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Refresh:

Remodelling Building Design Sustainability from a Human Centred Approach

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University of Reading

UNIVERSITY OF Southampton

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EPSRC
Engineering and Physical Sciences Research Council

Drivers

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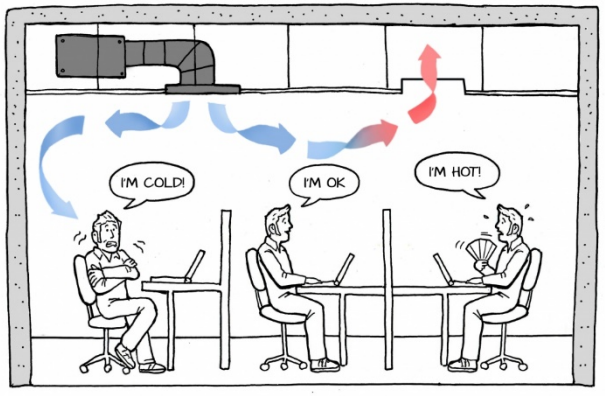
Sustainability agenda is significant

- Buildings responsible for ~40% energy use
- Legislation demands carbon reduction
- Benefits for companies by cutting energy costs

We are all familiar with poor work environments

Too hot, too cold, stuffy, no control, noisy.....



Evidence that poor environments affect wellbeing and productivity –> substantial cost!






The Team – so far

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Professor Janet Barlow, University of Reading

Urban Meteorology

professor m.c. schraefel, University of Southampton

Human computer interaction

Dr Cath Noakes, University of Leeds

Indoor air and building ventilation

Dr Marco-Felipe King, University of Leeds

Computational Fluid Dynamics

Hannah Gough, University of Reading

Urban airflows

Collaboration University of Birmingham (A. Quinn, M.Sterling) and University of Surrey (A. Robins)

Hypothesis

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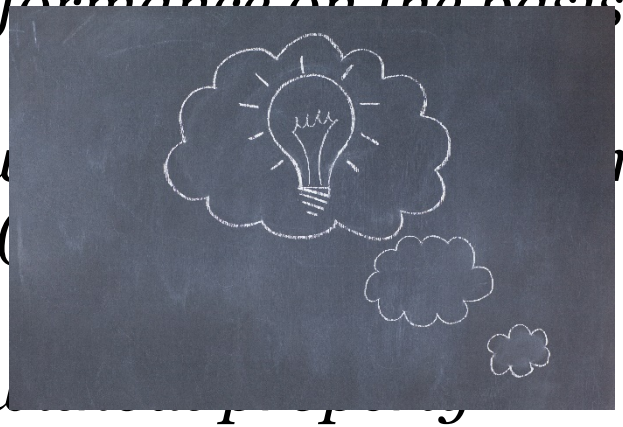
Poor indoor environments are the result of approaching building performance on the basis of:



(1)u re

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considering effects of the environment on human cognitive performance.

How can we create sustainable buildings that are also creative and productive environments for people?

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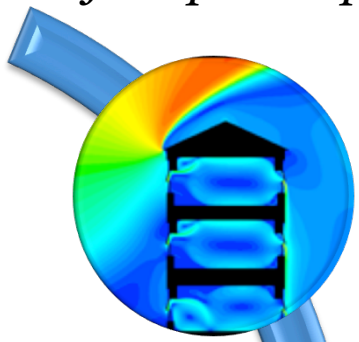
Explore the impact of urban microclimate on building ventilation for optimal performance of occupants.

Urban microclimate



Impact of built environment on airflow into buildings

Human cognitive response to static and transient indoor conditions

Present data relating building and person co-interaction

Programme

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Baselines (year 1-2):

- human baseline cognitive assessments;
- building-airflow interaction simulation parameters

Controlled scenarios (year 2-3):

- Controlled expts between building and occupants interactions
- Start to couple CFD of internal and external flow-fields

In the wild (year 3-5):

- couple internal air and performance measures with external microclimate
- quantify effect of turbulence on ventilation/humans/energy

Time (years)

What we know?

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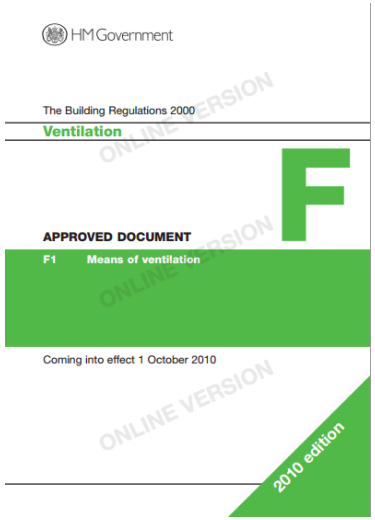
- Big historical body of work around comfort and ventilation informs current guidance:
  temp ranges, volume flow, humidity for different environments
  Steady state conditions, ***aimed at designers***



Links between ventilation, comfort, IAQ, health and performance/productivity

- Low vent rates are = adverse health effects
- Correlation between ventilation and school performance
- Studies on IEQ in offices quantify relationship between ventilation +productivity – and the economic cost

Ventilation & Human Interaction

- Bulk air movement
  - Determines overall IAQ – dilution of pollutants
  - Determines mean comfort – operative temp
  - Fairly straightforward to assess
- Local airflows
  - Determine human experience – comfort, specific pollutant concentrations, air movement etc.
  - May vary within a space and with time
  - Interaction with human thermal plume may be important

What don't we know?

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- Transient behaviour
  - limited work on indoor airflow (bulk or local) under transient conditions
  - fluctuations in comfort and IAQ
- Mechanisms for influence on performance
  - what are the airflow patterns in indoor environments
  - is it ventilation rate or local flow that is critical
  - how does a nat vent space compare to a mech vent space
- UK relevance
  - most studies in Denmark, US, Japan
  - What is most significant for our buildings, our workforce, our climate?

Approaches

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Human performance studies

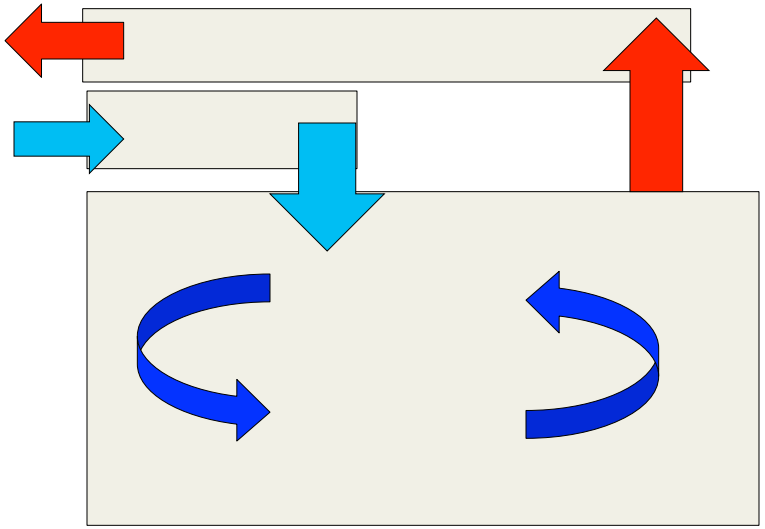
- Mostly chamber studies comparing controlled conditions
- Many studies include subjective response – questionaire
- Some studies use proxy measures (eg sickness records)
- Increasing number of studies on task performance – esp school
- Small but growing number measuring physiological parameters

Airflow assessment

- CFD modelling and tracer gas studies to assess (steady state) air distribution and ventilation performance
- Small but growing number of studies showing transient effects, importance of human movement, thermal plume etc (shadowgraph imaging, water tank models, some CFD)

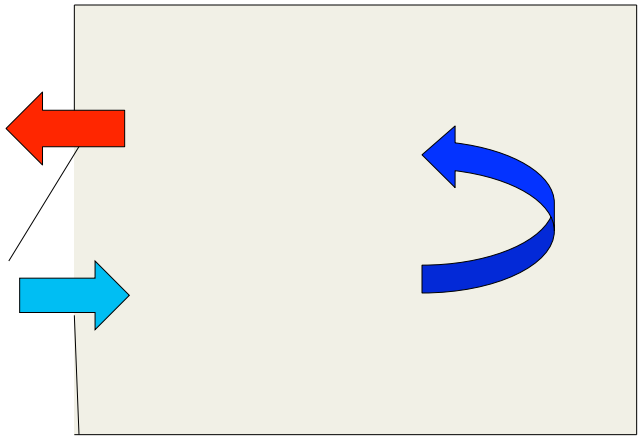
Building Airflow – First Steps

Mech vent



- Aim for steady conditions
- Largely disconnected
- Underperformance?

Nat vent



- Flow depends on design and local climate
- Connected and variable

Indoor -Nat vent

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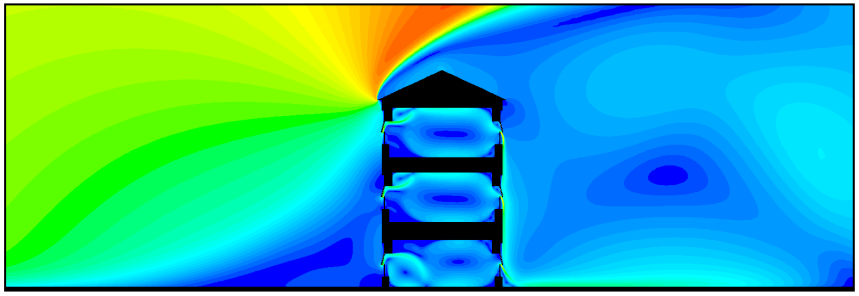
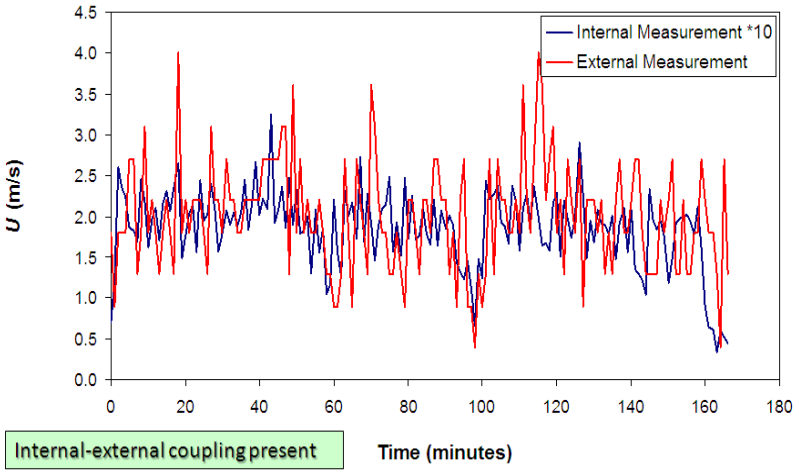
- Can reach very high ACH values ~30ACH
- Difficult to condition in extreme climates
- Unreliable in deep plan buildings
- Can be low tech & cheap





Low wind speed 0.4m/s

•2 air changes per hour

High wind speed 5m/s

•30 air changes per hour

Purging ventilation

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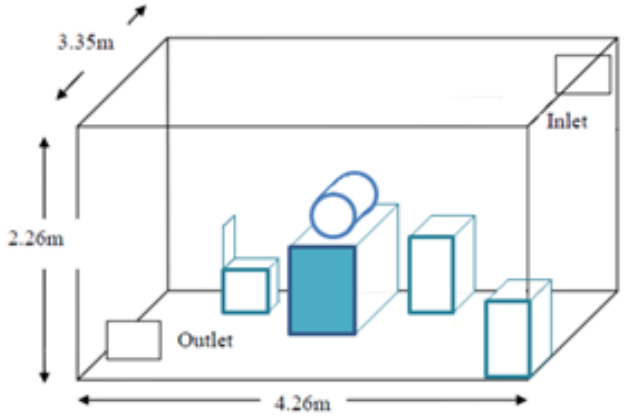
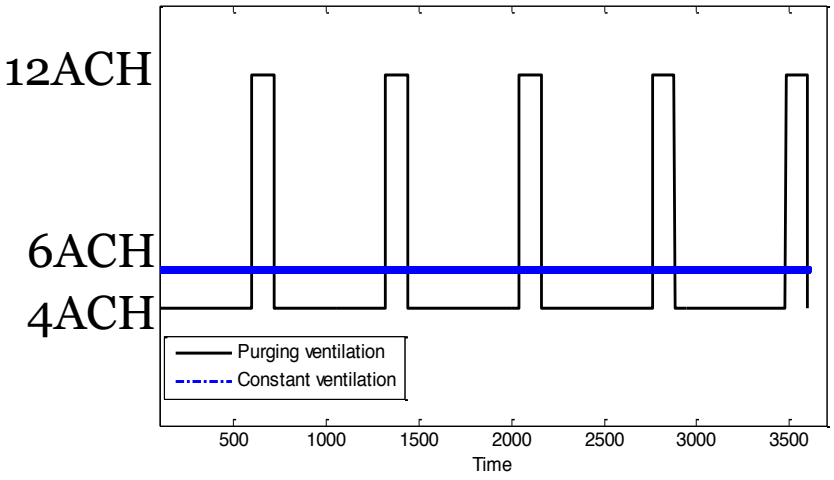
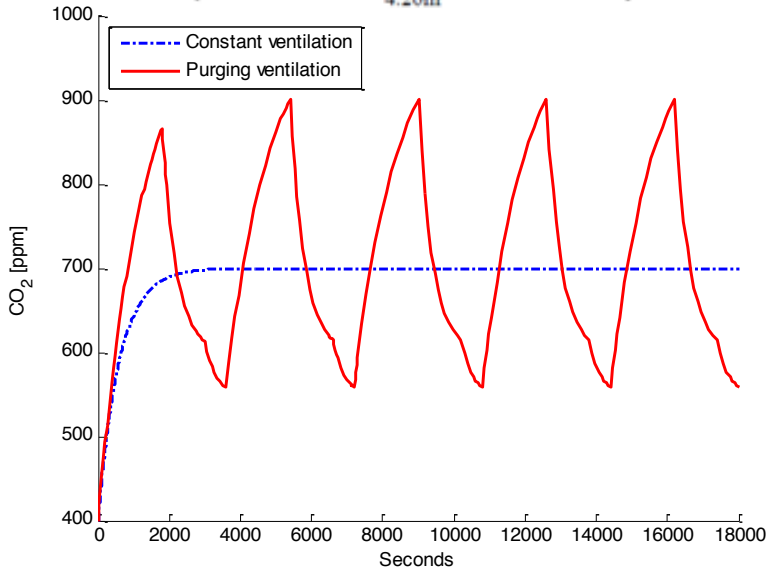
❖ Immitating the variation of natural ventilation:

1. Could we?
2. Should we?
3. Effect of local turbulence?







In the wild

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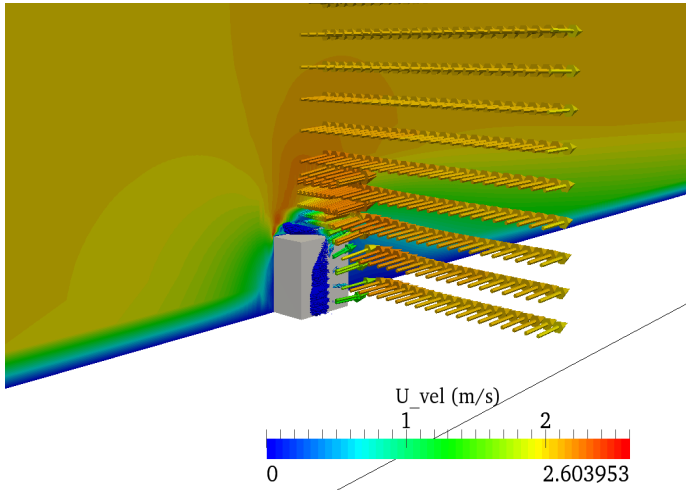
Silsoe v 1.0

CFD – Quantitative



Silsoe version 2.0 Sept 2014

Pressure taps and tracer gas to gain an understanding of the effect of urban canopy flow on ventilation

Next Steps...

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- Combine CFD and experimental studies to look at transient indoor-outdoor flow in test buildings: Silsoe
- Real-time CFD models of transient flow in bulk air and human microclimate
- Completing large scale physiological oriented study to understand how specific targeted movements improve performance in lab workers - inform cognitive performance approaches

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Any questions?

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