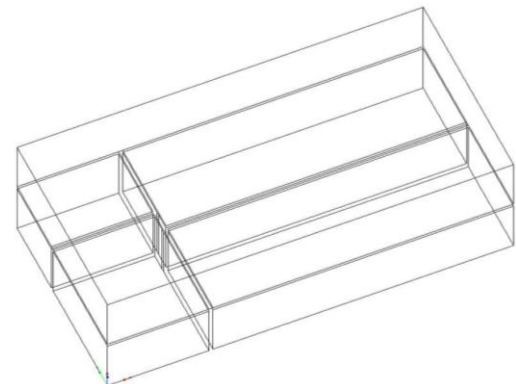
- IP: inch-pound
- SI: Systeme Internationale, i.e., metric

## ■ Air wall (air curtain):

- A narrow stream of air directed across an opening to deter the transfer of hot or cold air, contaminants, and insects from one side to the other, e.g., in grocery store refrigerator cases

# Lingo

- Models – Design and analytical:
  - Design models describe, e.g., 2/3D graphics
  - Analytical models allow analysis
- Space boundary: physical barriers to energy flow between spaces
  - 1st Level: depend only on building elements
  - 2nd Level: depend on spaces behind the boundary, typically a subdivision of first level space boundaries



# Lingo

- Transmittance:

- Measure of ability of anything to transmit radiation:  
transmitted / incident flux [%]

- Plenum:

- Enclosed space in a structure that allows air movement, typically for return air

# Lingo

## ■ R-value:

- Measure of thermal resistance (inverse: conductivity)
- Heat loss per  $m^2$ :  $\Delta$  Temperature / R value

## ■ U –Factor:

- Heat transfer through glazing (function of temperature) [BTU/ sq. ft./hr. degrees F]. T
- Lower U-Factor = better the glazing insulation

## ORID -

Objective: What facts did you see this *quarter*? What factual statements can you make based on the data?

- e+ GUI difficult
- 2011 results better than 2009
- Problem types
  - sensor
  - system
- If we change objectives, we can meet them

**ORID -**  
**Reflective: What surprised you? What encouraged or discouraged you?**

- It is difficult to figure out if something works – to diagnose problems
- Data sample intervals and sampling durations matter – a surprise
- We got better with practice
- Y2E2 has an admirable intent but the reality does not match → question of what hope we have
- Lab downstairs uncomfortable (184)
- Amount of bad data, often from sensor problems
- Ambiguity – we needed to make our own assumptions

## ORID -

Interpretive: What sense to you make of what you did this quarter?

- You (we) can make a difference in performance with real effort
- Looking at the \$, people pay attention
- Free (student) labor helps (or has been crucial for) Stanford with analysis

## ORID -

Decisional: What are our proposed next steps? What is your action plan for next steps?

- Get a job
- Need to be very smart to do the work – it is complex
- Update data manual
- Communicate findings to owners and future students
- Try to leave a product of class more of what we would liked to receive

# Recommendation: Predict *and* Measure ...

## Green Is as Green DOES *Performance is more compelling than design awards*

By Michael G. Ivanovich

HEATING/VENTILATING/AIR CONDITIONING  
**HPAC**  
ENGINEERING

From the Editor

February 2003

### Green Is as Green DOES

*Performance is more compelling than design awards*

By Michael G. Ivanovich



Green comes in many shades these days. In the vernacular of the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system for new buildings, they are platinum, gold, silver, and "certified." One would think he or she were walking in a forest of precious metals to be in a city with green buildings. A recent article in *The New York Times*,<sup>1</sup> however, says otherwise. Prominent green-building developers stated that the financial benefits of green buildings are either set there or upriver. The few successes mentioned in the article, such as the Conde Nast building at 4 Times Square in New York, were noted as exceptions.

Coincidentally, on the day the *New York Times* article appeared, I was attending a press conference at the National Building Museum in Washington, D.C., hosted by Johnson Controls and timed to coincide with the opening of the "Big & Green: Toward Sustainable Architecture" exhibit. I toured the exhibit and, later, listened to presentations on green-building projects that are under way or have been completed at the Pentagon, the National Geographic Society, and Furman University.

The "Big & Green" exhibit was, for me, a disappointment because it "showed" design and "talked" quite a bit about performance; however, there was very little actual performance data to allow visitors to judge just how well these supposedly green buildings, or some of their more innovative features, are performing in real life.

Generally, too much emphasis has been placed on communicating aesthetics and lists of features for me to give much credence to green-building design awards. Some certified green buildings have been operating for two years or more, with sophisticated building-automation and control systems capable of monitoring and reporting key performance data. Some are fully metered and submetered. But very little data, if any, is presented when designs of these constructed and occupied buildings are discussed, which begs the question why.

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