



## Newman Consulting Group, LLC

Consultants for Energy-Efficient and Sustainable Buildings



# Transforming Older Buildings Into High Performance Facilities

ASHRAE DL – Golden Gate / San Jose – 12/11/13

## James L. Newman

CEM, CSDP, LEED AP BD+C, ASHRAE OPMP & BEAP, FESD

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

- Trainer, Energy Standard 90.1
- Past Member, Air-to-Air Energy Recovery Technical Committee
- Past Vice-Chair, Industrial Air Conditioning Technical Committee
- Past Board Member; Distinguished Service Award (Local), 2005
- Distinguished Lecturer, 2010-Present
- Distinguished Service Award, 2012, 2013

BUILDING OWNERS & MANAGERS ASSOCIATION (BOMA)

- Member, Energy & Environment Committee (National)
- Judge, TOBY Awards (The Office Building of the Year, Local)
- Chair, Sustainability for Success Committee (Local)

ENGINEERING SOCIETY OF DETROIT (ESD)

- Distinguished Service Award, 2007; Fellow, 2010
- Member, Construction & Design Committee
- Spokesperson on Energy & Environmental Issues
- Past Chair, Council of Affiliated Societies

U.S. GREEN BUILDING COUNCIL (USGBC)

- Past Board Member; Distinguished Service Award (Local), 2008
- Past Chair, Public Policy Committee (Local)
- Member, Green Schools Advocacy Committee (Local)

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“If You’re Not Green –  
 You’re Nuts!”

That was the blunt message of the CEO of Ann Arbor, MI, property managers McKinley Inc., Albert Berriz (DTE/ESD Energy Conference, 2 May, 2012)

*“If you’re not into ‘do no harm,’ if you’re not into sustainability, if you don’t care about the environment — you ought to care about 30 percent return on investment,” Berriz said. “This is not frou-frou. This is bottom line dollars.”*

- McKinley manages a \$3 billion portfolio of property, including 15 million ft<sup>2</sup> of shopping centers and offices, and 34,000 housing units, in 25 states, with a staff of 1,200.
- *“Our owners are thrilled about sustainability ... because obviously, it makes money.”*

## Q: What is a “Green” Building?

- A. Intelligent, Integrated Systems
- B. Above Standards
- C. Costs Less to Operate & Maintain



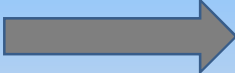
## What's Here Now

- ANSI/ASHRAE/IESNA Standard 189.1 for Design of High Performance Green Buildings (2009, revised 2011)
- LEED V4 – uses ASHRAE 90.1-2010  $\Xi$  much more difficult to get additional energy points
- ASHRAE Energy Standard 90.1 – 2013 (even more stringent than 90.1 - 2010)
- ASTM Building Energy Performance Assessment (BEPA) Standard – 02/10/11
- ICC's International Green Construction Code (IGCC) – published as new code in 2012 – (input from ASHRAE, AIA, USGBC, IESNA, BOMA, etc.)
- ASHRAE Building Energy Quotient (bEQ) Label (more difficult but more comprehensive than Energy Star) – 03/01/12
- Green Globes, EPA Energy Star, Living Building Challenge, etc.
- Energy Use Index (EUI) – Btu/SF/yr

## Driving Forces – Regulatory – 11/13

- EU since 2003
- States requiring Performance Disclosure: CA, WA, FL, HI, OK, UT, ME, D.C.
- Cities requiring Performance Disclosure: Seattle, New York, Boston, Philadelphia, Chicago, Austin, TX; Westchester, PA; Burlington, VT
- Federal legislation being discussed

## What Happens to HVAC Systems as Time Passes?

Green  Grey  
(or Brown)

## How to Determine Building Energy Costs Relative to Similar Buildings

EPA Portfolio Manager Energy Star Analysis

*or*

ASHRAE bEQ Labeling Program

*then*

An Energy Audit

## Energy Audits (1)

- Purpose: Identify and develop modifications to reduce energy use and/or cost of operating a building
- Types:
  - Preliminary: Examine Utility Bills for Information
  - Level I: Walk-Through Analysis
  - Level II: Energy Survey & Analysis
  - Level III: Detailed Analysis of Capital Intensive Modifications

## Energy Audits – (2)

- Building Energy Consumption:
    - \*Envelope (Walls, Windows, Roof)
    - \*Lighting (Interior & Exterior)
    - \*HVAC
    - \*Domestic & Process Water (Hot & Cold)
    - Laundry
    - Food Preparation
    - Conveying Systems
    - Plug Loads
    - Other Systems – Compressed Air, etc.
- \* in EAct 2005 for tax deductions



## Energy Audits – (3)

Steps:

1. Collect & analyze historical energy use
2. Study building, operation, characteristics
3. Identify potential modifications to reduce energy use/cost
4. Analyze engineering & economics of potential modifications
5. List rank-order, appropriate modifications
6. Document analysis process, results, report

| CRATING PERIOD  | 1 | 2 | 3 | 4 |
|-----------------|---|---|---|---|
| ENVELOPE        | A |   |   |   |
| HEATING SYSTEMS | A |   |   |   |
| COOLING SYSTEMS | B |   |   |   |
| PLUG LOADS      | B |   |   |   |
| WATER           | A |   |   |   |
| WASTE           | A |   |   |   |
| ENERGY USE      | C |   |   |   |
| Overall Rating  | B |   |   |   |

## Why Do Building Owners Turn Down Energy Audits?

Cost of the audit?

Cost of what has to be done after the audit?

Fear? Of what?

- Lack of expertise of the auditor?
- Exposure of poor O & M practices?
- Exposure of no maintenance at all?
- Exposure of lack of knowledge (or incorrect assumptions) about the building operation?
- More work for the overworked building staff?
- What else?



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## What Do *You* Have To Accomplish?

Must make the Owner or Facility Manager Comfortable

- With you and your team
- With what will be accomplished
- With how much money they will save
- With how it will make them look to their superiors, or their stockholders
- With how their employees and/or tenants will feel

## Why “Green” in Today’s Tough Times ?

Save Costs

- Natural Resources
- Paper, Waste Recycling
- Travel: Webcasts, Teleconferencing

Improve Productivity

- Indoor Environmental Quality
- *People* are highest cost of a building

**Sustain Financial Viability of Organization**

## Driving Forces - Business

- Energy efficient buildings
  - Lower operating costs
  - Higher net operating income
  - More valuable
  - More attractive to tenants
- Energy inefficient buildings
  - Less competitive in the marketplace
  - In danger of obsolescence

## How to Reduce Energy Consumption

## Methods of Reducing Energy - HVAC (No Cost/Low Cost)

- Calibrate Sensors and 'Stats
  - Adjust Economizer Dampers
  - Optimize Volume of Outside Air
  - Optimize Discharge Temperature
  - Install Programmable Thermostats
  - Update to Occupancy-Based Control w/CO<sub>2</sub> Sensors
  - Optimize Start-stop of Equipment
  - Seal Ducts
  - Properly Clean Cooling and Heating Coils
- It's all about *good and proper* O & M practices

## Clogged Filters



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## Clogged Filters That Didn't Make It



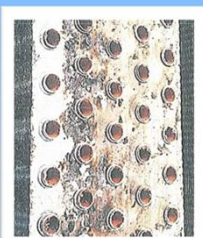
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## Potential IAQ Problems: HVAC



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## Most of Today's HVAC Cleaning Methods are Unproven and Unreliable



Standard methods only reach into the first 1-2 rows of the coil structure. Inner rows on 5-8 row coils typically are unaffected by most cleaning processes.

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## Metro Area Elementary School

| AHU | Pre-Clean Velocity Avg (ft/min) | Post-Clean Velocity Avg (ft/min) | % Increase |
|-----|---------------------------------|----------------------------------|------------|
| 1   | 217                             | 664                              | 206        |
| 2   | 197                             | 715                              | 262        |
| 3   | 178                             | 767                              | 331        |
| 4   | 38                              | 761                              | 1926       |
| 5   | 77                              | 748                              | 876        |
| 6   | 231                             | 884                              | 282        |
| 7   | 4                               | 331                              | 7476       |
| 8   | 578                             | 670                              | 16         |
| 9   | 646                             | 667                              | 4          |

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## Metro Area High School Results

|                 | AHU1 | AHU2 | AHU3 | AHU4 | AHU5 | AHU6 | AHU7 | Avg. |
|-----------------|------|------|------|------|------|------|------|------|
| Before cleaning | 1.20 | .93  | .85  | 1.07 | .89  | 1.32 | 1.15 | 1.05 |
| After cleaning  | .25  | .17  | .18  | .21  | .17  | .20  | .19  | .19  |

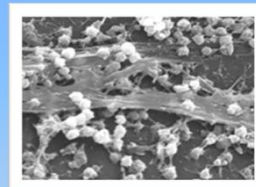
*Pressure differential inches/wc*

**Average pressure differential of coil was reduced 80%**

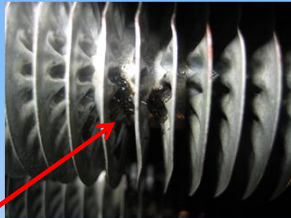
**Average CFM was increased by 40%**

## Biofilm Challenge

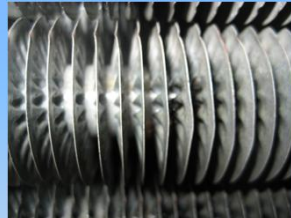
- Bacteria grow in/on coils and fins.
- This clogs them and reduces the efficiency of the system.
- Bacteria on coils and fins can generate odors (“Dirty Socks smell”) that become a severe irritant - may lead to health issues.



## Biofilm Challenge



Close-up of coil after conventional cleaning (note: black tar like substance is biofilm)

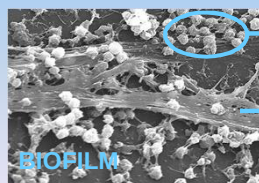


Close-up of coil after cleaning using engineered EFM after conventional cleaning

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## What Is Biofilm?

- Biofilms are aggregates of predominately bacterial cells attached to and growing on a surface. (Costerton J.W. and Stewart, P.S., 2001 Battling Biofilms. Sci. Am., 285:74-81)
- A biofilm forms when bacteria begin to excrete a slimy, sticky substance that allows them to adhere to surfaces.
- This extracellular polymeric substance (EPS) provides the biofilm with increased resistance to antimicrobial agents, heat/cold and cleaners.



**Micro-organisms**  
(bacteria, fungi, algae...)

**Biofilm EPS binding matrix**  
(exopolysaccharides, proteins...)

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## Methods of Reducing Energy - HVAC (Moderate Cost)

- Low S.P. Drop, High MERV-Rated Filters
- Optimized VAV Systems with Thermally-powered Diffusers
- VFDs on Fans, Chillers, Pumps
- Repair AHUs Rather than Replace

## Typical Median Service Life (yrs.) (Examples)

- |                                                           |     |
|-----------------------------------------------------------|-----|
| • DX Air Distribution Equipment<br>(except Rooftop Units) | >25 |
| • Chillers, Centrifugal                                   | >25 |
| • Cooling Towers, Metal                                   | >22 |
| • Boilers, Water-Tube (H.W., Steam)                       | >22 |

- ASHRAE, Abramson et al., 2005

See ASHRAE database for up-to-date information:  
[www.ashrae.org/database](http://www.ashrae.org/database)

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## Example: Air Handling Units

### Repair or Replace?

Many things to think about:

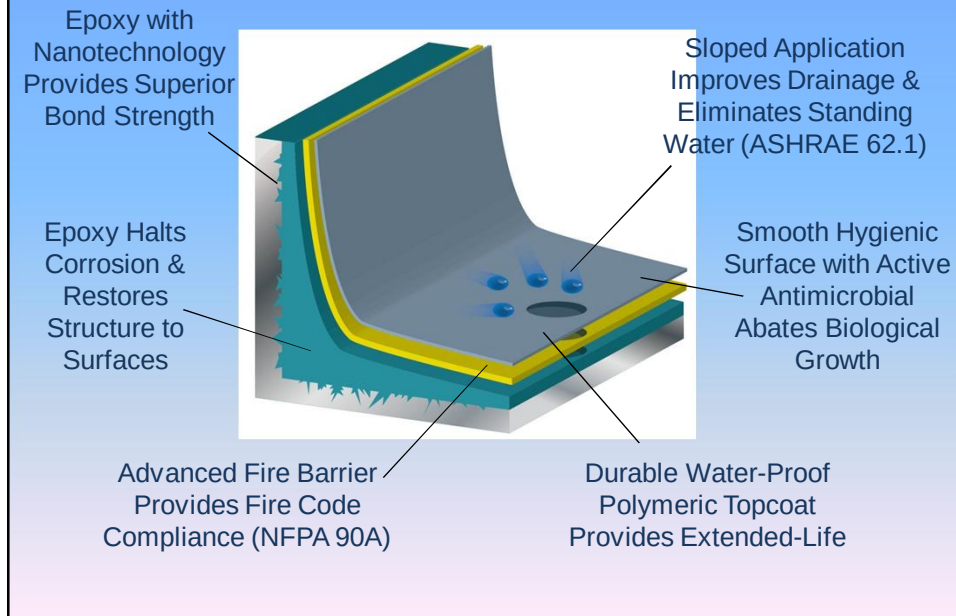
- Age
- Available space
- Efficiency of new equipment
- Cost of removal and installation
- Time involved/disruption of operation
- Etc.

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## System Installation



## Technology



## Methods of Reducing Energy - HVAC (Higher Cost)

- Variable Flow Chilled Water systems
- Smaller Centrifugal Compressors – Oilless, with Magnetic Bearings (now up to 700+ tons)
- Total Energy Recovery Heat Exchangers
- Geothermal Heat Pumps
- Microchannel Heat Exchangers
- Cool Storage (ice, water)
- Desiccant Systems/Dedicated Outdoor Air Systems
- Displacement Ventilation & Underfloor Air Distribution
- Indirect Evaporative Cooling

## Methods of Reducing Energy -Lighting

- Lighting
  - Linear Fluorescent Lamps: T-8, T-5 w/Electronic Ballast
  - Compact Fluorescent Lamps (CFL)
  - LED Lamps
  - Sensors: Light, Motion
  - Dimming
  - Zoning
- Natural Daylighting
  - Light Shelves
  - Skylights
  - Light Tubes



## Methods of Reducing Energy (Renewable and Other)

### Renewable Energy: Passive and Active

- Solar
- Solar Photo-Voltaic
- Wind Energy
- Wave Energy
- True Geothermal

### Additional Options

- Radiant Cooling
- Radiant Heating
- Reheat from Waste Energy
- Thermal Chimneys
- Fuel Cells



What else is there?

## Smarter Water for a Smarter Planet



Q: How many gallons of potable water do Americans use every day – *just to flush toilets?*

A: Almost 5 billion!

## Water Savings

- Exterior
  - Water efficient landscaping
  - No potable water use or no irrigation
- Interior
  - Toilets & urinals (low-flow or waterless)
  - Sinks (low-flow, with or without sensors)
  - Showers (low-flow)
  - Shower with a friend??



## Water Saving/Reuse

Gray Water  $\equiv$  Water that can be recycled & reused:

- Condensate from (clean) drain pans
- Water from sinks
- Water from washing machines, dishwashers
- Rainwater
  - Collection cisterns
  - “Green” Roofs



## Be Careful What You Ask For

- Less potable water being used for flushing toilets
  - Good
    - Conserve water
    - Lower power requirements for water distribution plants
  - Not so good
    - Drains plug up
    - Treatment in waste plants not being rebalanced for higher waste/water ratio, or for more and different chemicals being flushed down drains

Putting it all together

## Quality Assurance

- Testing & Balancing – To Ensure *HVAC Systems* are Performing as Designed
- Commissioning – To Ensure *Building* is Performing as Designed



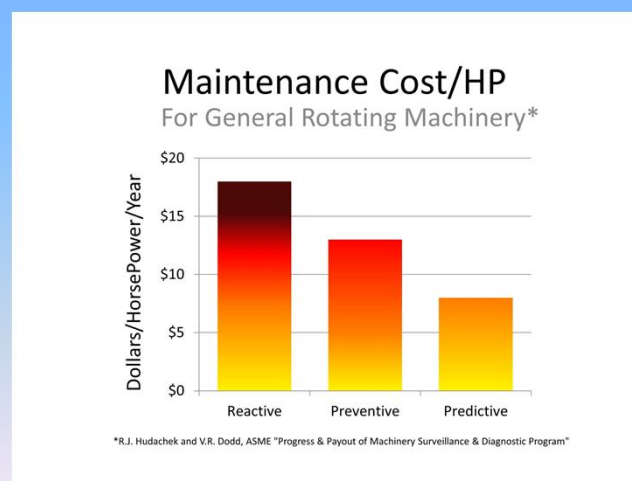
## Operation & Maintenance

- Best Designs & Construction - Doomed to Failure Without Proper and Ongoing Maintenance
- Commissioning and Re-Commissioning
- Retro-Commissioning to Return to Original Design Concepts and Operation

## An Effective Maintenance Strategy Improves Performance (and Increases the Bottom Line)

- Reduces unscheduled downtime
- Reduces maintenance costs including emergencies, scheduled teardowns and secondary damage
- Quality assurance for warranty and recurring problems
- Reduces energy and operating costs
- Extends equipment life and operating efficiency
- Allows for proactive and predictive analysis of problems rather than reactive, which is crisis management (expensive!)

## Maintenance Costs: Reactive vs. Preventive vs. Predictive

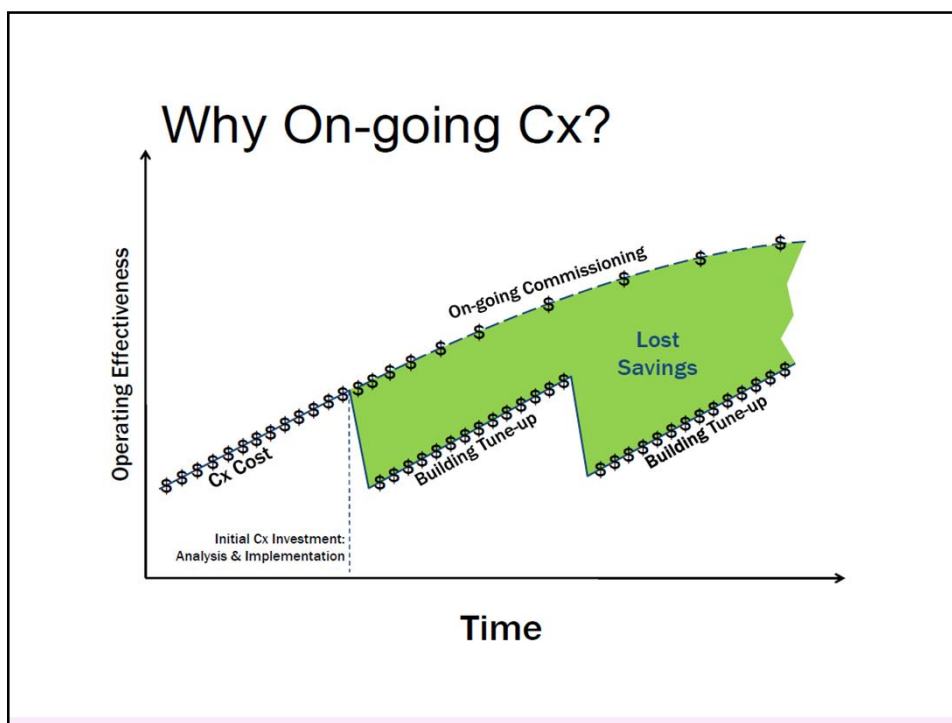


## Benefits of Retro-Commissioning (1)

- Reduce energy consumption and operating costs
- Gain full understanding of energy usage, requirements, and savings
- Return equipment to its proper operational state and prolong life of equipment
- Reduce operational and maintenance expense
- Reduce consumption of natural resources
- Improve air quality and the indoor environment

## Benefits of Retro-Commissioning (2)

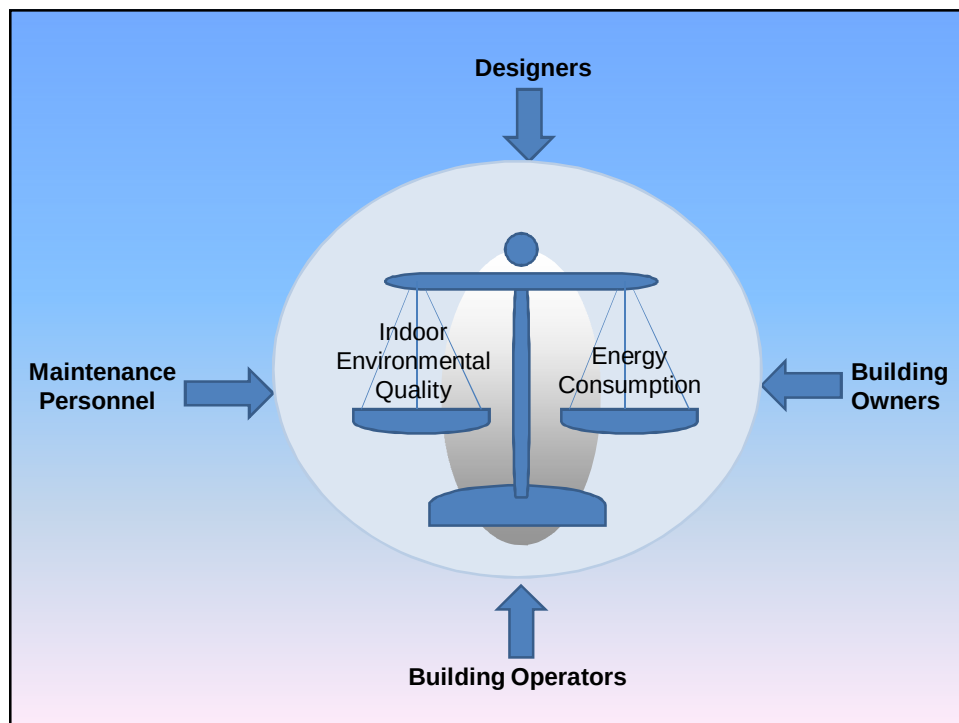
- Increase productivity
- Reduce staff time spent on emergency calls
- Increase tenant satisfaction, reduce complaints and improve occupant comfort
- Update building information
- Improve facility equipment operation and energy efficiency
- Reduce impact on the planet



## Technology ≠ Performance

“An inefficient system run well  
can perform better than  
an efficient system  
run poorly.”

- Newman

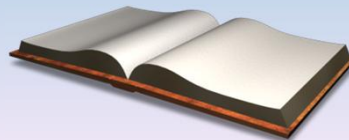


## Where To Get Information - ASHRAE

- Procedures for Commercial Building Energy Audits
- Energy Conservation in Existing Buildings
- Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
- Standard Measures of Measuring, Expressing and Comparing Building Energy Performance
- Preparation of O & M Documentation for Building Systems
- Sustainable, High-Performance O & M (2012)
- Advanced Energy Design Guides (AEDG) – 30% / 50% – free!

## Where To Get Information - Other

- USGBC: LEED-EB: O & M Guidelines  
Based on EPA Energy Star® Portfolio Manager,  
ASHRAE Energy Standard 90.1.  
Green Operations Guide (2010)
- BOMA: Preventive Maintenance & Building Operation Efficiency (2003 – written by ASHRAE member)
- IFMA Foundation: Sustainability “How-To” Guides
- EPA Energy Star
- Rocky Mountain Institute
- PECI



## References & Resources

[www.ashrae.org](http://www.ashrae.org)

[www.usgbc.org](http://www.usgbc.org)

[www.wgbc.org](http://www.wgbc.org) (World Green Building Council)

[www.aia.org/cote](http://www.aia.org/cote) (AIA Committee on the Environment)

[www.eren.doe.gov](http://www.eren.doe.gov)

[www.sustainable.doe.gov](http://www.sustainable.doe.gov)

[www.energystar.gov](http://www.energystar.gov)

[www.nrel.gov](http://www.nrel.gov) (Renewable Energy)

[www.rmi.org](http://www.rmi.org) (Rocky Mountain Institute)

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## References & Resources (cont.)

[www.peci.org](http://www.peci.org) (Portland Energy Council – O & M Techniques)

[www.greenseal.org](http://www.greenseal.org)

[www.greenguard.org](http://www.greenguard.org)

[www.fpl.fs.fed.us/ahrc/mold/mold-methods.html](http://www.fpl.fs.fed.us/ahrc/mold/mold-methods.html) (Forest Products Lab)

[www.ifmafoundation.org](http://www.ifmafoundation.org)

[www.NCGconsulting.us.com](http://www.NCGconsulting.us.com)

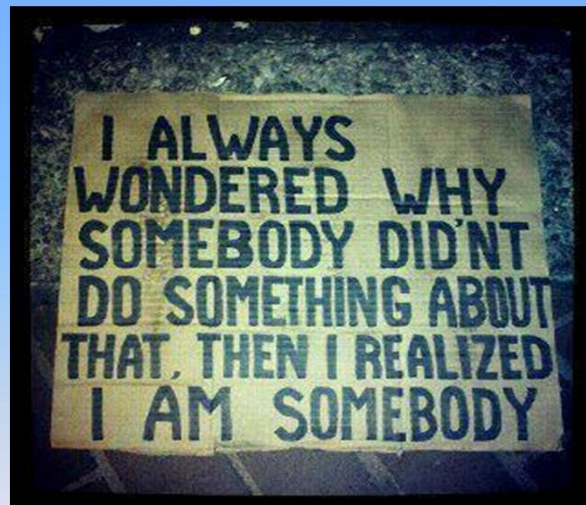
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## So What Now?

- Use what you're learning today – never stop learning
- Think “Outside the Box”
- Keep up-to-date
  - ASHRAE Standards, LEED Guidelines
  - BOMA/IFMA/USGBC/ASTM, etc.
  - Government Regulations
- Join professional organizations
- Get a professional certification
- Be a teacher, not just a student



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***“We Do Not Inherit the Earth from Our Ancestors –  
We Borrow It from Our Children” – Native American Proverb***

***Build Green – Everyone Profits!*** - USGBC