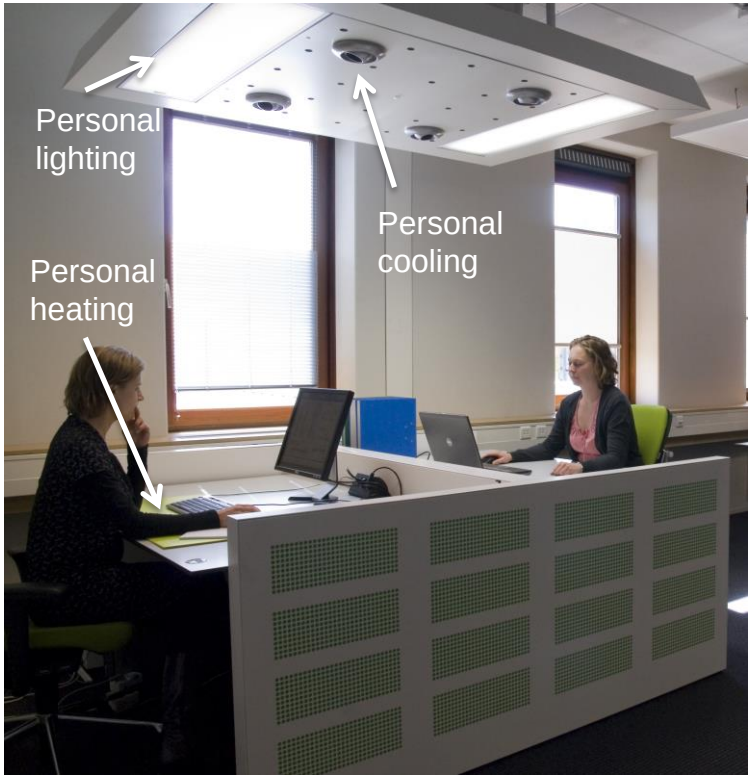

PERSONAL COMFORT
A simple way to improve employee satisfaction | Marleen Spiekman
TNO innovation for life

INTRODUCTION

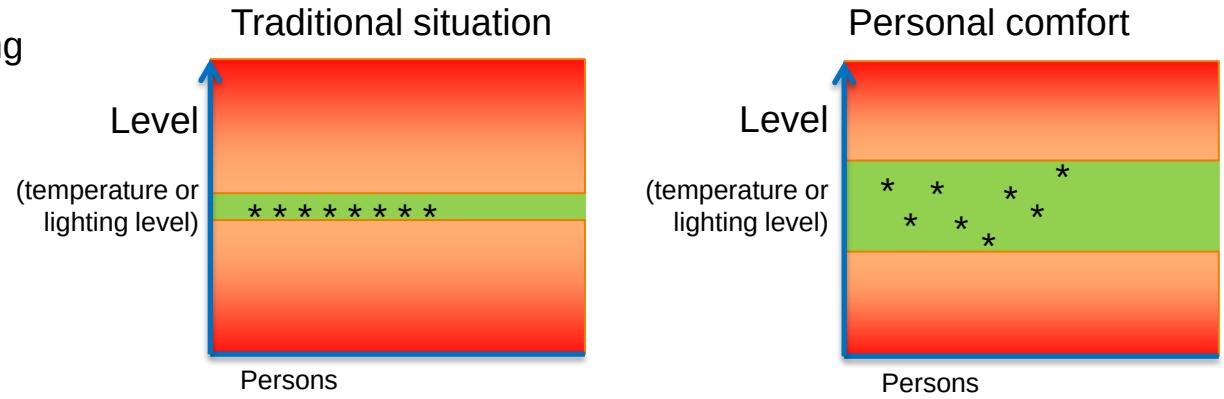
- Different preferences regarding indoor climate
  - Complaints, especially in open plan offices
- Personal control of heating, cooling and lighting
  - Improvement of comfort levels and productivity

    (e.g. Wyon, 1996; Wyon and Wargocki, 2006)
  - Energy saving potential



INTRODUCTION

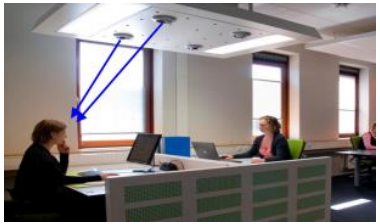
- Principle: central climate levels down, local climate levels personally controllable
  - E.g. room temperature lowered from 22°C to 20°C, local heating at working desk: add 0°C to 4°C
  - Idem for lighting and cooling

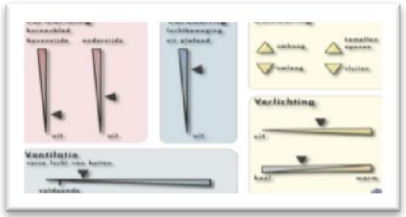


- Research questions
  - Does this principle lead to improvement of personal comfort and energy saving?
  - Which global levels and local ‘devices’ are optimal?

ADVANTAGES PERSONAL COMFORT

- **Improved comfort levels**
  - Personal control of indoor climate
  - Less complaints
  - Higher productivity





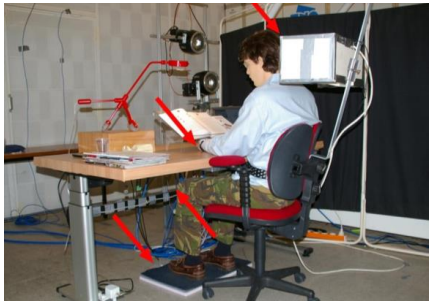
- **Energy saving**
  - Wider bandwidth of central climate control
  - Saving on energy for heating and cooling

* Energy saving potential depends on type of building, occupancy rate and system efficiency

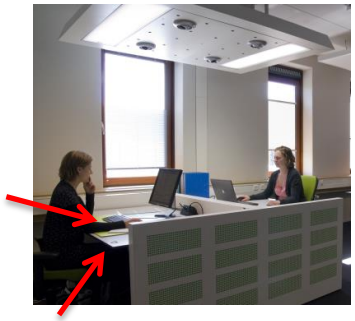
- **Easy to upgrade buildings**
  - Plug and play
  - Low investment costs, no major renovation needed

RESEARCH METHOD

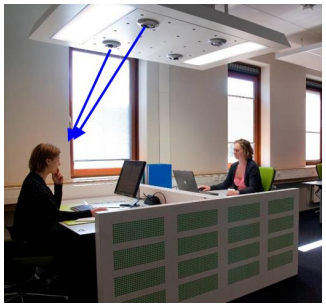
Evaluation of various configurations:



Lab experiment
Personal heating



Living lab experiment
Personal heating



Living lab experiment
Personal cooling

Lab experiment
Personal heating and lighting

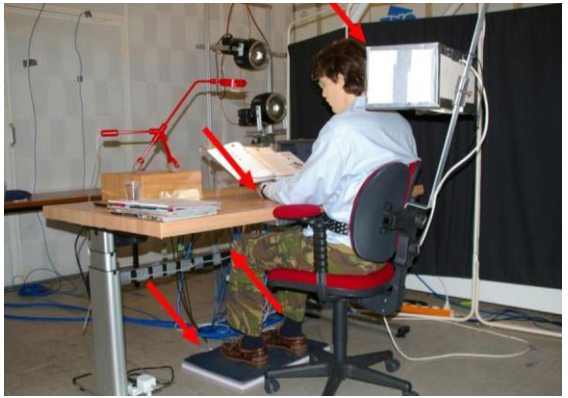
Measurements:

- Questionnaires: perceived overall, thermal and visual comfort, perceived overall thermal sensation and per body part, visual comfort at desk/room/screen/adjustment when looking around
- Measurements: Temperatures, flows, illuminance levels → to calculate comfort levels and energy saving

LAB EXPERIMENT PERSONAL HEATING

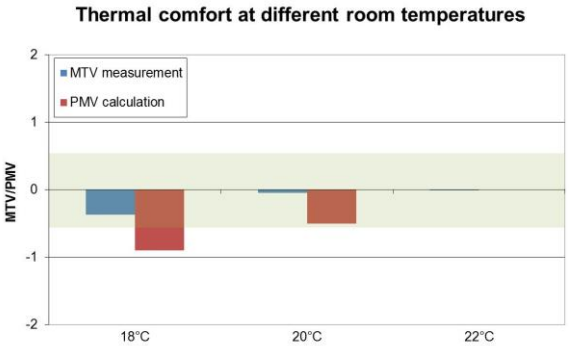
Set-up:

- Individually controllable heating panels integrated in furniture:
  - On desk, below desk, below feet, behind neck
- 3 room temperature conditions: 18, 20 and 22°C
- 10 healthy male test subjects

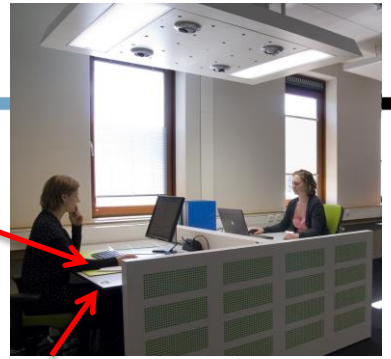


Results:

- Big individual differences in perception of comfort level
  → this emphasizes the importance of personal control
- Lowering set point of central heating system to 20°C possible
  → energy saving potential
- Neck heating, foot heating less efficient than upper/lower desk heating
  - Lesson 1: upper/lower desk heating preferred configuration
  - Lesson 2: room temperature can be reduced but not too low



LIVING LAB EXPERIMENT PERSONAL HEATING

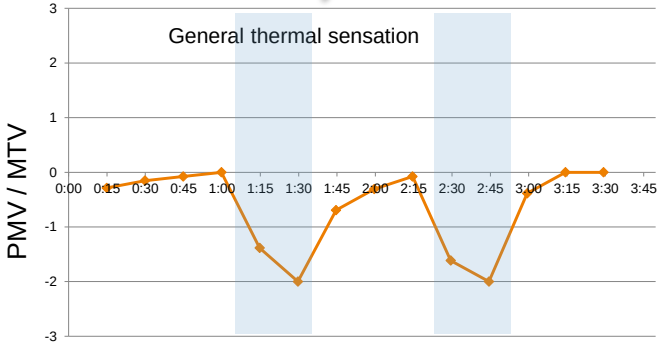


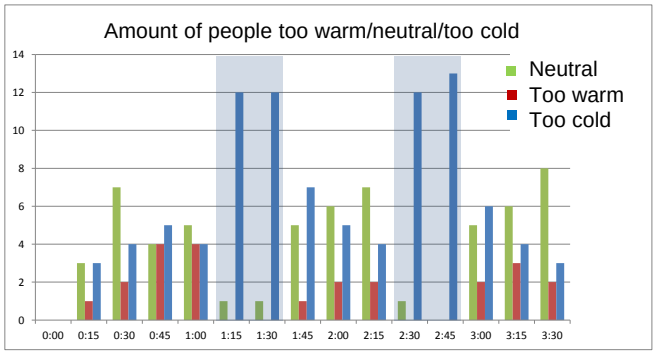
Set-up:

- Individually controllable heating panels integrated in desk
- 2 conditions: 18°C with and without use of heating panels
- 13 healthy test subjects

Results:

- It was possible to create comfortable situation with this personal heating configuration
  - Even after 30 minutes of no heating
  - Lesson 1: faster response system
- Big individual differences in perception of comfort level
- Not all people were able to create a comfortable situation
  - Lesson 2: Some too cold: → room temperature 18°C too low
  - Lesson 3: Some too warm: → due to interface design?

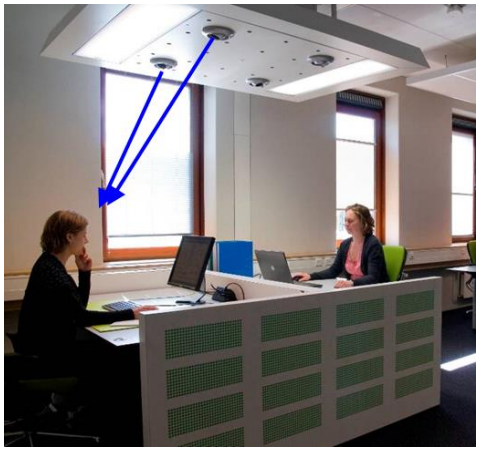




LIVING LAB EXPERIMENT PERSONAL COOLING

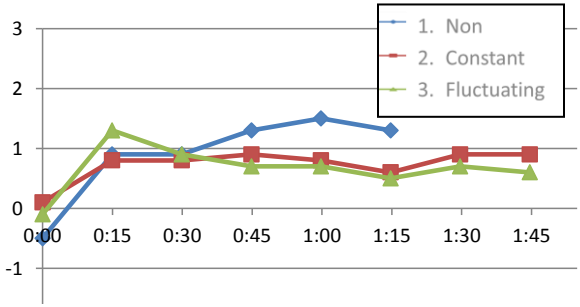
Set-up:

- Individually controllable airflow directed to upper part body
- 3 conditions: no airflow, continuous airflow, fluctuating airflow
- Room air temperature: 28°C
- 10 healthy test subjects



Results:

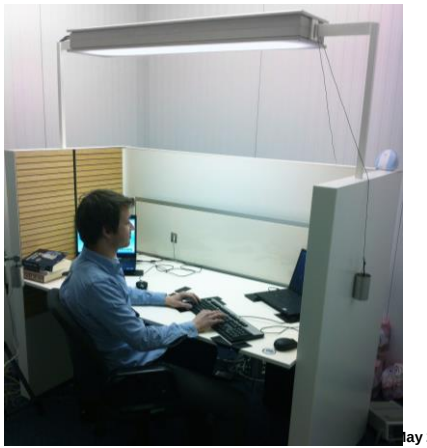
- Airflow results in improved thermal sensation and comfort levels
  - Energy saving potential
  - Complaints about too warm legs
- Based on questionnaire: fluctuating airflow appreciated slightly better, however noise was a problem
  - Lesson 1: use fluctuating airflow device with low noise levels
  - Lesson 2: add airflow directed to lower part body (under desk)



LAB EXPERIMENT PERSONAL HEATING (& LIGHTING)

Set-up:

- Individually controllable heating panels in front of participant above and under desk
- Individually controllable direct lighting above desk
- Room air temperature: 20,5°C
- 20 healthy test subjects



Results:

- Maximum additional local temperature: +1,2°C
  - Good enough for some, but not enough for others
  - Panel to far from person (+ normally radiation blocked by computer screen).
  - Lesson: this location of the panels not effective for comfort and energy efficiency

DEVELOPMENT OF PROTOTYPE PERSONAL CLIMATE SYSTEM

Lessons learned from experiments:

- System has potential to improve comfort levels
- Energy savings up to 25% for heating and 45% for cooling
- Bandwidth central climate control: ca. 20°C – 28°C (instead of 22°C – 24°C)
- Heating panels optimal location upper/lower desk
- Heating panels with faster response system developed
- Airflow devices above and below desk
- Devices with low noise levels developed
- Emphasis on interface design important

NEXT STEPS

- Development of prototype Personal Climate system
- Testing in real office situation (50 work places)
  - Before installation of prototype Personal Climate
  - After installation of prototype Personal Climate system
  - Study:
    - Long term experiment
    - Improvement thermal & visual comfort levels (reduction dissatisfaction)
    - Reduction annual energy use
- Implementation strategy together with stakeholders
- Together with several industrial/research partners and end users:

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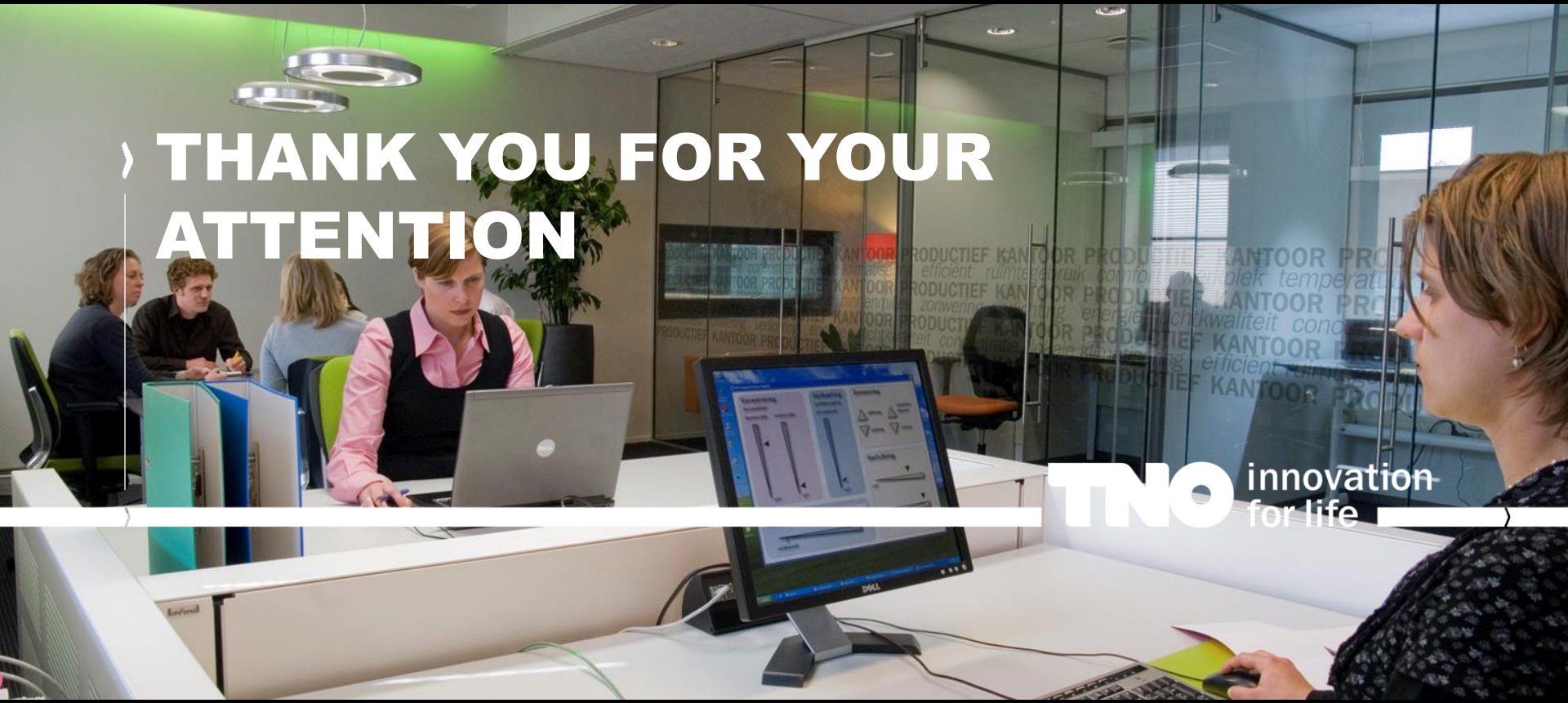
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