Individually Controlled Indoor Environment

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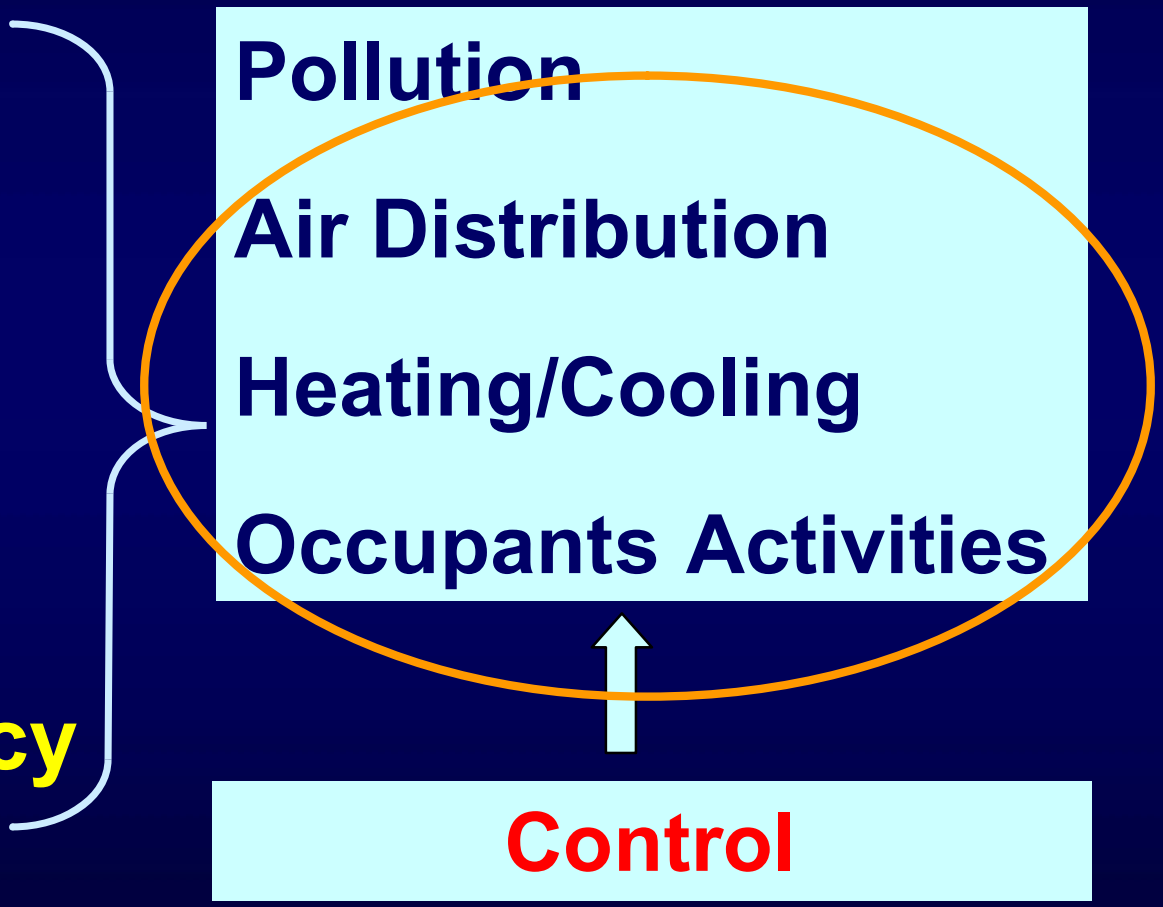
Indoor Environment

- Health
- Comfort
- Performance
- Energy efficiency



Room Air Distribution

- Inhaled air quality
- Protection from infectious agents
- Thermal comfort
- Occupants' activities
- Individual control

Room Air Distribution

Total volume ventilation

- Clean air is supplied far from occupants
- Uniform environment
- Limited control

Large differences between occupants in regard to:

- Preferred Temperature
- Air movement sensation
- Clothing insulation level
- Activity level
- Air quality perception

Room Air Distribution

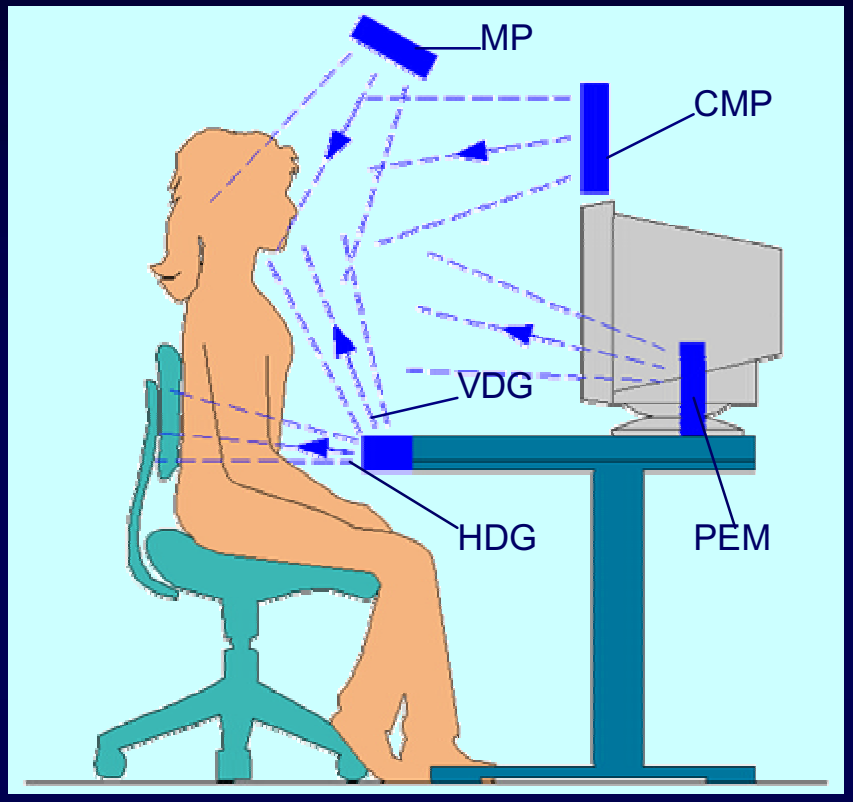
Personalized ventilation (PVS)

- Clean air is supplied to the breathing zone
- Individual control & Preferred environment

Personalised ventilation has potential to:

- Satisfy more occupants
- Improve inhaled air quality
- Improve occupants' performance
- Decrease risk of spread of infectious diseases

Personalized Ventilation: Inhaled Air Quality



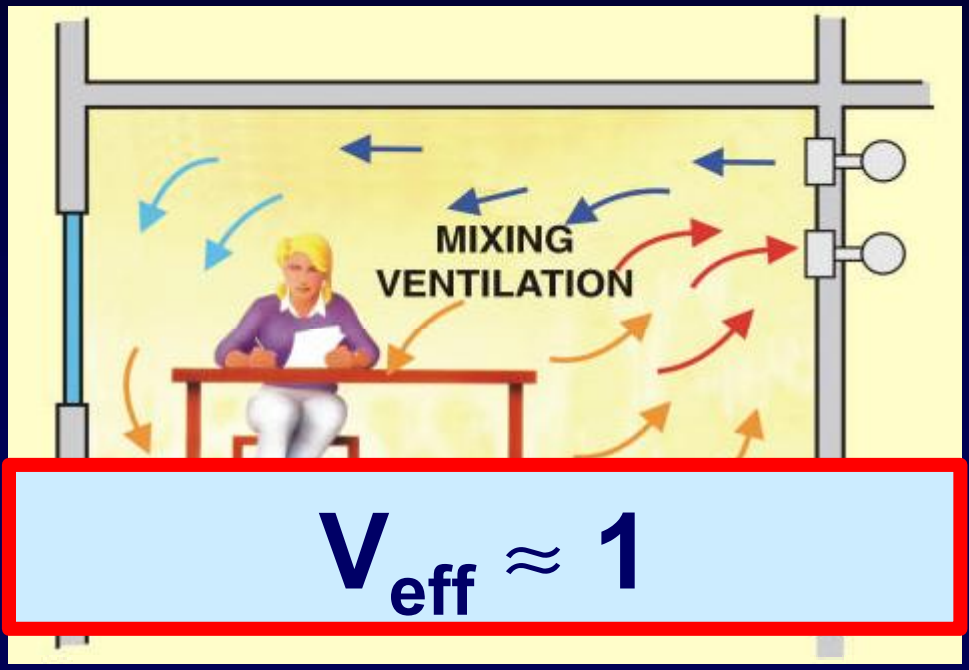
Air Supply Options:

- **Front edge of desk (HDG)**
- **Top edge of desk (VDG)**
- **Movable air pannel (MP)**
- **Above monitor (CM)**
- **Desk diffusers (PEM)**
- **etc.**

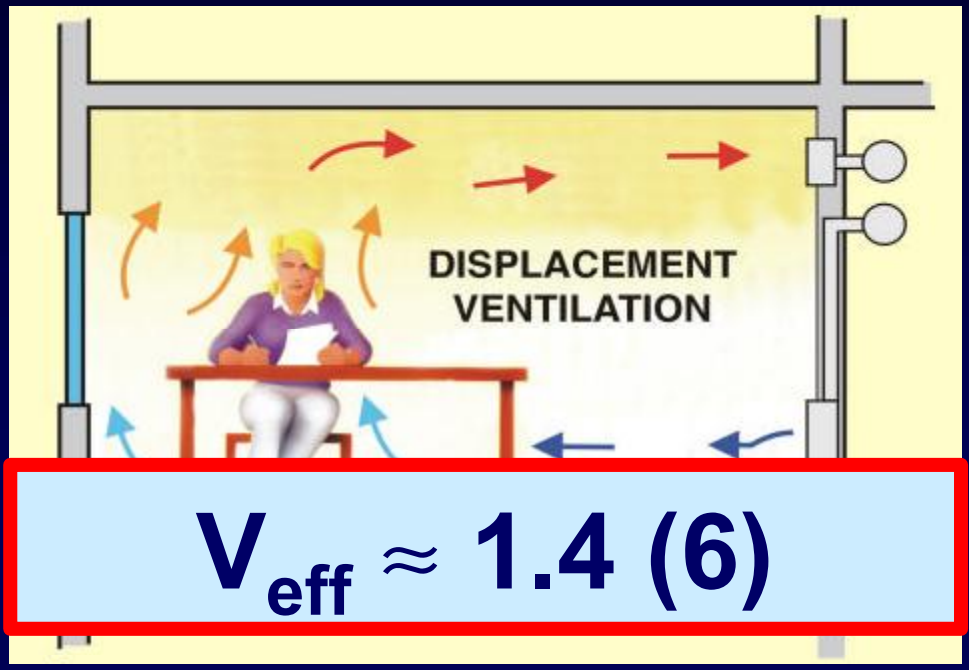
Ventilation effectiveness: $V_{eff} = \frac{C_e}{C_i} > 100$

Ce – pollution concentration at exhaust
Ci – pollution concentration in inhaled air

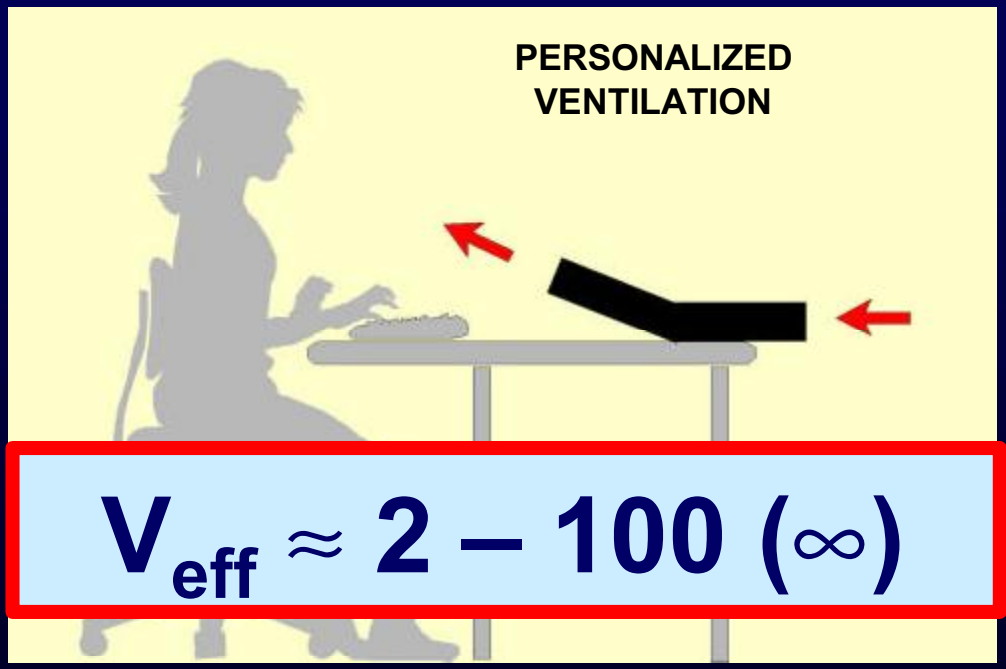
Room Air Distribution: Inhaled Air Quality



$V_{eff} \approx 1$



$V_{eff} \approx 1.4\ (6)$

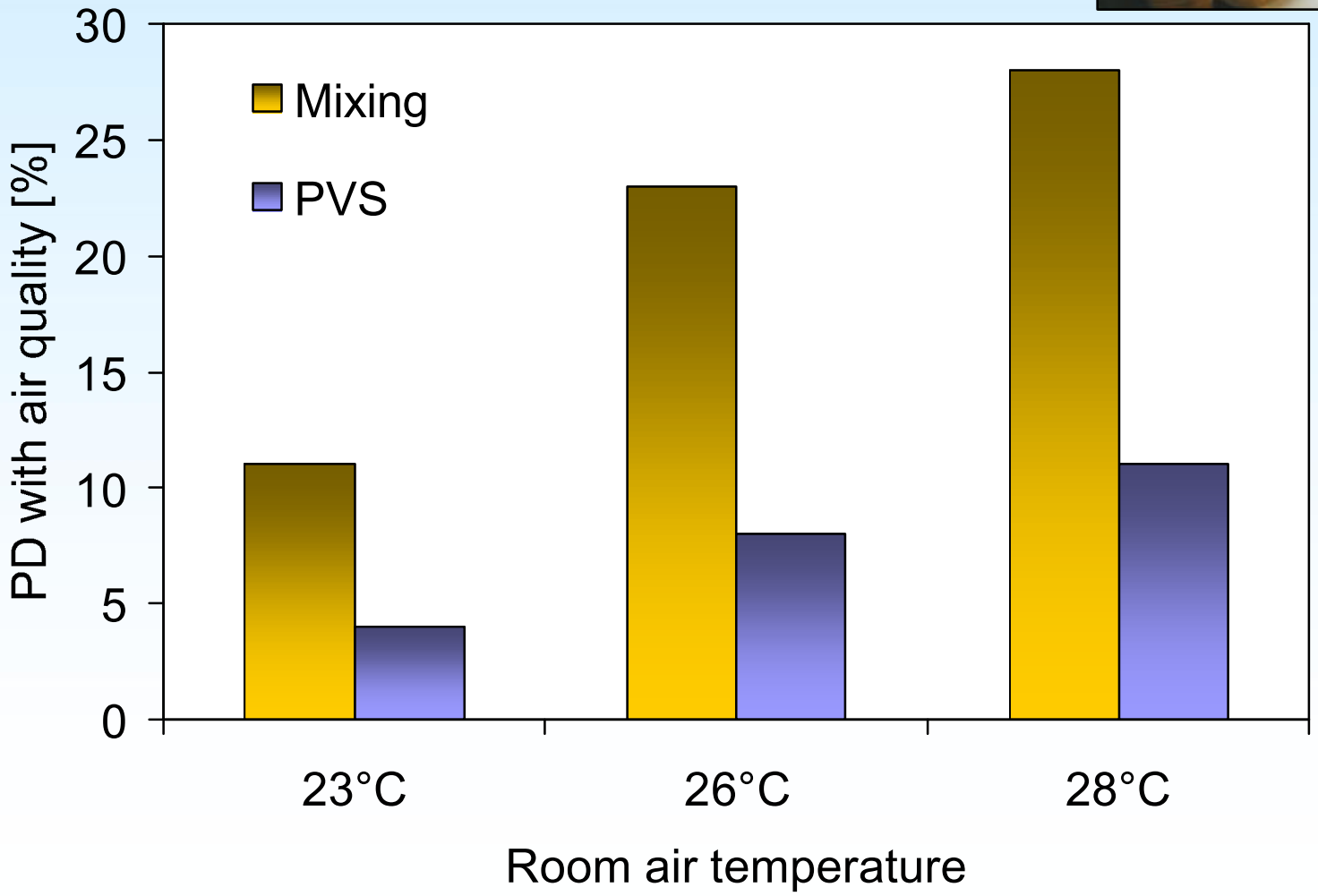


$V_{eff} \approx 2 - 100\ (\infty)$

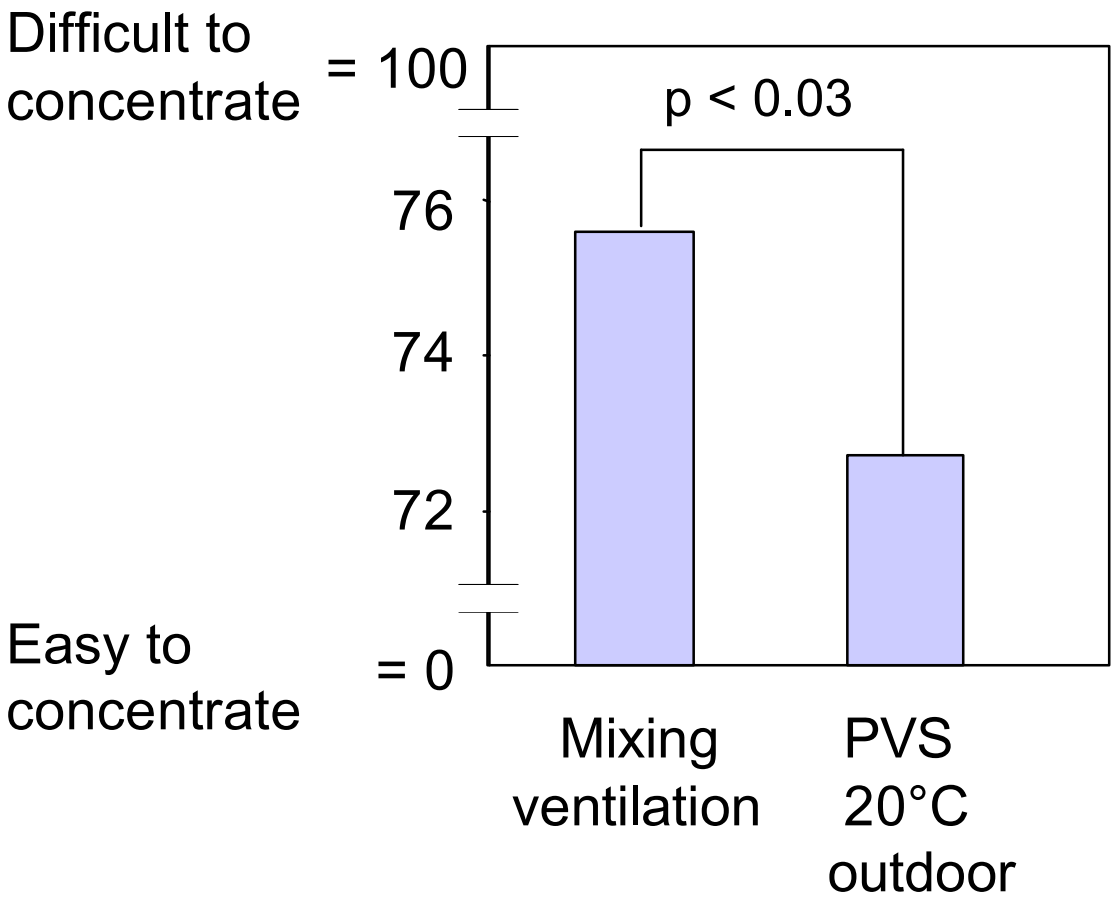
Human Response: Perceived Air Quality

20 L/s/person

t_{PVS} = 23°C



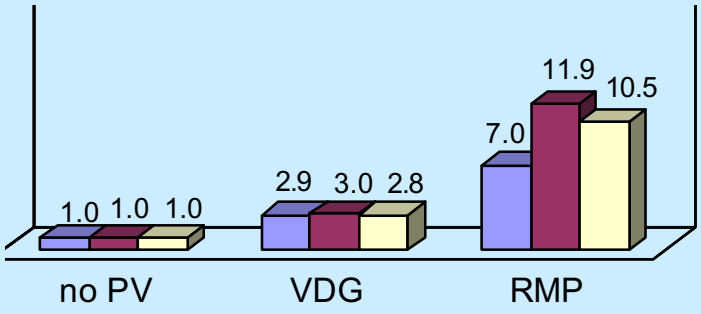
Human Response: SBS Symptoms



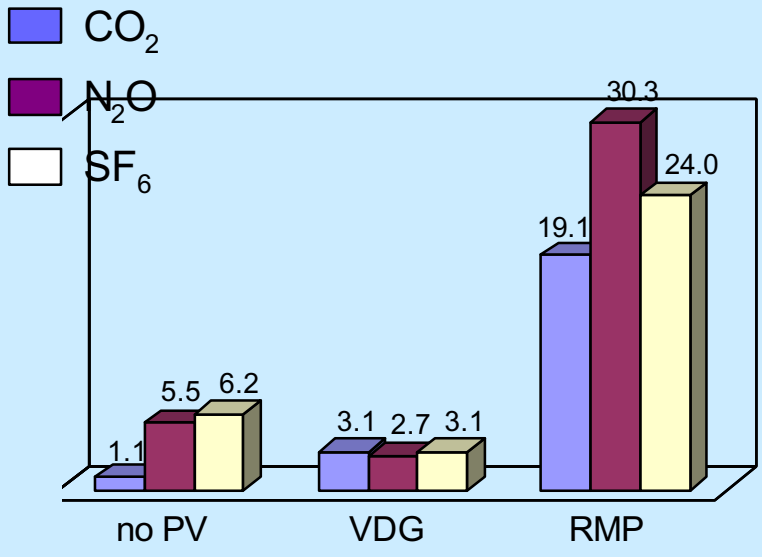
Transport of Pollution

Personalized Ventilation: Transport of Pollution

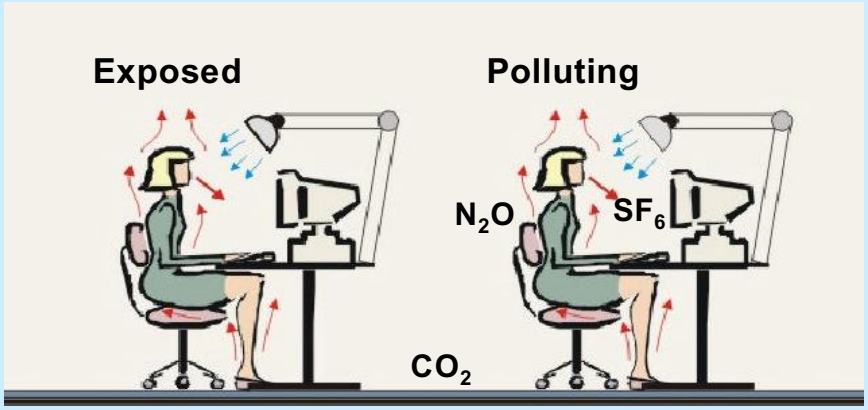
The results show how many times PVS in conjunction with mixing or displacement ventilation decreased contaminants in inhaled air in comparison with mixing ventilation alone



Mixing ventilation



Displacement ventilation



Transmission of Infection Agents

Next Killer Flu: The H5N1 bird-flu virus!

- Origin:
  Birds – sick, dying, dead poultary?

- Pandemic Mortality Rates:
  7.4 – (180 – 360) million

- Spread around the world:
  less than 180 days

- Routs of spread:
  touch, eat, breath?

Air Distribution: Protection of Occupants

Sneezing, coughing, talking

⇩

Droplets (0.01– 100 μm) with viruses

⇩

settling, evaporation, inhalation

Breathing - Exhalation

⇩

Airborne aerosols (< 1 μm) with attached viruses (0.003 to 0.06 μm)

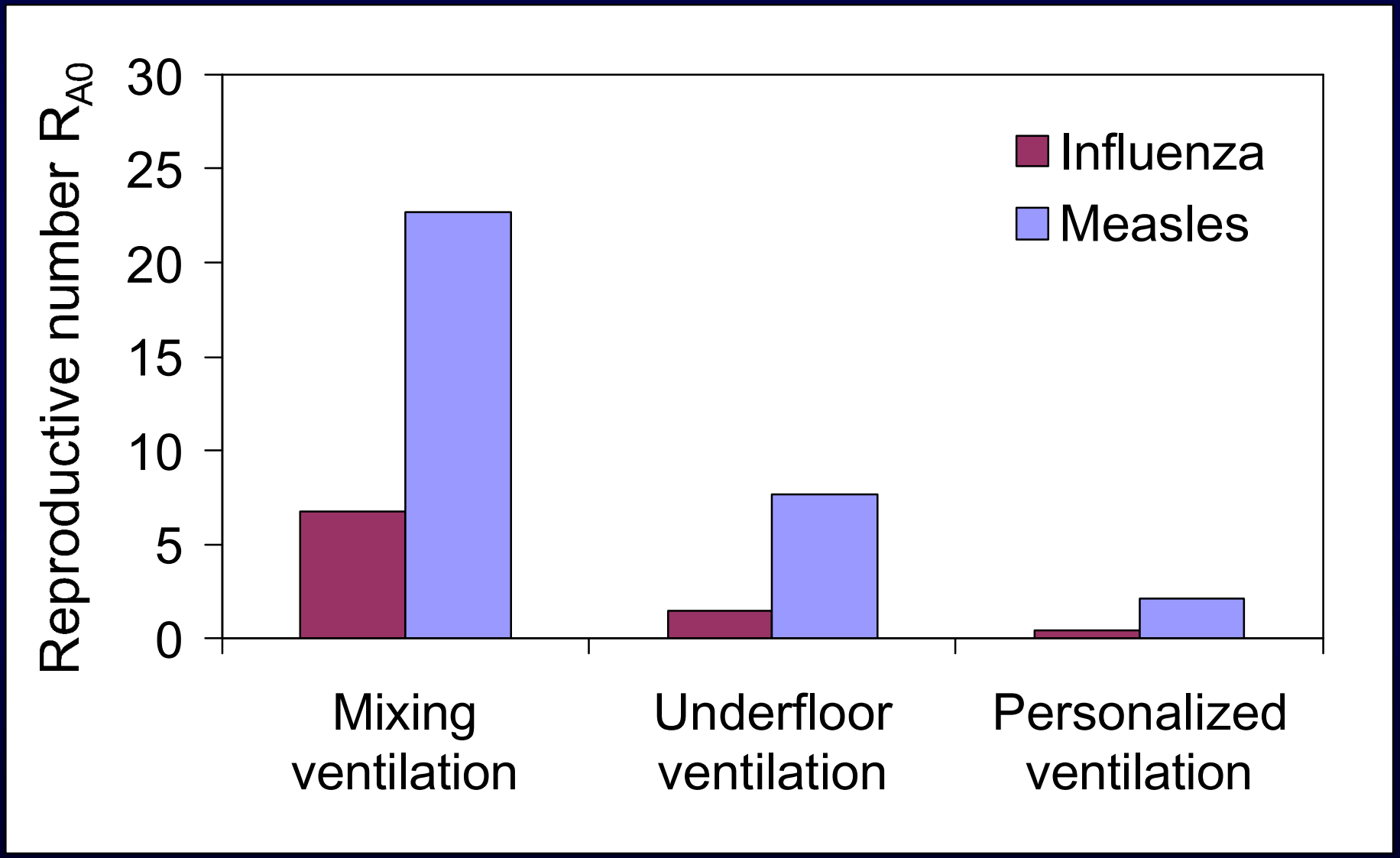
⇩

Inhaled by occupants

Airborne Transmission of Infectious Agents

R_{A0} - reproductive number of secondary infections that arise when a single infectious case is introduced into a population where everyone is susceptible

[Rudnick and Milton, 2003]

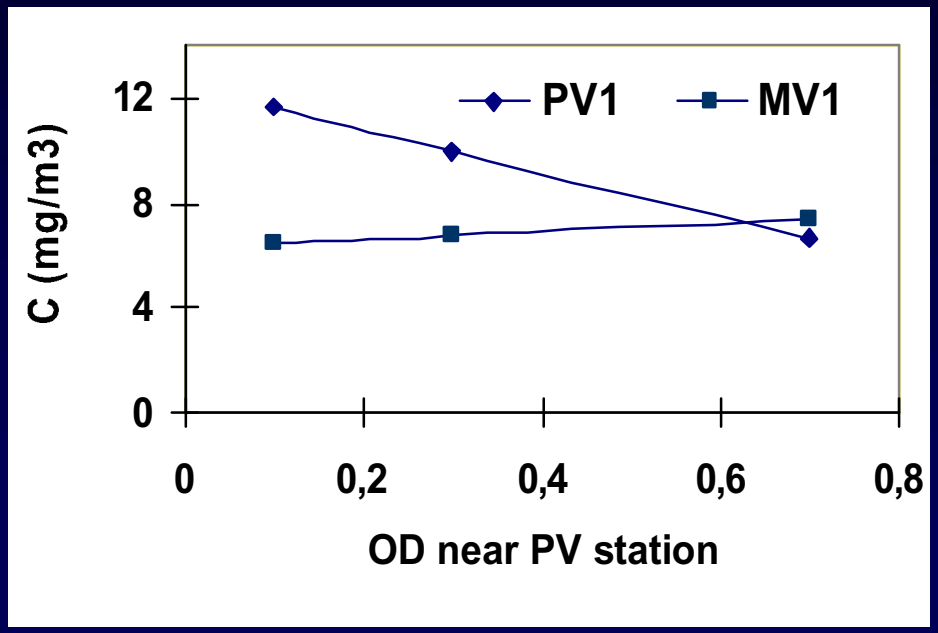


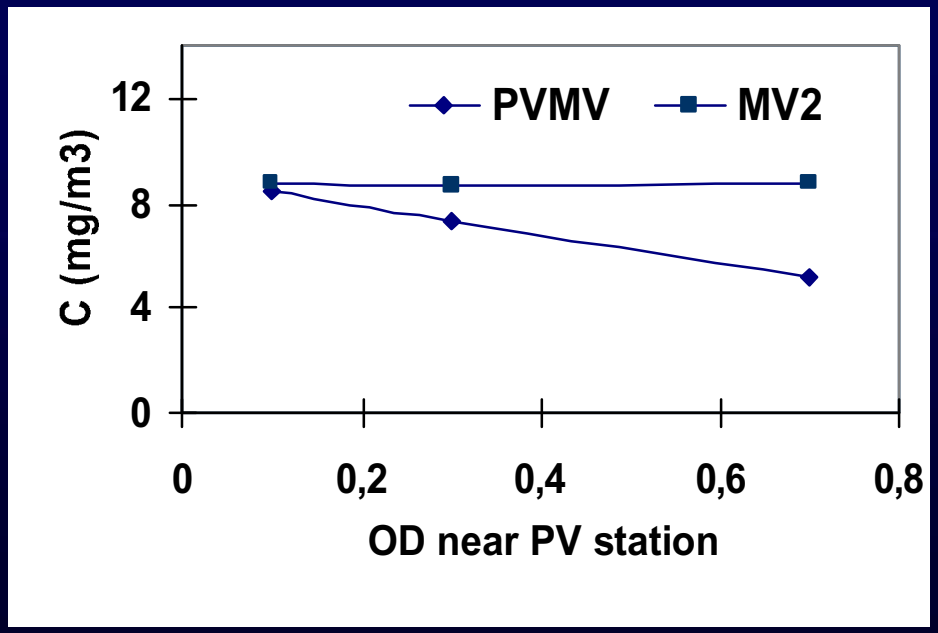
Occupant's Activities

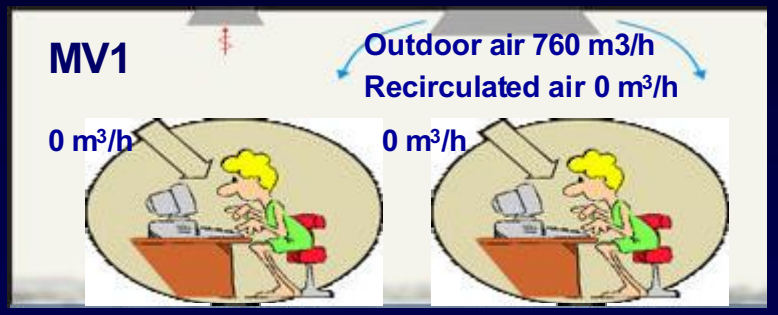
Occupied density (OD) - the ratio of the time an occupant stays at workplace with PV over the total time he/she stays in the room.

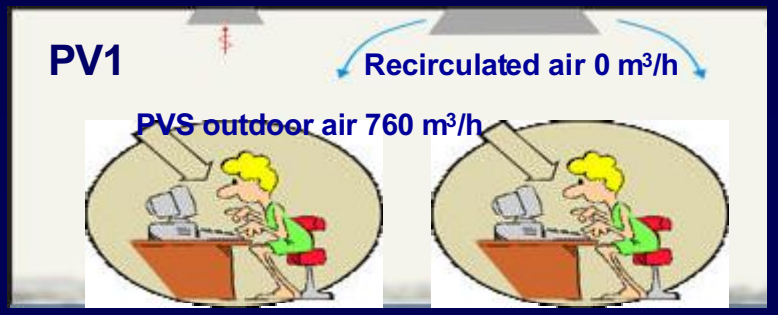
OD = 1 means that occupants stay at their workplaces and are exposed to personalized air all the time.

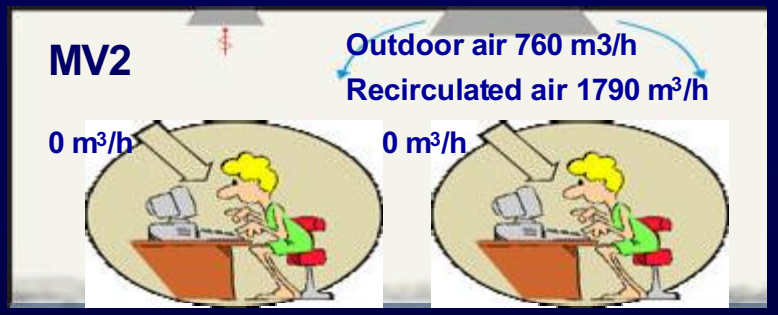
Occupant's movement in the room

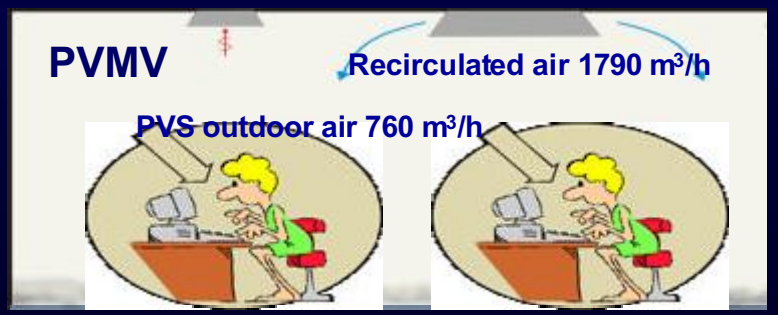








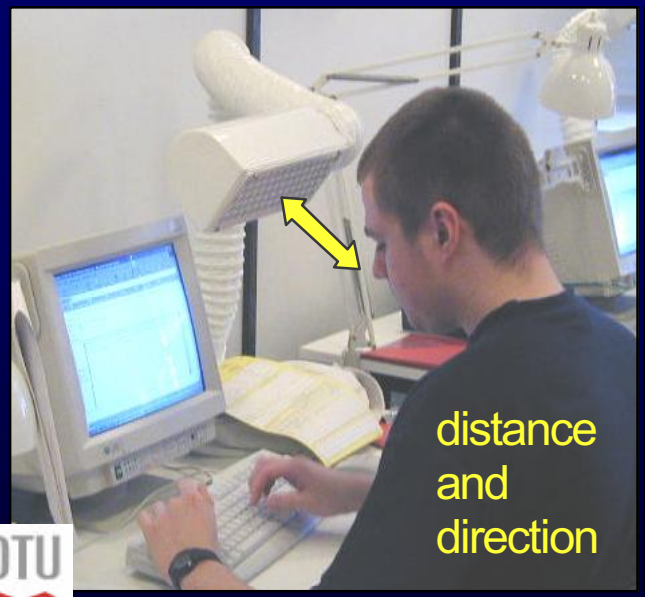




Personalised Ventilation: Individual Control

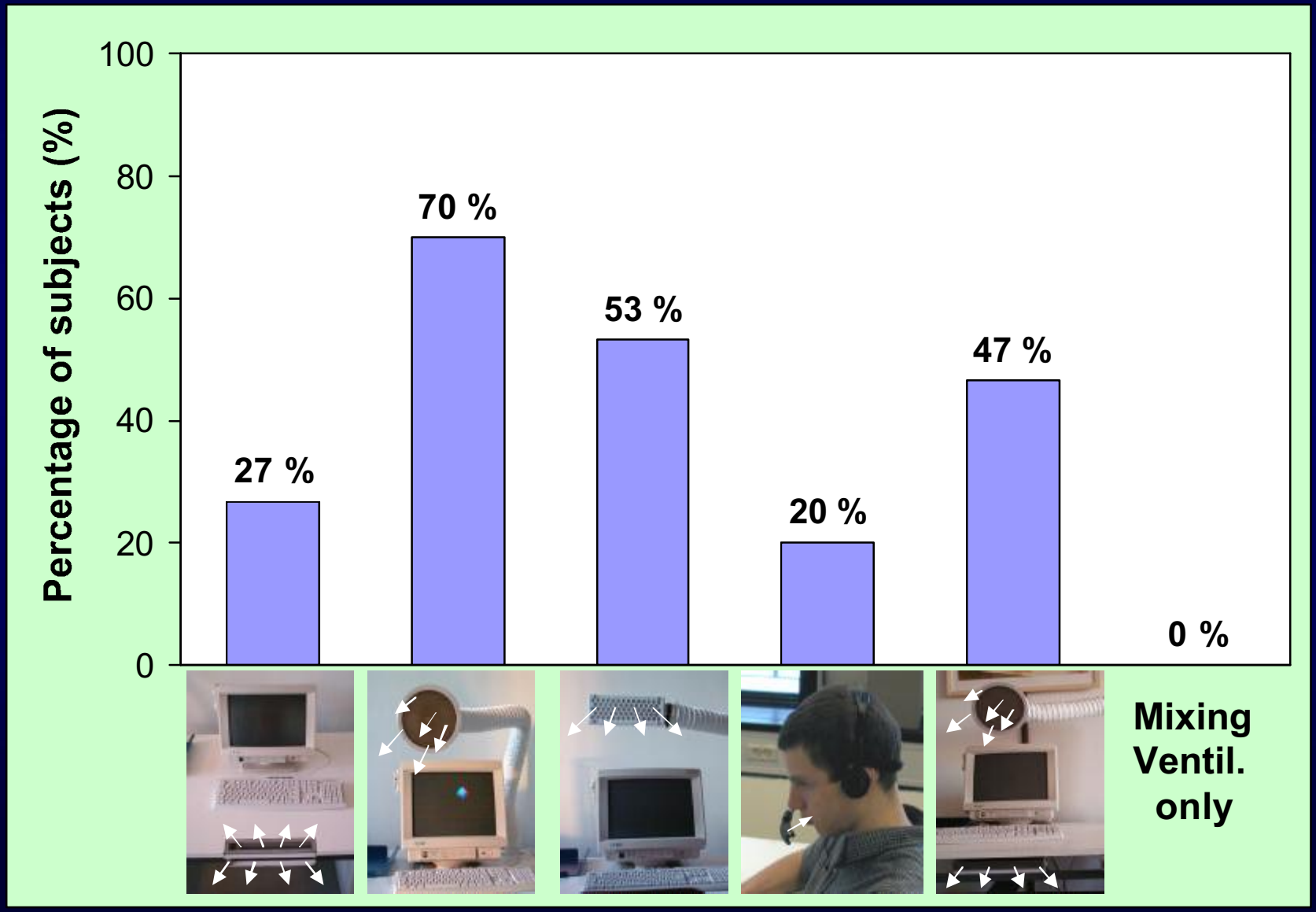
Individual control:

- Airflow direction
- Preferred temperature
- Preferred velocity:
  0.2 m/s – 1.8 m/s



Subjective Preference

Which system(s) would you like to have on your desk?



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Personalised heating and ventilation

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Performance tests with Human subjects and breathing thermal manikin





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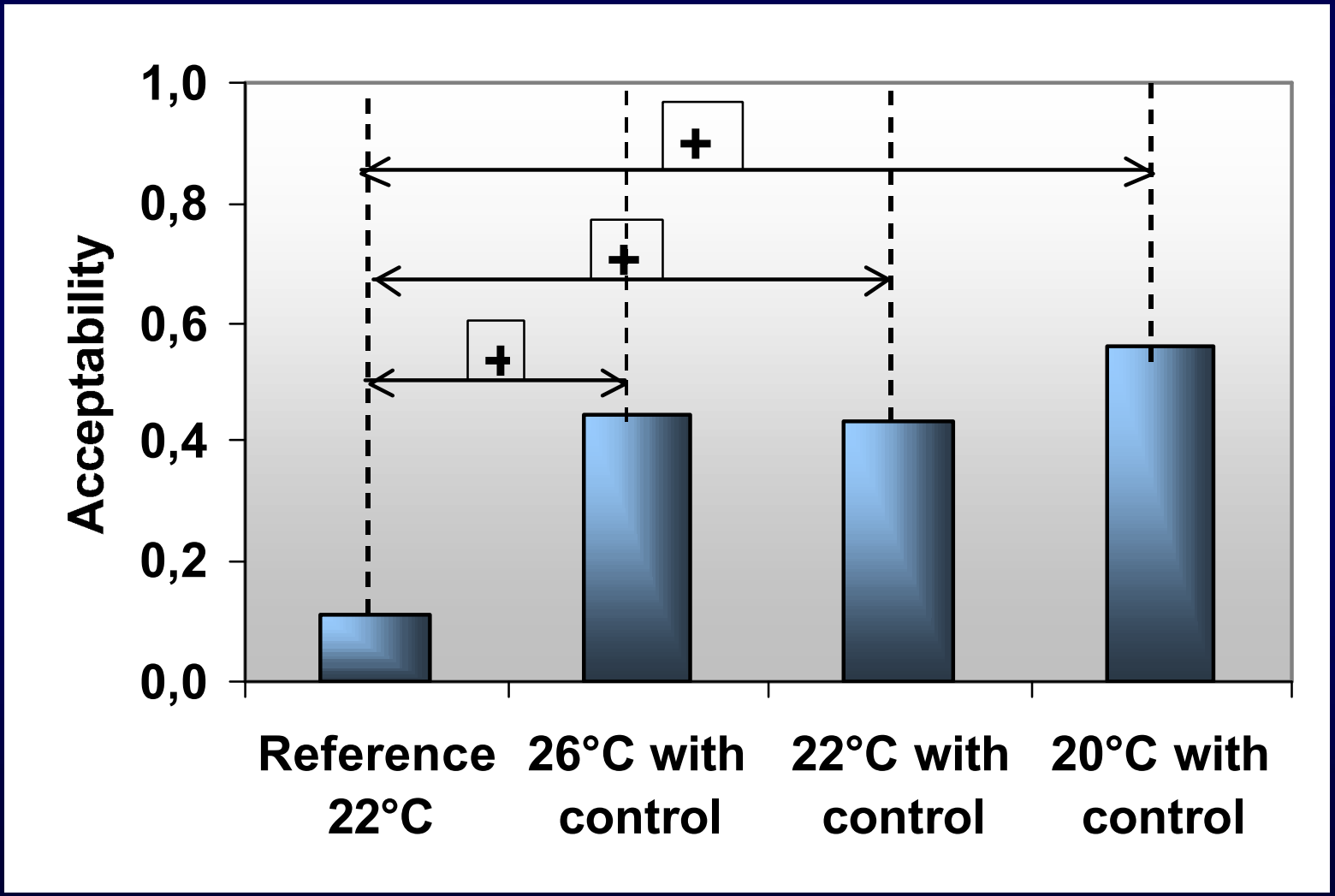
Perceived Air Quality



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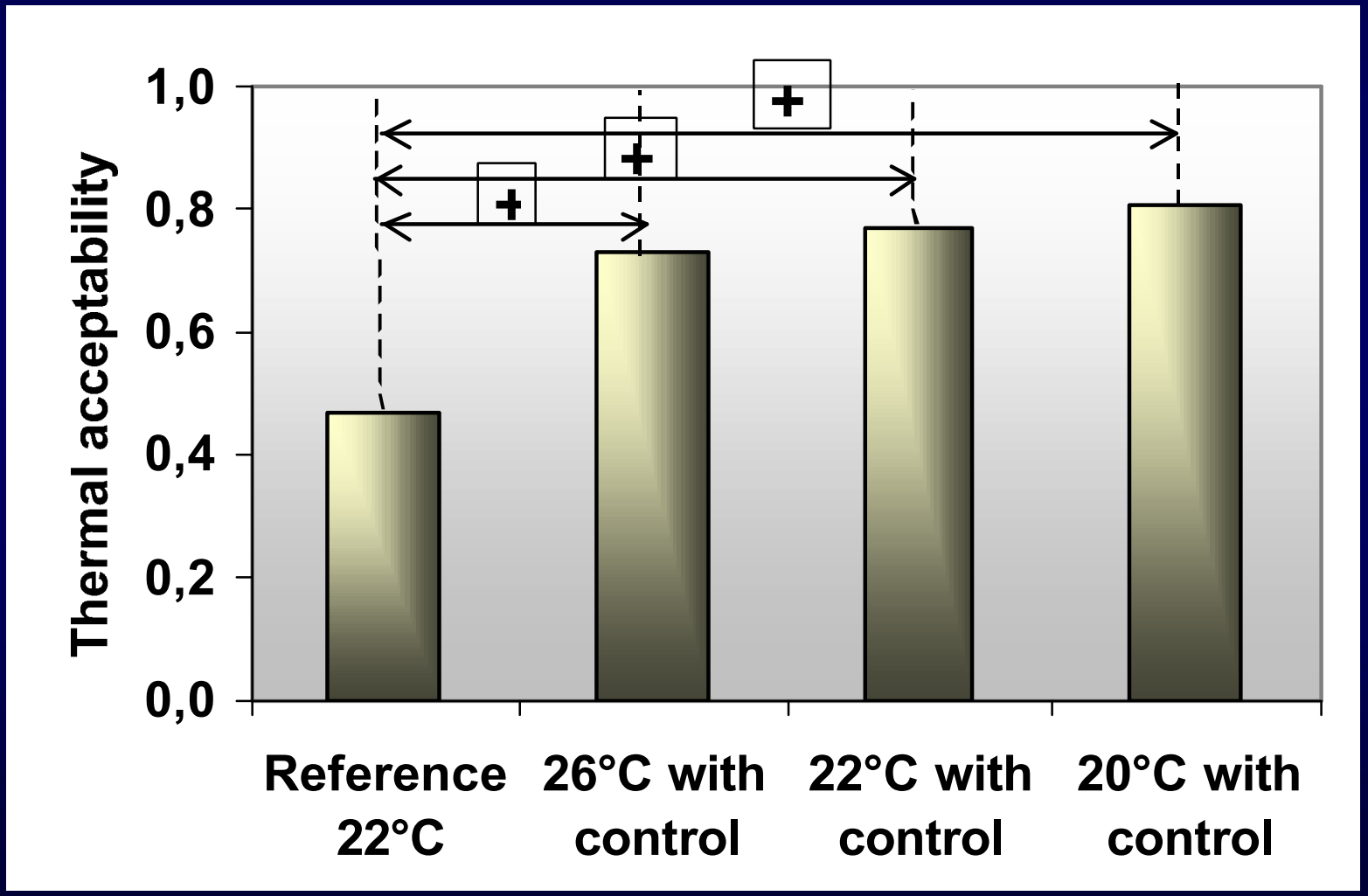
Thermal Comfort



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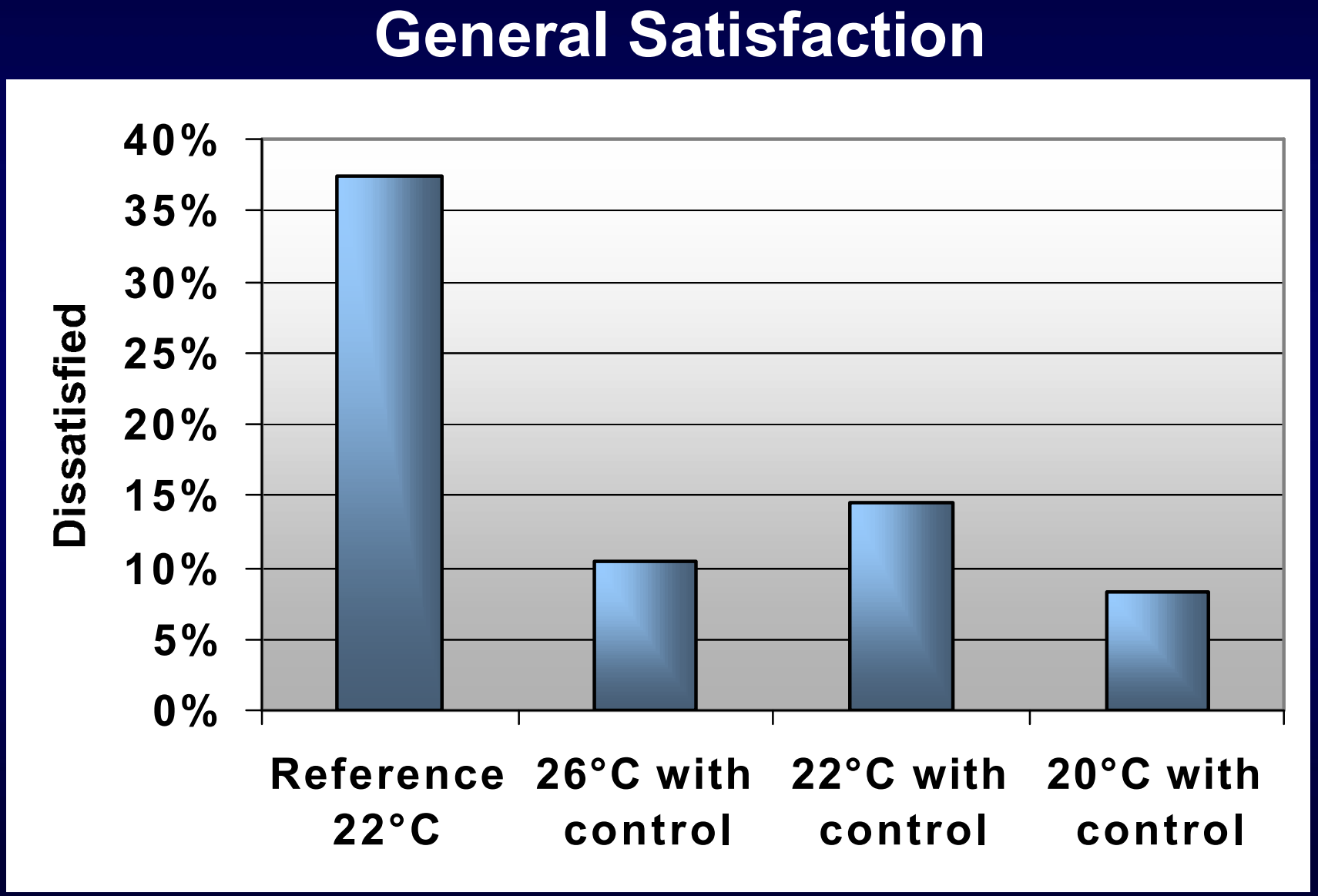

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Practical Sollutions