THE FUTURE OF DCV

- Research areas and possibilities

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FUTURE RESEARCH ON DCV SYSTEMS

- DCV systems have two basic tasks in HVAC system design:
  - Control of thermal comfort (TC)
  - Control of air quality (AQ)

- Future research topics:
  - Demand specification
  - Demand control variables
  - Demand variability
  - DCV components
  - DCV system design
DEMAND SPECIFICATION

• Identify critical factors for the well-being and efficiency of humans and processes (biology, medicine, psychology, process technology…)

• Classify critical factors
  - Safety (short-term hazard)
  - Health (long-term hazard)
  - Well-being
  - Efficiency (being well)
  - Use of energy

• Quantify in engineering terms
DEMAND CONTROL VARIABLES

- **TC**: Well-known; air enthalpy
  (temperature, humidity, air velocity…)

- **AQ**: Complicated
  - Air enthalpy: perception
  - CO2: indicator, no problem per se

*General considerations*
- Gases: perception & health (e.g. VOC)
- Gases: perception (e.g. cooking odour)
- Gases: health (e.g. radon, CO)
- Particles: perception & health
DEMAND VARIABILITY

- Demand variability is decisive for the feasibility of DCV systems
- The larger the variability, the larger the potential
- Offices: Rarely 100% occupancy, on average < 40%
DCV COMPONENTS: 1

- Large variation of demand → large variation of supply
- DCV components must handle large turn-down ratios
- Important components:
  - DCV sensors
  - VSD fans (incl. motors and drives)
  - Supply-air terminals (diffusers)
DCV COMPONENTS: 2
SENSORS – MAIN CHALLENGES

• Relations unclear: concentration levels ↔ perceived air quality ↔ comfort and health

• DCV sensing technologies must comply with requirements on:
  - Accuracy, reproducibility, repeatability
  - Cost of installation and maintenance

• Available IAQ discrete technologies set the limits:
  - occupancy sensors
  - humidity and gas (VOC) sensors
  - combined sensors
DCV COMPONENTS: 3
SENSORS - FUTURE DEVELOPMENTS

• Future IAQ integrated technologies:
  - IR+NDIR+MOSFET
  - Selective response
  - Programmable matrix sensors

• Future cost reductions:
  - Wire- and battery less installation
  - Long-term stability
  - Auto-calibration
DCV COMPONENTS: 4
- VSD FANS

- Optimal fan efficiency at low flow
- Optimal motor efficiency at low speed
  - AC (PM) motors,
  - DC (BLDC-PM) motors
- Optimal motor drive operation at low speed
DCV COMPONENTS: 5
- SUPPLY-AIR TERMINALS

- Room-distribution authority over a large flow range
- Flow control over a large pressure range
- Thermal comfort even with low supply temperature
- Low noise level over a large flow range
DCV SYSTEM DESIGN

• **Aims:**
  - Individual COD (TC and AQ) and customer satisfaction
  - Design latitude and flexibility to demand changes
  - Energy efficiency: $W_e$ (SFP, SPF), $Q_c, Q_h$

• **Future system design possibilities:**
  - Low relative utilization: Series
    → Parallel AHU
  - Low SFP: Centralized
    → Decentralized fans

• **Future design traps:**
  - Parasitic heat transfer
  - Parasitic drive power
EXAMPLE 1: PARASITIC HEAT TRANSFER

- Low supply temperature improves drive-energy efficiency
- Low supply temperature will increase parasitic heat transfer

Ratio = 1 → we have lost all the cooling capacity

Courtesy of M-L Maripuu
EXAMPLE 2: ALTERNATIVE SYSTEM DESIGN

SERIAL OR PARALLEL DESIGN

• Serial design

• Parallel design

CENTRALIZED OR DECENTRALIZED FANS
CONCLUSION

DCV is just as much about knowing why, what and when as knowing the how!

Hence we must look at all aspects such as:

• Demand specification
• Demand control variables
• Demand variability
• DCV components
• DCV system design