



## Building/Energy Management Systems

- ❑ **Sensors:** (cont.)
  - Sensor location is CRITICAL !
    - ❑ Residential HVAC sensor location
    - ❑ Office building sensor locations
      - Temperature
      - Relative Humidity
      - Motion Detectors
  - Sensor type/appearance:
    - ❑ involve customer in sensor location selection and appearance
    - ❑ Are sensors "active/passive"; type of display, etc.
    - ❑ How much control do customers get?

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## Building/Energy Management Systems

- **Controllers:** (OUTPUT device)
  - ❑ take sensor input, compare with desired setpoint and regulate output signal to cause a control action at the controlled device.
  - ❑ **Thermostat:** combination of sensor and controller
  - ❑ Pneumatic **RECEIVER/CONTROLLER**
    - direct acting vs. reverse acting

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## Building/Energy Management Systems

- ❑ **PIPETRADES JATC Field Trip:**
  - Honeywell "Master Energy Controller"
    - ❑ Temperature/enthalpy sensor input (AI)
    - ❑ Output to economizer dampers (AO)
    - ❑ Output to refrigeration compressors for mechanical cooling stages (DO)
  - **AI:** analog input (room temperature/outside air temperature)
  - **DO:** digital output for on/off control (contact closure)
  - **AO:** analog output for proportional control (0 - 10 vDC or 4 - 20 mA)

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## Building/Energy Management Systems

### ■ **Controlled Devices:**

- **control valves** (chilled water, hot water)
- **relays** (lights/compressor staging)
- **damper actuators** (VAV boxes, economizers, inlet vanes)
- **Variable Frequency Drives (VFD's)**
- **HVAC equipment** (fans, pumps, duct heaters, compressors, humidifiers, etc.)

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## Building/Energy Management Systems

### ■ **Control System Types:**

- **open loop:** (no feedback)
  - pressure dependent VAV
  - temperature control directly from sensor
  - supply air reset control off outside temp
  - boiler reset control off outside air temp
- **closed loop:** (includes feedback)
  - pressure independent VAV
  - supply air reset control off space temp
  - boiler reset control off space temp

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## Building/Energy Management Systems

### ■ **Control System Types** (cont.)

- **on/off:**
  - staging package unit capacity
  - multiple stage refrigeration compressors
  - boiler staging
  - time-of-day scheduling
- **PID: P**roportional **I**ntegral **D**erivative
  - "smart" control; eliminates hunting
  - controls "learn" how they affect system
  - Integral/derivative functions add the effect of "time"

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## Building/Energy Management Systems

### ■ Control System Types (cont.)

#### □ Pneumatic systems:

- least first cost (\$ 500 - \$ 600 per point)  
(\$ 200 - \$ 300 per VAV box)
- reliability
- easy for user to understand/maintain (?)
- time-proven design
- difficult for plant monitoring
- minimizes amount of electrical/control wiring

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## Building/Energy Management Systems

### ■ Control System Types (cont.)

#### □ DDC (Direct Digital Control):

- higher first cost (\$ 800 - 1,200 per point)  
(\$ 400 - 500 per VAV box)
- more difficult/confusing to install and maintain (?)  
(lots of electrical low voltage wiring)
- actuators have been problematic
- powerful building monitoring and facilities tool
- tighter temperature/RH control capabilities
- interfaces with HVAC equipment for troubleshooting and monitoring

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## Building/Energy Management Systems

### ■ Control System Types (cont.)

#### □ Combination DDC/pneumatic:

- pneumatic used for VAV systems/actuators
- DDC for HVAC equipment control/ monitoring

#### □ DDC system "architecture"

- computer hardware interface (PC's, modems, printers, etc.) to system "front-end"
- graphic software packages for ease-of-use
- "twisted pair"/Belden control wire for interface with "stand-alone" control panels @ equipment
- unlimited number of AO/DO/AI/DI points

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## DDC Systems

- Take advantage of "Information Age"
  - replace older pneumatic controls with DDC
- Internal diagnostics on major equipment
- Unlimited trend-logging/reporting capabilities
- Improved troubleshooting for service technicians
- Remote monitoring/control

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## DDC Systems

- Multiple users at once
- Lighting system controls
- Security system controls
- Fire/Life safety controls
- Process Monitoring/Control
- BACNET/LONWORKS compatibility issues

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## Building/Energy Management Systems

- **Control System Strategies:**
  - Time-of-day scheduling
    - Timeclocks
    - Programmable thermostats
  - Demand Limiting
    - Utility rate structure with "demand charges"
  - Optimum start/stop

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## Control System Strategies

- **Load Shedding/Peak Shaving:**
  - Contract with utility company to voluntarily reduce demand during "power crisis" mode
  - Identification of critical loads:
    - Computer/server rooms
    - Telecommunication centers
    - Fire/Life safety systems
    - Production/Manufacturing processes
  - Communication with user groups CRITICAL !

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