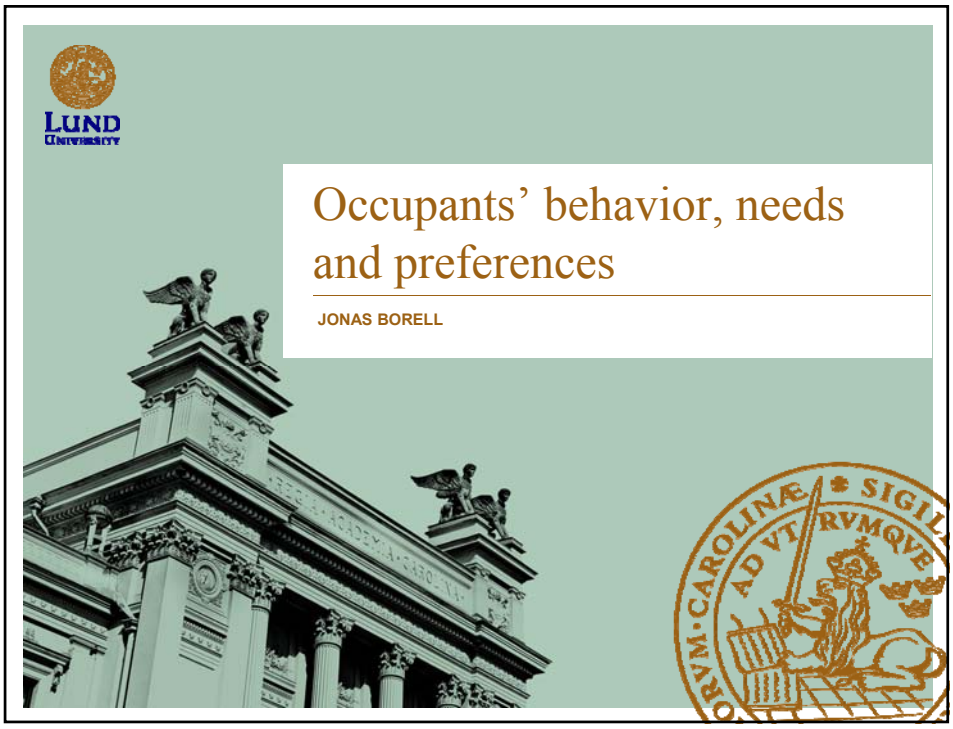
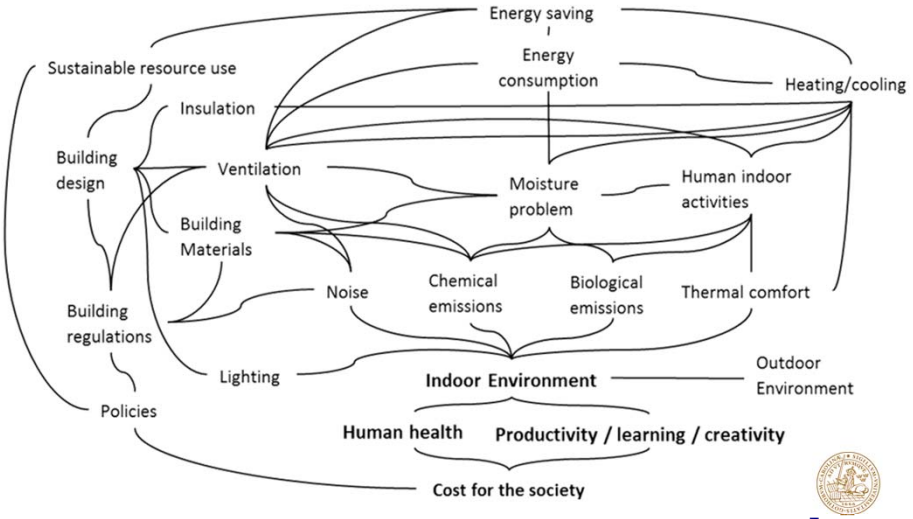


Systems view of buildings and indoor environment



LUND UNIVERSITY

Buildings have many purposes

- Create ”climate” different from outdoor
- Protect us
- Provide privacy
- Etc

- These purposes are design criteria for buildings

- How do we want the indoor ”climate” to be? What parameters are relevant?

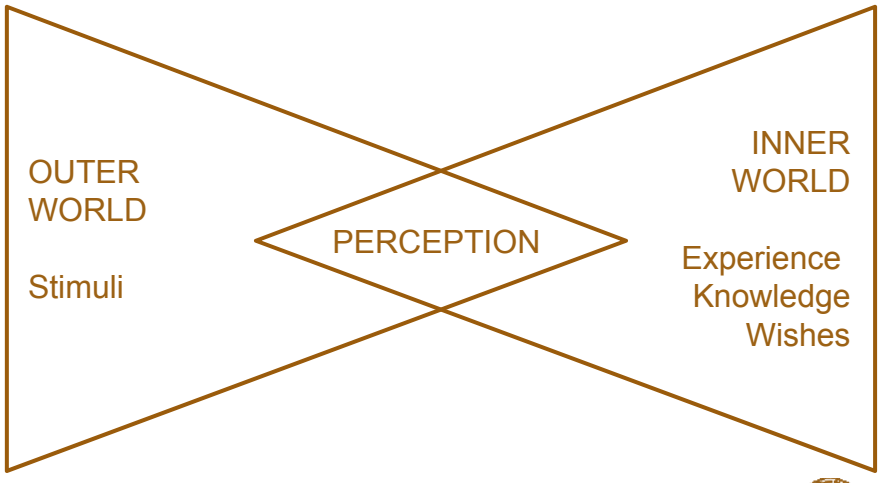
LUND UNIVERSITY

Indoor sources of airborne particles - examples

- Buildings and their occupants need ventilation
- Mechanical ventilation can be very effective
- It may also have side effects, such as noise or the spread of allergens and pathogens

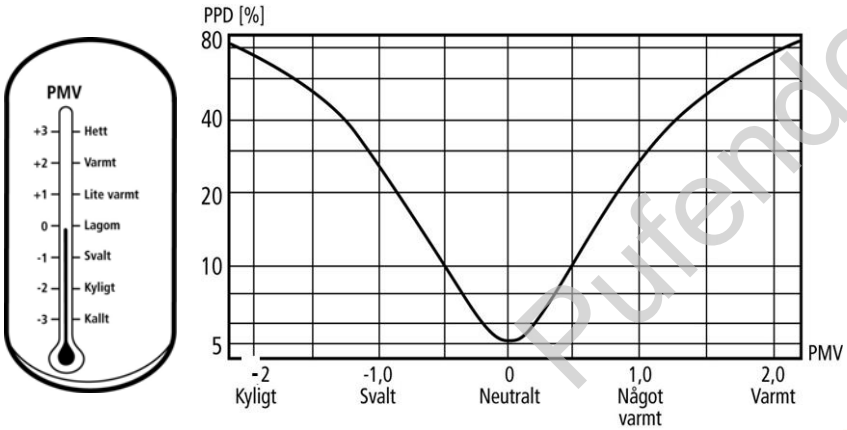
LUND UNIVERSITY

Cognition and decision making



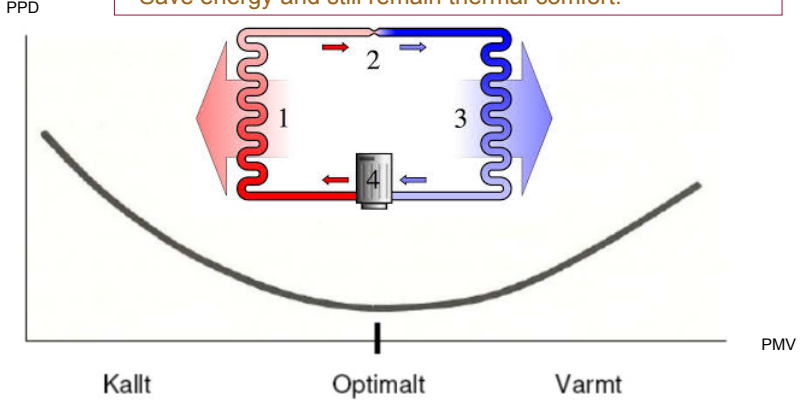
Thermal sensation

PPD: Predicted Percentage Dissatisfied

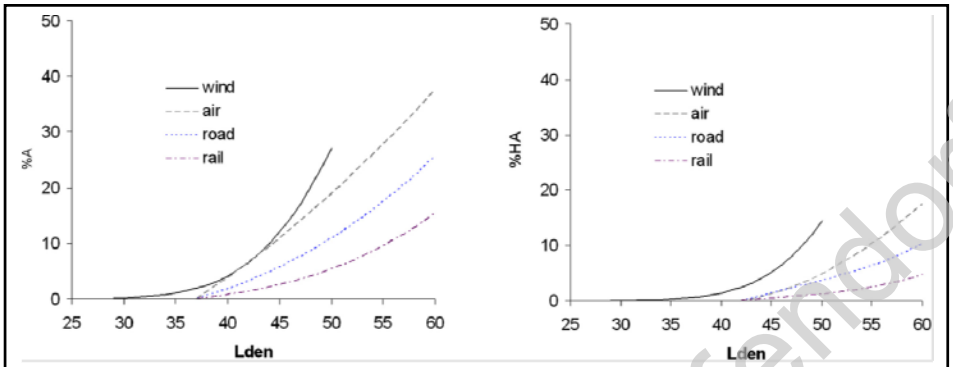


PMV: Predicted Mean Vote

- Adjust clothing instead of heating/cooling a room too much.
- Lower temperature in winter (20 C) and higher temperature in summer (26 C).
- Save energy and still remain thermal comfort.



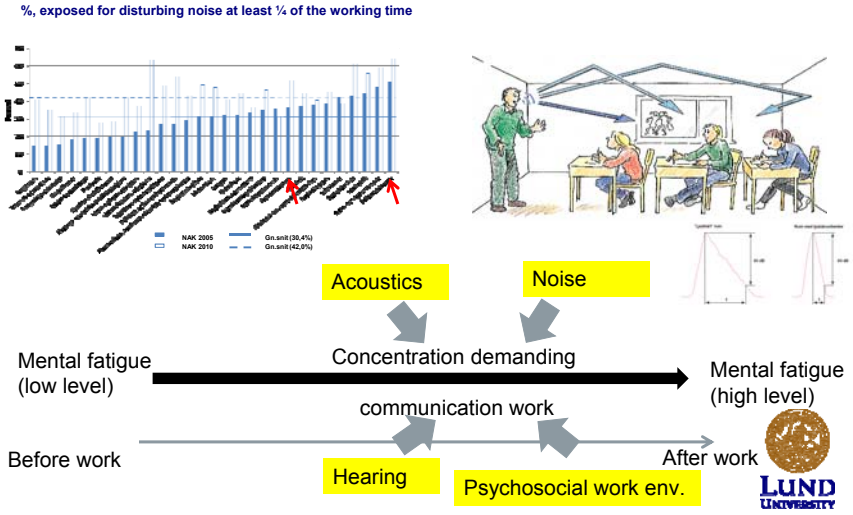
Thermal comfort



Comparison of the percentage of residents annoyed (%A) or highly annoyed (%HA) indoors due to wind turbine noise (wind) and due to transportation noise (air, road and rail).

Noise in schools I and II (NFA, DTU)

Jesper Kristiansen, Søren Peter Lund, Roger Persson, Hitomi Shibuya, Jörn Toftum, Geo Clausen



Sleep disturbance

Sleep

- recovery process essential for humans to function properly
- good night sleep – an important aspect of an individual's quality of life

Chronic noise induced interference with sleep

Impairs functions of sleep such as:
- Brain restoration
- Provision of a period of respite for cardiovascular system

Can have adverse effects on:
- Daytime functioning
- Mood next day
- Vigilance and cognitive performance

Regluations – environmental noise (guidelines according to infrastrukturprop. 1996/97:53)

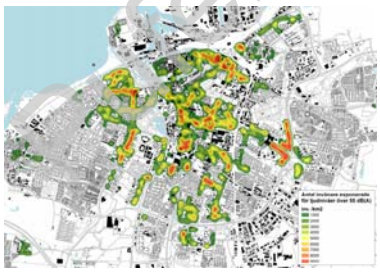
Location	Measure	Road	Track	Flight
Indoors	Eq	30	30	30
Indoors	Max	45	45	45
Outside(façade)	Eq	55	60	55
Outside	Max	70	70	70

Eq: $L_{Aeq,24h}$, Max: L_{AFmax} (FBN)

- Today approximately 2 million persons in Sweden are exposed to a noise level that exceeds the regulations set up by the Swedish parliament (>55 dBA outside at façade)
- At least 25 % of EU citizens are exposed to noise in such extent that it affects health and quality of life

Malmö – actions for noise exposures 2014

- Citizens exposed to >30 dBA indoors: 48 000,
  >55 dBA outdoors: 126 000
- Estimated cost (incl health care and loss of work): 1 100 MSEK
- Proposed long term measures (250 MSEK):
  - Source: Lower speed limit, try silent asphalt, driving style and silent car/tires
  - Sound reduction: Noise barriers, Improvement of window sound reduction at dwellings (allowance)
  - Focus on sensitive places, e.g. schools, pre-schools and parks



http://www.malmo.se/Stadsplanering--trafik/Trafik--hallbart-resande/Trafikbuller.html

Occupants diversity

- Different needs, different preferences, different behaviors
  - Age, occupation, gender, culture
  - People with physical/cognitive disabilities
  - Occupants mood
- Different contexts / activities
  - Distraction
  - Level of activity
  - Healthy / sick
  - Illumination level
  - Noise level

Certec

LUND UNIVERSITY

Occupants susceptibility

- Most susceptible people to unhealthy indoor environments are:
  - oldest (20%) and youngest (15%) [Sweden, 2011]
  - those that exhibit physiological symptoms due to the built environment (asthmatic, allergic, etc)
- However, everyone can benefit from technologies and practices that can improve the indoor environment.

Certec

LUND UNIVERSITY

Interactions between building and occupants

- Things to consider
  - Cognitive help
  - Accessibility
  - Inclusive solutions
  - Preferences, needs and behaviors
  - Internet of things
  - Interface design

Certec

LUND UNIVERSITY

What we don't know…

- How do different factors interact - especially when humans are introduced into the system?

We *do* know that:

- Humans as physical beings have certain needs and certain effects on their environments
- Humans as psychological beings have certain needs and certain effects on their environments
- There is much variation in the "human element"