Desk Mounted Personalized Ventilation Systems

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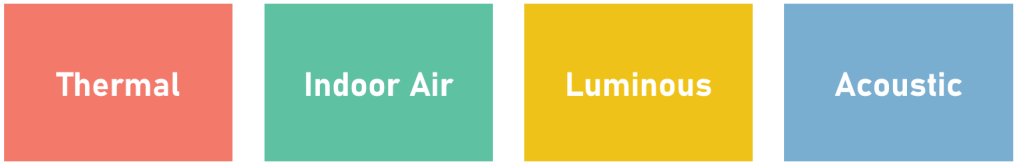
Indoor Environmental Quality and Personalized Environmental Control Systems (PECS)

IEQ – Indoor Environmental Quality

4 Environmental Parameters

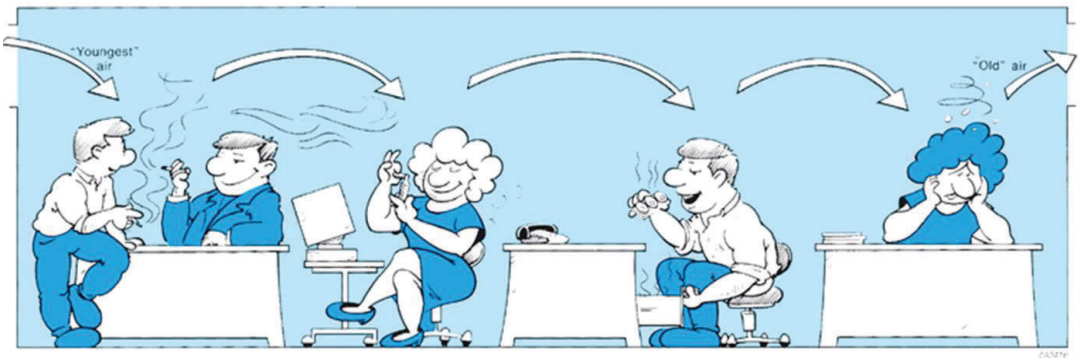


Comfort, Satisfaction, Productivity, Health and Well-being
Of people

Personalized Environmental Control Systems (PECS) – Personalized Ventilation (PV)

- PECS condition the immediate surroundings of the occupants, creating a ”personalized” space
- PECS provide individual control of indoor environmental quality (IEQ) factors
  - Heating / cooling, ventilation, lighting, and acoustics
- Why is PECS particularly important and relevant right now?
- COVID-19 pandemic
  - Increased interest in infection control -> personalized ventilation can provide fresh air more efficiently
- Climate change
  - Resiliency to climate-related disruptions, e.g., heatwaves, wildfires and outdoor air pollution, etc.
  - Energy efficiency, carbon neutrality
- Comfort and health of indoor occupants -> interaction of multiple IEQ factors

Indoor Air Quality – Personalized Ventilation (PV)

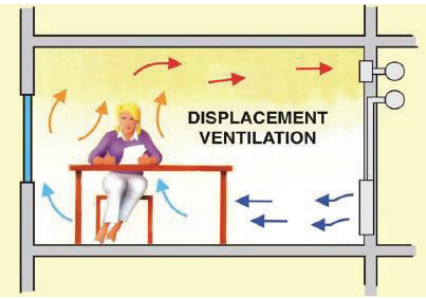


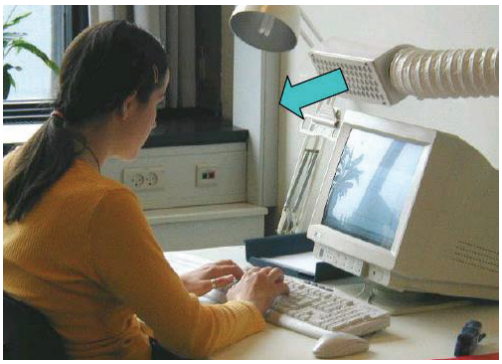
> *We would hesitate to drink water from a swimming pool polluted by human bioeffluents. Still, we accept consuming indoor air that has previously been in the lungs of other persons and is polluted by human bioeffluents and other contaminants generated in the space.*

– P. O. Fanger, 2001

Personalized Ventilation (PV) Systems

- Local volume conditioning: it aims at supplying the clean and cool air close to an occupant before it is mixed with the room air
- The most important advantage of personalized ventilation is its potential to provide clean, cool and dry air at inhalation (breathing zone)



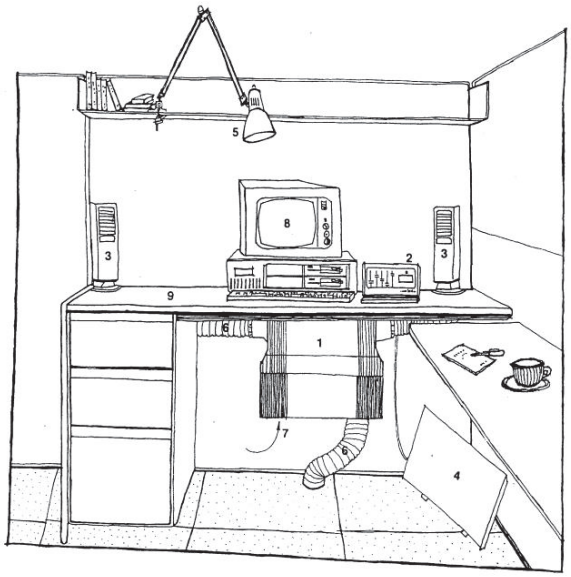


Melikov, 2010

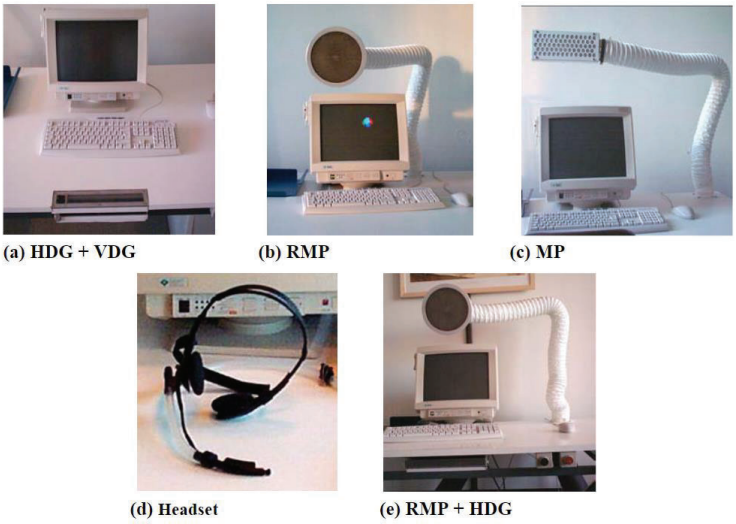
PECS and PV Studies

- Personalized heating, cooling, and ventilation
- Earlier studies had more focus on personalized ventilation, and individual needs and preferences
- Different Air Terminal Devices (ATDs)
- Different systems and combinations
- Approaches:
  - Physical measurements
  - Measurements with (breathing) thermal manikins
  - Human subject experiments
  - Field measurements

PECS and PV Studies

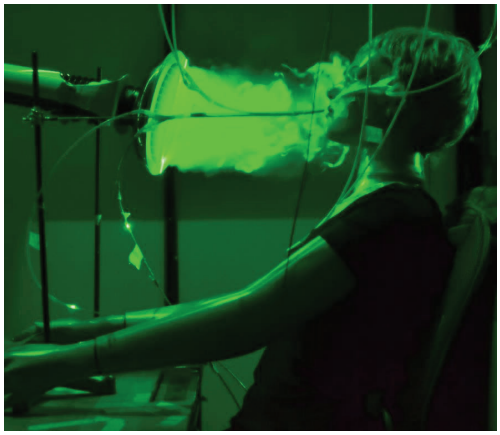


Bauman et al., 1998



Kaczmarczyk et al., 2006

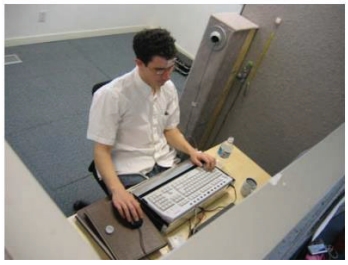
PECS and PV Studies



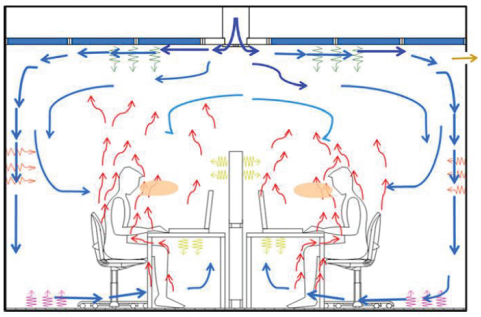
Bivolarova et al., 2017

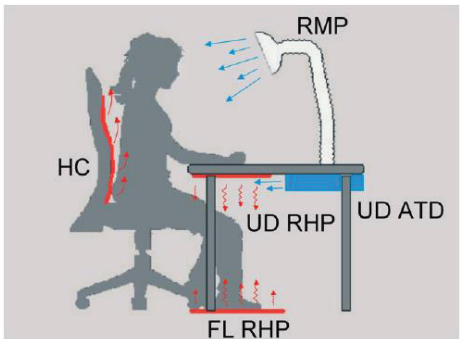
Melikov, 2016

PECS and PV Studies

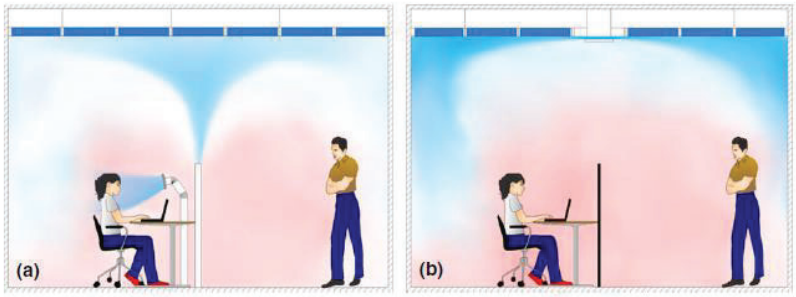


Zhang et al., 2009





Watanabe et al., 2010



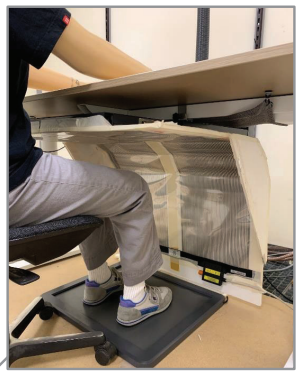
Melikov, 2016

Development of PECS Prototypes at DTU

v1
- Air Terminal Device (ATD)
  - Recirculation + Filter
- 3 Independent Heating Panels (for thighs, shin, and feet)

v2
- Improved ATD
  - Recirculation + Filter
  - **Cooling mode** (Peltier element, waste heat dissipation by **air**)
- Same heating panel as v1

Mockup: Flexible Heating Panel (FHP)

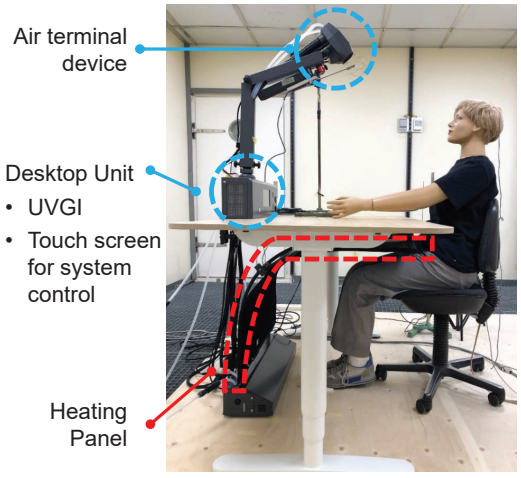


v3
- Improved ATD
  - Recirculation + Filter + **UVGI**
  - Cooling mode (Peltier element, waste heat removal by **water**)
- **Single Flexible Heating Panel**

Settings (Discrete)	
Ventilation	1 – 10
Cooling	1 – 5
Heating	1 – 10

PECS v3

(Current Version)



Kazanci et al., 2022 and Shinoda et al. 2022

Summary and next steps

- Development and improvement of PECS with functions that could address multiple IEQ factors
- Guidance (unified method) in performance evaluation, installation, and operation
- Research gaps that need to be addressed:
  - Integration with the ambient (main HVAC) system
  - Building codes/regulations, standards
  - Commissioning and maintenance
  - User interfaces and interaction with occupants
  - Sizing
  - Cost-benefit and productivity
- To be addressed in IEA EBC Annex 87 - Energy and Indoor Environmental Quality Performance of Personalised Environmental Control Systems (https://annex87.iea-ebc.org)

Bivolarova, M. (2022) Knowledge gaps regarding Personalised Environmental Control Systems (PECS). CLIMA 2022 Congress. Seminar | New IEA EBC Annex on Personalized Environmental Control Systems (PECS)

Thank you for your attention

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