Building Sustainability through Building Automation

BUILDING OPERATING MANAGEMENT'S
NFMT2014
National Facilities Management & Technology March 4-6, 2014 • Baltimore

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Learning Objectives:

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- Enumerate significant factors leading to building sustainability
- Justify how building automation can help a facility professional achieve higher energy efficiency
- State why an open standard BACnet system offers greater sustainability achievement than proprietary control systems


PLEASE INFORM GROUNDSKEEPING THAT THE GREEN SPACE IS INVADING MY PERSONAL SPACE.
cartertoons.com

Definition

- Building Automation System (BAS)
  - A centralized, interlinked, network of hardware and software, which monitors and controls the environment in commercial, industrial, and institutional facilities.
  - While managing various building systems, the automation system ensures the operational performance of the facility as well as the comfort and safety of building occupants.
  - Installed in new buildings or as part of a renovation.

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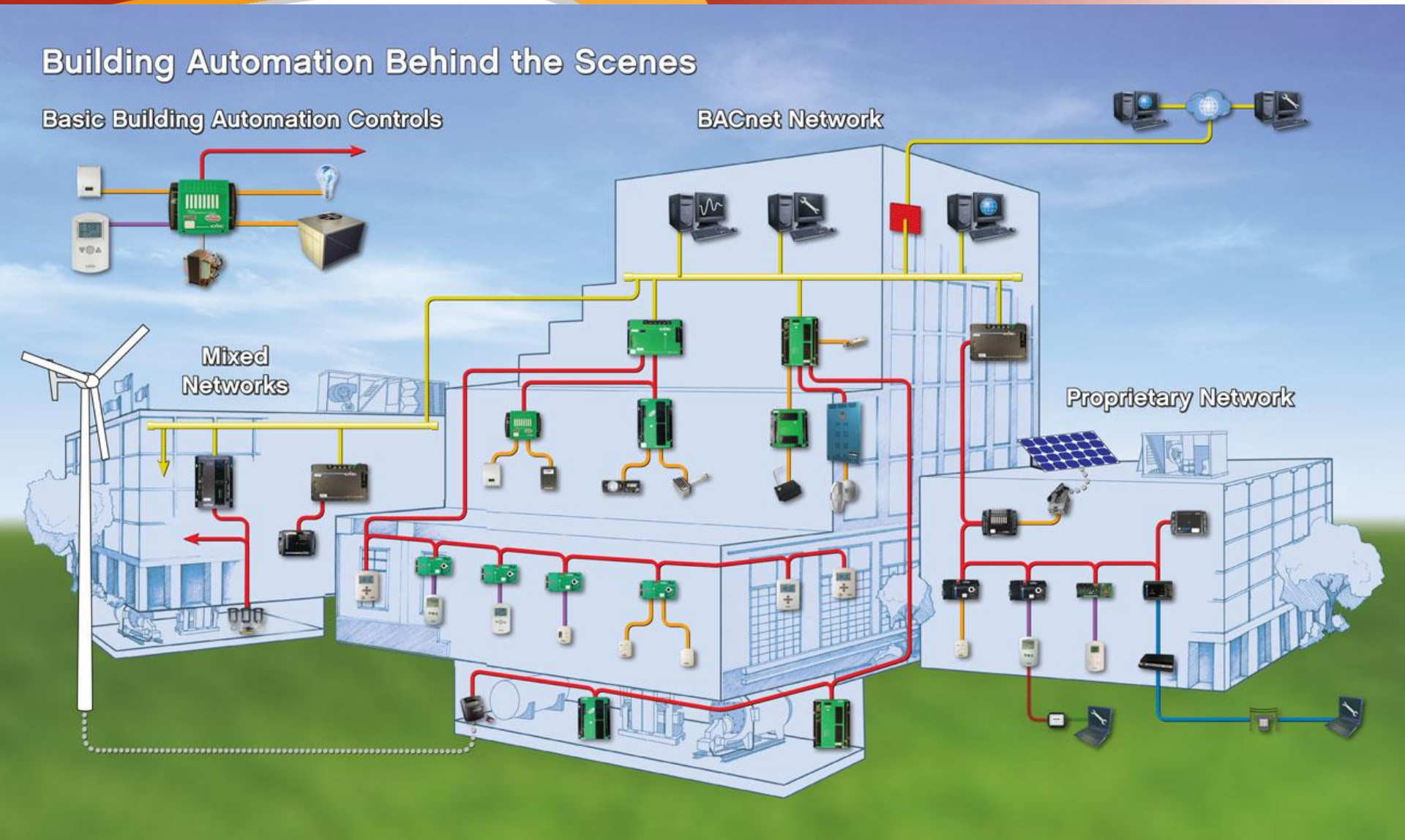


Related Terms

- Building Automation and Control Systems (BACS), Building Control System (BCS), and/or Building Management System (BMS).
- Building Operating System (BOS)—a new term introduced by those in the Owner/FM profession
- Controls—This term is appropriate in describing discrete devices that control particular pieces of equipment or processes.
- Direct Digital Control (DDC)—describes the communication method used in modern devices (hardware and software). Collectively, DDC products control various building systems and form the automation system.
- Energy Management System (EMS)—generally understood to be the same as a "Building Automation System" but may have special emphasis on energy metering/monitoring.
- Energy Management and Control System—well, you're getting the idea.
- Smart (Intelligent) Building—a building equipped with a data-rich BAS.

Another Definition

- Sustainability
  - Engaging in practices that lead to long-term viability
  - Practices that provide for the future without sacrificing the present
  - End game: a building that requires no more in terms of resources than what it can return
  - Examples:
    - Net Zero Energy (Zero-Net Energy; ZNE)
    - Living Building Challenge (http://living-future.org/lbc)

Why Go Sustainable?

- Social or professional responsibility
- Environmental stewardship
- Green building certification
- Regulatory mandates
- Promise of cost savings
- Image or brand warmth

Whatever the Reason . . .

- No matter what propels you toward the sustainability goal, building automation and control systems can contribute greatly to its achievement.

Benefits of BAS for Green Buildings

- Building automation can benefit your green building in a number of ways.
- Let's look at four important benefit categories:
  - Higher Energy Efficiency
  - Lower Operating and Maintenance Costs
  - Better Indoor Air Quality
  - Greater Occupant Comfort and Productivity

AT THE "ENERGY SAVINGS CONFERENCE"

Higher Energy Efficiency—Practices

- Scheduling
  - Purpose: To avoid the costs associated with unnecessary lighting or space conditioning (i.e. temperature, humidity, air quality).
  - Avoids wild swings in runtime for mechanical equipment (optimizing start/stop times for occupied periods)
  - Levels out associated demand for energy (electricity, gas, water)

Higher Energy Efficiency—Practices

- Scheduling
  - Surprisingly, many pieces of mechanical equipment remain unscheduled, have their schedules overridden, or are programmed incorrectly.
  - 10% (or more) energy savings can be achieved through scheduled control alone.

Higher Energy Efficiency—Practices

- Occupancy-Based Control
  - Easy to achieve through occupancy sensing.
  - Can be supported or verified through security/ access systems such as card swipes and CCTV.
  - Occupancy-based lighting control is most common; Occupancy-based control through integrated systems (Lighting + HVAC or Lighting + HVAC + Security) are also common.
  - Self-learning (or Adaptive) occupancy sensing is also possible.
  - Combine occupancy sensing with scheduling for best results.

Higher Energy Efficiency—Practices

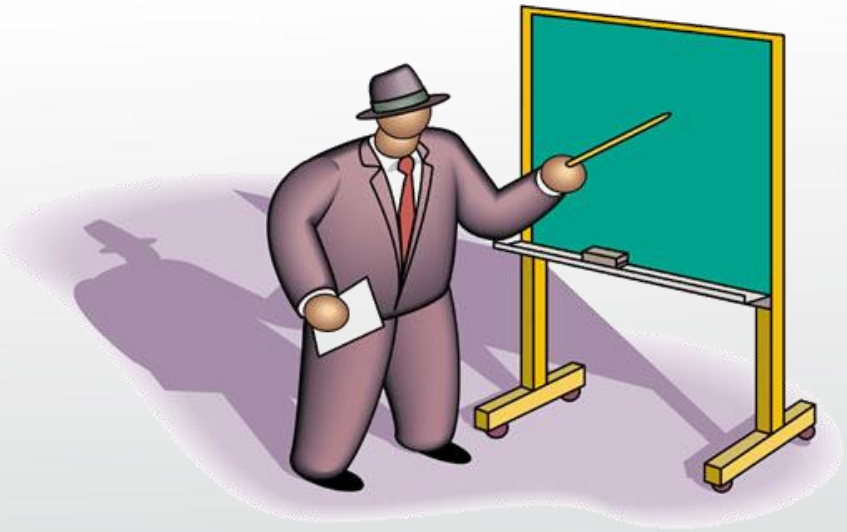
- Misc
  - Proper implementation of advanced, demand-based zoning systems such as VAV and chilled beam, can create a good deal of energy savings.
  - Coupling these strategies with proper static pressure control of the supply air (such as with VFDs on the fans) results in further energy efficiencies.

Higher Energy Efficiency—Practices

- Misc
  - Consider practices that involve resetting the various air stream temperatures, supply water temperatures, and cooling tower condenser temperatures to optimum setpoints as the dynamic loads change.
  - Lighting controls reduce unnecessary artificial lighting via motion sensors and schedules as well as by controlling daylight harvesting louvers.
  - A control system saves water and energy by controlling rainwater harvesting and landscape irrigation.

Higher Energy Efficiency

- Success Story
  - http://www.bacnetinternational.net/success/stories.php?sid=54



Higher Energy Efficiency—Success Story

- TDK Headway Technologies
  - Market: Technology Manufacturing
  - Owner: TDK Corporation
  - Location: Silicon Valley
  - Building Size:
    - 115,000 sq ft
  - Project Type:
    - Energy Retrofit
  - Year completed:
    - 2012

Higher Energy Efficiency—Success Story

- Their Business:
  - Manufactures aluminum titanium carbide wafers consisting of thousands of read/write heads used in computer hard drives.
  - TDK sales of such devices account for about 1/3 of all such sales worldwide.
  - ISO-14001 registered quality system and Class 100 clean room manufacturing

Higher Energy Efficiency—Success Story

- The Situation
  - Corporate mandate of continuous improvement
  - Annual energy-use reduction goals but dictated by fabrication requirements
  - Location costs challenge them to be ultra-competitive in a worldwide arena
  - Had achieved year-over-year energy reduction goals for 5 previous years
  - BUT, had done so through low-hanging fruit

Higher Energy Efficiency—Success Story

- The Challenge
  - Achieve 10% energy reduction goal
  - WITHOUT disrupting the fabrication (24/7/365 operation)
  - Maintain environment at 68° +/- 1 degree and 45% RH +/- 2.5%

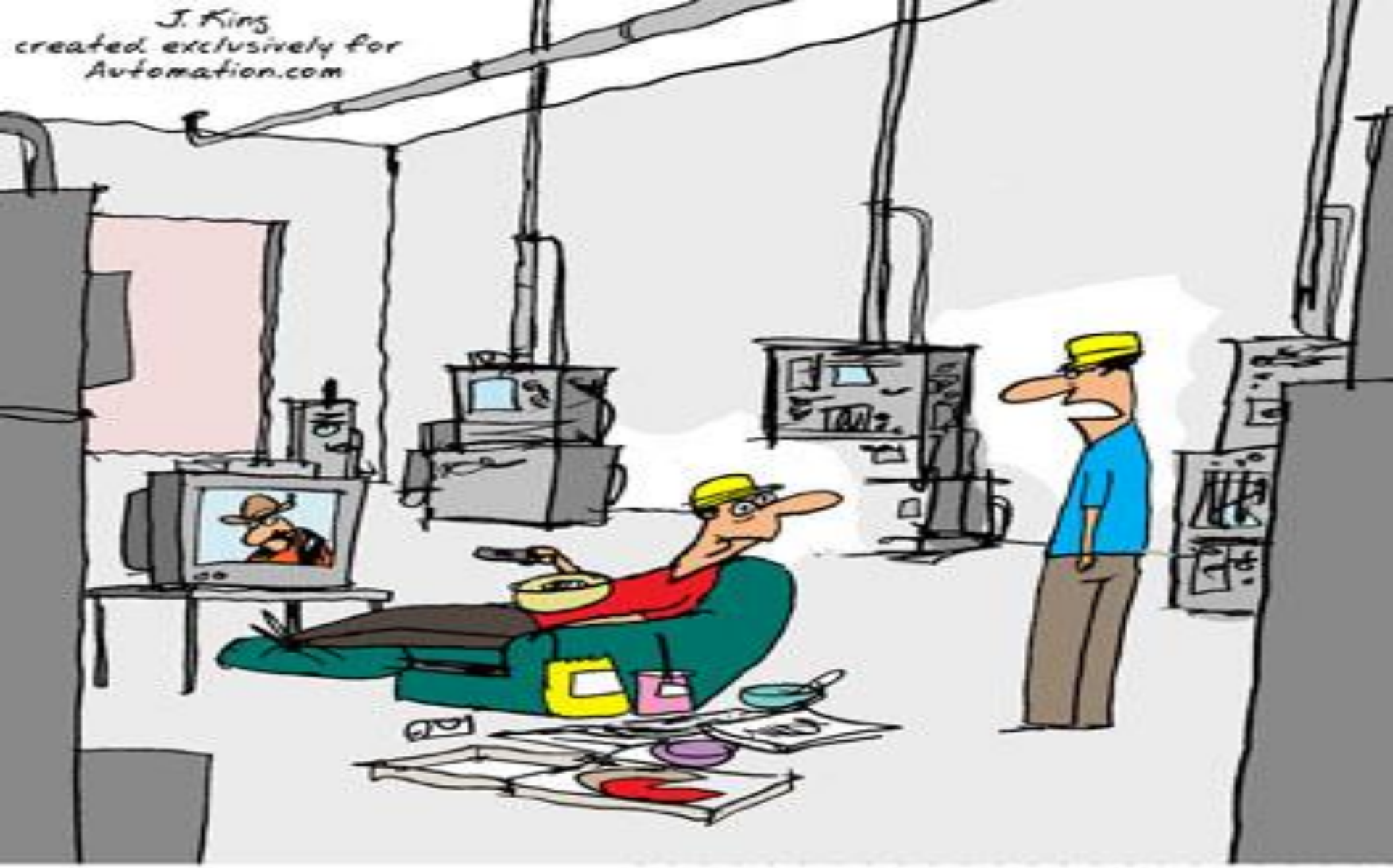
Higher Energy Efficiency—Success Story

- The Solution
  - Deep energy audit
  - System-level thinking
  - From conditioning 100% of air to conditioning supply and make-up air (sensors and BACnet controls)
  - For water usage (chilled, hot, steam), all requiring gas, added VFDs, staged cycle usage, sensors and BACnet control to maintain only required pipe pressures

Higher Energy Efficiency—Success Story

- The Results
  - ROI in 10 months!
  - Electricity: 5.4 to 4.4 megawatts continuous demand ($800K savings)
  - Gas: of 10 boilers in operation before, only 5 in operation now
  - PG&E rebate check: $633,500
  - Mayoral recognition for CO_2 reduction

Higher Energy Efficiency—Success Story



"I realize our new, automated factory has made your job easier, but can you at least look busy?"

Lower O&M Costs—Practices

- Go BACnet
  - For up-front building/system design, selection of an automation system based on an open communication protocol, and BACnet® in particular, offers future proofing benefits such that subsequent updating will always lead to interoperable devices and systems.

Lower O&M Costs—Practices

- Go BACnet
  - In terms of building operation, an interoperable control system can offer training-related synergies, thereby reducing or containing labor costs.
  - With disparate systems in place, the cross-training of technicians and operators can be daunting.
  - An interoperable system, on the other hand, means that technicians and operators can learn one front end or operator workstation while nicely managing the interoperating systems.

Lower O&M Costs—Practices

- Go BACnet
  - In addition, BACnet was built for integration of building systems. The notion of integration is central to LEED® certified or other green buildings.
    - A&E professionals speak of an "integrated design."
    - Contractors talk about "integrated project delivery."
  - Integrated approaches to building systems can have a positive impact on transportation footprints, on training and cross training of employees, and, of course, on the most efficient operation of equipment.
  - Integration of systems can have a distinct positive impact on initial costs and operating budgets.

Lower O&M Costs—Practices

- General Practices
  - Trends and logs provide information for further optimization of the system as well as for documentation requirements for building certification.
  - Based on sensor data, software alarms and notifications alert service personnel to issues before they cause discomfort to building occupants and escalate into bigger, more costly problems.

Lower O&M Costs—Practices

- General Practices
  - Remote network monitoring and troubleshooting via the Internet reduces service calls.
  - Sensors with data ports also allow quick network access and control to service personnel using a laptop computer and a network interface.
  - Current sensors and power meters monitor energy consumption and electrical generation by wind turbine and/or photovoltaic arrays for credit from the utility company.

Lower O&M Costs—Practices

- Mechanical Retrofit Practices
  - Example: Roof-top Units (RTUs)
  - According to DOE, inefficient ones waste $1K-$3.7K per unit per year

Retrofit with Advanced Controls	Replace
>7 tons cooling capacity and <10 years old	>10 years old or R22 refrigerant
With constant speed fan	Poor operating condition
Good working condition and another 5 years or more expected life	Improved comfort/humidity control required
	Extensive building retrofit underway

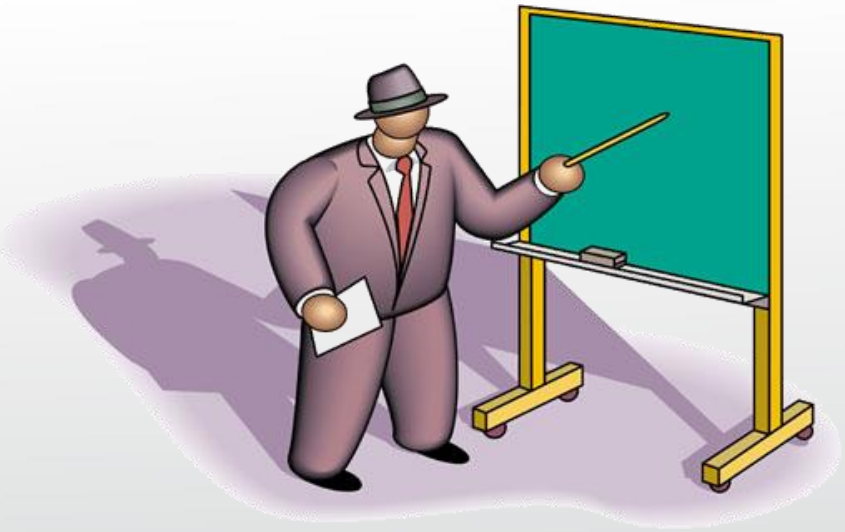
http://www.advancedrtu.org/

Lower O&M Costs—Practices

- Lighting System Retrofit Practices
  - Low-hanging fruit but perform audit to focus on right stuff first
  - In addition to space measurements and type/age/wattage of lamps, etc., ask: "What controls (if any) are present?"
  - From dimming to daylight harvesting to scheduling to occupancy-based control, O&M costs are lowered.

Lower Operating & Maintenance Costs

- Success Story
  - http://www.bacnetinternational.net/success/stories.php?sid=52



Lower Operating & Maintenance Costs—Success Story

- Neutec Pharmaceuticals
  - Market: Bio-Med
  - Owner: Neutec Pharmaceuticals
  - Location:
    - Sakarya, Turkey
  - Building Size:
    - 400,000 sq ft
  - Project Type:
    - Phased Expansion
  - Year completed:
    - 2012

Lower Operating & Maintenance Costs—Success Story

- The Challenge
  - Class 1000 clean rooms
  - Title 21 CFR part 11
  - Stringent reporting
  - Adding needed mechanical systems and control without disrupting operations and while delivering the necessary reporting data

Lower Operating & Maintenance Costs—Success Story

- The Solution
  - AHUs, VFDs, specialized filters
  - BACnet sensors, controllers, advanced operator workstation

Lower Operating & Maintenance Costs—Success Story

- The Results
  - A. Tarkan Asalkan, General Manager: "The system has allowed the facility to operate at peak efficiency because we know when we have a problem with our controlled environment long before it is out of tolerance. This allows my facilities staff to take corrective action before we lose any production. The reliability of the control system is unbelievable. We actually took out an early industrial process control system in one area of the plant because _____ proved they could control the space to within +/ 0.2C and +/- 1% humidity in a similar area. Until that time, the best our process system could achieve was twice those tolerances. This level of control means we can improve production rates by 5-10%, which translates to a lot of money!"
  - In another area: "We now set the alarm at 21% because that gives us an hour to address the issue before we have to shut down. As a result, our planned breakage was reduced by over 15% and our costs are running well below projections."

Climate Change

Better Indoor Air Quality

- Can proper indoor air quality be achieved without sacrificing costs or comfort?
  - Today's control systems can lead to a well-tuned building where energy performance, comfort, and sustainable factors all reside harmoniously.
  - The difference between a building that does and a building that doesn't is most often tied to the design and installation of the control system.
  - That's where qualifying the controls contractor, energy service provider, or system integrator really pays off.

Better Indoor Air Quality—Practices

- Demand Control Ventilation (DCV)
  - Ventilation systems historically designed based on assumed occupancy (ASHRAE 62).
  - DCV is newer and may be better.
  - Here, only the proper amount of outside air is introduced into the space by monitoring return air or space CO_2 levels and controlling fresh air dampers.
  - A great deal of money can be saved by NOT conditioning hot summer outside air or cold winter outside air.

Better Indoor Air Quality—Practices

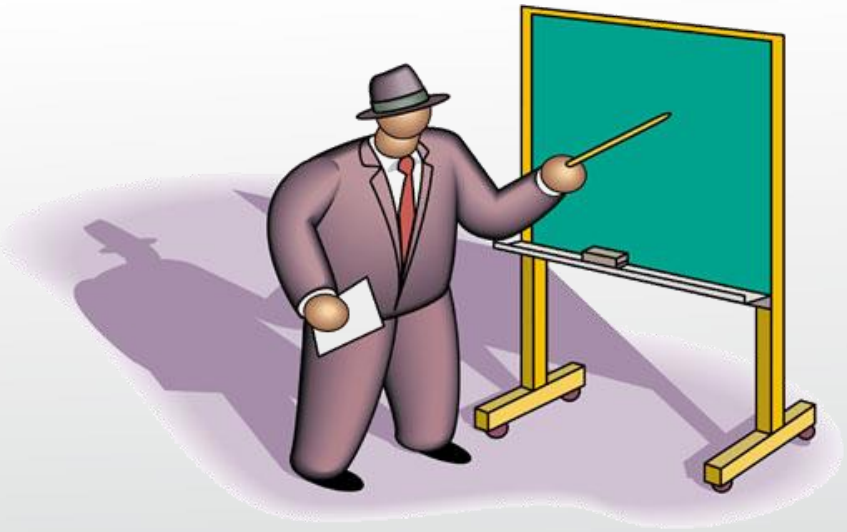
- ASHRAE Standards
  - Changing
    - ASHRAE 62 addresses ventilation and air quality
    - ASHRAE 55 addresses thermal comfort
    - ASHRAE 90.1 addresses energy efficiency
  - Moving toward 189.1 as a comprehensive green building standard to eventually replace all the above plus those set by the California Air Resources Board and SMACNA.
  - Standard 189.1 mirrors, to a great extent, the organization of the LEED standards:
    - IEQ
    - Site Sustainability
    - Water Use Efficiency
    - Construction Plans and Operation
    - Atmosphere, Materials, & Resources
    - Energy Efficiency

Better Indoor Air Quality—Practices

- General
  - Temperature, humidity, and air-flow sensors monitor conditions necessary for comfort.
  - Carbon dioxide (CO_2) and carbon monoxide (CO) sensors monitor pollutants, ensuring the required minimum fresh air ventilation.
  - Control systems provide smoke control during a fire, maintaining breathable air zones for evacuation.
  - The control system monitors and controls natural ventilation dampers.

Better Indoor Air Quality

- Success Story
  - http://www.bacnetinternational.net/success/stories.php?sid=59



Better Indoor Air Quality—Success Story

- Name: The Bullitt Center
- Market: Commercial Office
- Project Type: New Construction
- Location: Seattle, WA
- Completed:
  - Earth Day 2013
- Size:
  - 6-stories
  - 50,000 Sq. ft.

Better Indoor Air Quality—Success Story

- Claim to Fame:
  - Billed as the world's "greenest" and most energy efficient office building
  - First commercial office building in the U.S. to meet the requirements of the international Living Building Challenge

Better Indoor Air Quality—Success Story

- Other Characteristics
  - Low-leakage shell
  - Large, smart windows
  - FSC wood products
  - VOC/off-gassing considerations
  - Rainwater collection potable water use
  - Composting toilets for on-site waste processing
  - 14,000 square foot rooftop photovoltaic solar array
  - Green roof

Better Indoor Air Quality—Success Story

- Mechanical/Control Provisions
  - AHUs, VAVs, and heat pumps sourced by ground wells
  - Radiant floor heating/cooling with BACnet control
  - Smart windows with BACnet control
  - Sensors and BACnet controllers for indoor air quality management (and free cooling) via DCV
  - BACnet-fed energy dashboard for occupant/visitor education

Better Indoor Air Quality—Success Story

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Occupant Comfort and Productivity


Scrabble
PRODUCTIVITY
WWW.CARTOONaDAY.COM
? ? E ?
CAN SOMEONE PLEASE EXPLAIN WHY
PRODUCTIVITY HAS DECREASED
SINCE THE COMPANY BOUGHT
SMARTPHONES??!!

Greater Occupant Comfort and Productivity

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- Automation and control contributes greatly to occupant comfort.
- Comfort is linked to productivity.
- Sustainable practices are linked to productivity.
- Sustainable practices are closely tied to automation and control.

Greater Occupant Comfort and Productivity

- So,
  Let's look at sustainability related practices that are tied to automation and that contribute to comfort and productivity.

Greater Occupant Comfort and Productivity—Practices

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- Daylighting
  - Many studies (from office workers to school children) illustrate connection to productivity.
  - Better views (size of window, views of vegetation) = higher productivity.

Greater Occupant Comfort and Productivity—Practices

- Daylighting
  - In contrast, studies warn against a potential problem with glare. Simply putting as many windows in a space as possible without means to control the light coming in, can hinder productivity.
  - In addition, more daylighting = greater heat load more cooling demand (which requires control)

Greater Occupant Comfort and Productivity—Practices

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- Daylight Harvesting
  - Refers to automatic adjustment of interior lighting to offset varying supply of exterior daylighting.
  - Sensors, schedules, and automated control is essential here.

Greater Occupant Comfort and Productivity—Practices

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- Comfort
  - A factor of ventilation, temperature, and humidity; all require control
  - Studies: giving occupants any degree of control over comfort increases satisfaction
  - Example: adjustable diffusers for UFAD

Greater Occupant Comfort and Productivity—Practices

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- IAQ Revisited
  - Good IAQ measures reduce potential for sick building syndrome (SBS). SBS tied to sick days, higher medical costs, and lower productivity.
  - Cases of asthma and other respiratory at historic highs. Good IAQ practices also mitigate factors leading to symptoms.

Greater Occupant Comfort and Productivity

- A control system can tie building access to the activation of HVAC and lighting for a particular space (such as an office or zone).
- This is good for both individual comfort control (an imperative for green buildings) as well as efficient use of equipment and power.
- By the same token, schedules can offer similar benefits while permitting some override capability to suit individual needs.
- Trended or historical data can be used to both analyze and improve building performance.

Greater Occupant Comfort and Productivity

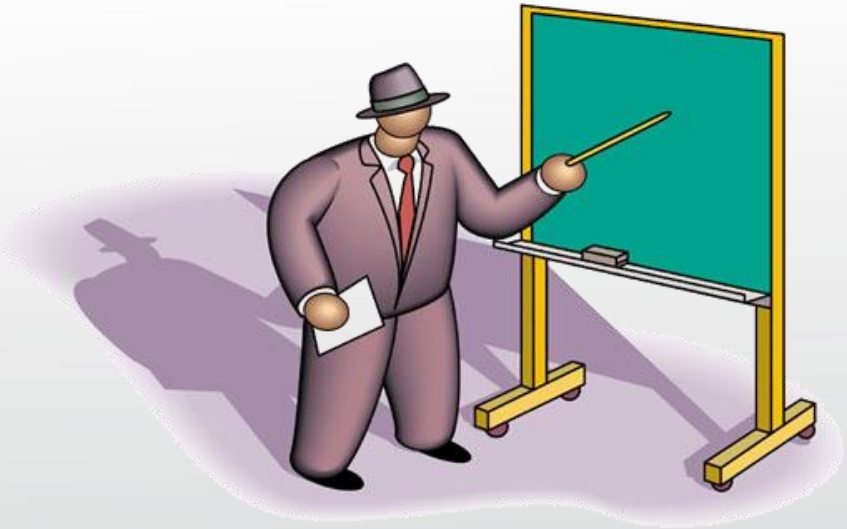
- Beyond occupant comfort, the control system also has a profound effect upon occupant productivity.
- This fits the greater intent of indoor environmental quality as defined by the LEED rating system for green buildings.
- As an example, a control system can monitor for CO_2 or other contaminants and initiate ventilation, alarms, or other remedial activities.

Greater Occupant Comfort and Productivity

- Controllers, based on sensor input, provide optimal zone ventilating, heating, and air conditioning.
- Sensors in each room sense temperature and allow occupant-controlled set points and overrides.
- Humidity sensors are used to control summer dehumidification and winter humidification of air.

Greater Occupant Comfort and Productivity

- Success Story
  - http://www.bacnetinternational.net/success/stories.php?sid=55



Greater Occupant Comfort and Productivity—Success Story

- Name: Grand Traverse Pavilions
- Market: Healthcare
- Location: Grand Traverse County, Michigan
- Project Type: Retrofit (1999 original construction)
- Completed:
  - 2011
- Size:
  - 2-stories
  - 175,000 Sq. ft.


Grand Traverse Pavilions

Greater Occupant Comfort and Productivity—Success Story

- Background
  - Home to 300 residents
  - Community-based senior and intergenerational residential care
  - Variety of adult respite services and supported and assisted-living areas
  - Staff specializes in Alzheimer's and dementia care.

Greater Occupant Comfort and Productivity—Success Story

- The Challenge
  - Owners "looking to improve comfort and operational efficiency"
  - Audit revealed
    - Outdated communication between control devices
    - Numerous comfort complaints
    - Inefficiencies making even routine management complicated and laborious for facility personnel

Greater Occupant Comfort and Productivity—Success Story

- The Solution
  - Legacy control left in place but integrated to new via BACnet
  - Re-piping/re-sequencing of radiant ceiling panels to VAV boxes
  - Aged chiller replaced and new brought under BACnet control
  - Web portal installed as window into integrated system

Greater Occupant Comfort and Productivity—Success Story

- The Results
  - Immediate improvement in levels of comfort and satisfaction of residents
  - Reduction in cooling load on the chiller and heating load on the boiler
  - $76,000 drop in annual utility expenditures
  - Director of Environmental Services, Dr. Robert Siekman: "The leading-edge control enables us to maintain an environment where the level of care can excel."

Learning Objectives Assessment

- An interoperable control system, such as one based on BACnet communications, can help lower operating and maintenance costs.
- Adding schedules to mechanical equipment control is a good way to increase energy efficiency.
- Choosing an open protocol approach to building automation, such as BACnet, can help you future proof your facility.
- In the LEED rating systems, the Sustainable Sites Category offers the most potential for points related to building automation systems.