Prof Tim Sharpe

BPE findings - cross project ventilation performance
Relevant recent projects

- EPSRC Assessment of Environmental and Energy effects of Domestic Laundering (100 + 40 houses)
- AHRC Study, sunshine and well-being in housing (40 houses)
- Scottish Building Standards - Guidance for Occupants of Low Energy Homes
- Knowledge Transfer Partnership with Cartwright Pickard Architects, London (20 houses on 5 sites)
- Scottish Building Standards - Research Project To Investigate Occupier Influence On Indoor Air Quality In Dwellings (200 + 40 houses)

- Technology Strategy Board (Innovate UK) Building Performance Evaluation Programme
  - Expert Evaluator
  - The Glasgow House (Phase 1)
  - Inverness expo (8 houses)
  - Bloom Court Livingston (2 + 6 houses)
  - Ti-na-Cladich, Dunoon (3 houses)
  - Queens Cross, Glasgow (6 houses)
  - Murray Place, Barrhead (3 houses)
  - Dormont Park, Dumfries (4 houses)

- Meta study of MVHR system in Domestic properties
• MEARU engaged in monitoring 7 domestic projects in Scotland
Total Energy Consumption

- Normalised for user per m²
- Occupancy context is important

Annual Energy Consumption kWh/m²
Total Energy Consumption

- Normalised for user per m²
- Occupancy context is important
Ventilation Context

- Energy reduction targets
- Performance Gaps - energy and environmental performance

- Increasing importance of ventilation - energy and health
- Air tightness

- Potential unintended negative consequences
Ventilation observations

- IUK studies
- Observed through measurements of CO₂
- Under 1000ppm = 8 l/s/p = good ventilation

“.ventilation rates above 0.4 h⁻¹ or CO₂ below 900 ppm in homes seem to be the minimum level to protect against health risks based on the studies reported in the scientific literature”  Wargocki, P. The Effects of Ventilation in Homes on Health. *Int. J. Vent.* 2013; 12, 101–118.
Bedrooms

- Focus on bedrooms
- Clear periods and intensity of occupation
- Of interest due to the occupied length of time
**Bedrooms**

- Focus on bedrooms
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**Graph:**

*ID2 – Master Bedroom Environmental Conditions 3rd – 9th February 2014*

Legend:
- Green: Carbon Dioxide Concentrations ppm
- Orange: Relative Humidity %
- Red: Temperature °C
Ventilation observations

- Scottish Regulations: below $5 \text{m}^3/\text{m}^2/\text{hr}@50\text{Pa}$ a ‘planned ventilation’ strategy is required
- Two-thirds have ‘overshot’ the regulation - not checked.
Ventilation effects

- Resulting ventilation rates are generally poor
- Mitigated mainly by window opening
Ventilation observations

Mechanical extract systems

- 83% underperforming
- 71% failing design performance criteria

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Research Project To Investigate Occupier Influence On Indoor Air Quality In Dwellings

Building Standards Directorate

Prof Tim Sharpe MEARU
Jonathan McQuillan Anderson Bell Christie
Dr. Stirling Howieson, University of Strathclyde
Paul Farren ASSIST DESIGN ARCHITECTS
Dr. Paul Tuohy ESRU, Strathclyde University
Key Findings

- Survey of ventilation habits
- Most trickle vents closed - 63% closed
- Hardly every changed
- Window opening more frequent - daily
- Drivers - temperature
- Barriers - heat loss
- 20% leave bedroom windows open at night
- Lack of knowledge - 82% had received no advice on ventilation
- No perception of Indoor Air Quality
Trickle vent performance

- % time over 1000ppm at night
- Significant periods of time with low ventilation
- Mitigated by window opening
- Better with open vents - but not effective
Resultant air change rates

- House with closed windows but open trickle vents
- No houses met requirement for IAQ = 8 l/s/p
- 42% below requirements for moisture control
Ventilation effects

- Risk of dust mite population
- Particularly in high occupancy which has standard ventilation provision
Ventilation effects

- Correlation between poor ventilation and indoor pollutants
- Formaldehyde, known carcinogen
Observations

- Trickle vents are frequently out of immediate reach due to height, furniture and positioning of blinds and curtains.
Observations

- The majority of bedroom windows surveyed have some form of blinds or curtains that would occlude the vents, especially at night when curtains and blinds are most used.

- No instances where vents had been interfered with or blocked
Observations

- Floor coverings frequently obstructed door undercuts - residents' comments including that they had to physically shorten doors to allow opening after fitting carpets.
Observations

• Floor coverings frequently obstructed door undercuts - residents comments including that they had to physically shorten doors to allow opening after fitting carpets
Observations

• Placement of trickle vent controls differs from window handles, which are required to be in an accessible position
Observations

- Noticeable cold air from vents - radiators not under windows
Observations

• Same provision irrespective of occupancy loads
Mechanical Ventilation

- Comparison of average and peak CO₂ levels in bedrooms of MVHR and non MVHR*
Mechanical Ventilation

- Comparison of average and peak CO₂ levels in bedrooms of MVHR and non MVHR*
Glasgow House - MVHR testing

- **SC6**: Comparison of MVHR (week 1) vs window opening (week 2)
- Week 2 - better perception, but measured values worse
- Explained by adaptive comfort, plus values overnight in bedrooms
- Energy consumption **Plot 1** - 1.1x higher, **Plot 3** - 2.8x higher
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MVHR issues

- Design intentions
- Design integration
- Ducts type and size

- Missing vents in bedrooms
- Unbalanced systems
- Unit location for filter cleaning
- Construction debris

- Noise
- Occupant understanding
- Lack of maintenance strategy
Conclusions
Conclusions

- Ventilation is not being designed
- Compliance is prescriptive and achieved at design stages
- No-one has an overview of the whole process
- Design should include performance
- Handover of aims (not just objectives)
- Evaluation of performance not intention
Progress

- Simple guidance for occupants of low energy homes for Scottish Building Standards


- CO₂ awareness raising
Conclusions

- BPE is a critical tool
- Closes the knowledge gap between design and occupancy
- Is a better way of ensuring compliance
- Protects against risk
- Increases knowledge throughout the process
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Conclusions

- Clients
  - Spend more on design and evaluation to get it right
  - Get what you pay for

- Architects
  - Expand your skills and influence to reclaim territory
  - Evidence based design

- New M.Sc. in Environmental Architecture in development
one last thing...
one last thing…
Thank you


- Occupant Interactions and Effectiveness of Natural Ventilation Strategies in Contemporary New Housing in Scotland, UK
  - http://www.mdpi.com/1660-4601/12/7/8480

- Building tight – ventilating right? How are new air tightness standards affecting indoor air quality in dwellings?
  - http://bse.sagepub.com/content/early/2013/11/27/0143624413510307

- An assessment of environmental conditions in bedrooms of contemporary low energy houses in Scotland
  - http://ibe.sagepub.com/content/23/3/393