Natural Ventilation in Schools:
Simulation Case Studies
CIBSE-IBPSA May 2010
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Sustainable Futures
Anyone involved with schools is involved in the creation of children’s futures

“Climate change is the most severe problem we are facing today”
Sir David King (Former UK Chief Scientific Adviser)

“Ignoring climate change will be the most costly of all possible choices, for us and our children.”
Peter Ewins (British Meteorological Office)

Sustainable Ventilation
• What should a sustainably ventilated school look like?
• What should it feel like?
• Is it about challenging and innovative design
• Or should it be less complicated…

St Francis of Assisi, Liverpool
A School, North Cameroon
Whitecross School, Herefordshire

Aesthetically pleasing
Well Designed
Safe and Secure
Healthy
Flexible
Space and Spaces
Light and Colourful
Good!

Quote from Bradford Headteacher in March 2005

So where do we start…

Responsibility Matrix

What we want our school to be:
Architecturally Pleasing
Integrated Design
Protects Occupants
Well Ventilated
Flexible
Open and Spacious
Light and Bright
Sustainable!

Sustainable Ventilation
• Sustainable Designs insist that we consider:
  – Orientation
  – Fabric
  – Windows
  – Daylight
  – Heating
  – Acoustics
  – Plant Selection
  – Comfort
  – Energy/Carbon Use
• Demands a holistic approach
Simulation Modelling
- Build a Virtual Model
- Subject it to local weather data
- Solar Gain Calculations
- Energy Calculations
- Ventilation Assessments
- Computational Fluid Dynamic Simulations
- Pick rooms and test the performance of windows

Importance of Ventilation
- Find that removing CO2 concentrations in the classroom (below 500ppm) is critical. - This reduces by 35% of the test results. With 100% recirculation into 2 sample classrooms in 8 schools
- Undertook Literacy and Numeracy Tests on a sample of 9-10 year olds

Guidance
- 3 litres per second per person minimum of controllable background ventilation
- 5 litres (1500ppm CO2) per second per person averaged over occupation period
- 8 litres per second per person must be available at all times as and when it is demanded (>1000ppm)
- Part F says BB101 can be used to demonstrate compliance in schools

Result has been...
- Myriad of Plant Led Solutions
  - HRV Ventilation
  - Auto Vents
  - Earth Pipes
- Possibly more efficient
- More Expensive-add to existing cost pressures
- More Maintenance Intensive
- Less Transparent to Control

Sheffield PFI 3-Case Studies
- Sheffield PFI 3
  - £46 Million PFI
  - 2 Secondary schools, 2 Primary Schools
  - Ran between 2004 and 2007
  - Designs pre-date BB101 and Part L2006
  - Similar funding issues to those of current BSF schools

Secondary Schools Section
- Trial Scheme had:
  - 2.7m ceilings
  - 2.5m high windows
  - Naturally Ventilated
  - Tropical Daylight
  - Lower Energy Use
  - £0.5 saving

An uncompiled integrated section that should work....
Window Design
- 3 x 2000mm high x 1180mm wide
- 400mm top pivoting hinge opening at top
- 1020mm centre pivot centre section
- 300mm top pivot and friction hinged for precision opening at the bottom (restricted to 150mm clear opening)

Window Design
- Caters for most external Conditions
- Windy days (top open)
- Cold days (top open, bottom a small amount)
- Still days (top and bottom)
- Warm Summer Days (all open)

Virtual Models for both Schools
- Meadowhead
- Westfield

Typical Classroom CFD
- Air Flow

CO₂ Statistics
- Hours CO₂ level exceeds stated Range
- No of Occupied Hours per Annun

Typical Classroom Analysis
- Temperature
Temperature Statistics

- Council insisted that both Westfield and Meadowhead windows were tested
- To ensure Comfort Conditions
- To verify CFD results
- 25 Pupils plus 1 Teacher simulated using 65W light bulbs and CO2 tubing placed in metal ducting

BSRIA Test

Test Results

Class MH 008 (3 windows fitted)

<table>
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<tr>
<th>Date</th>
<th>External Temp °C</th>
<th>Internal Temp °C</th>
<th>CO2 Maximum ppm</th>
<th>Average Fresh Air (l/s/p)</th>
<th>Av. Wind Speed</th>
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</table>

Test Results

Class WF 31 (only 2 windows fitted)

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<th>Date</th>
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<th>CO2 Maximum ppm</th>
<th>Average Fresh Air (l/s/p)</th>
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</table>
User Guides

- Published Guides to help teaching staff and pupils get the best from the window design

Does it Work?

- Hits all important technical requirements
- Kier FM have reported rooms were comfortable throughout the summer and winter
- Addresses capital financial constraints
- Is simpler and more transparent
- Less Maintenance
- More Hygienic
- Not strictly compliant with latest BB101
  Would be good to do some “live” monitoring of CO2 levels

Conclusion

- Sustainable ventilation is about looking for solutions that are not only carbon efficient but are also:
  - Affordable
  - Are transparent in control
  - Are maintainable
  - Are repeatable
  - Are simple but no simpler
- Maybe ventilation in schools is not so much a mechanical engineers problem, but is perhaps a facade specialists problem...

Thank You

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  - www.buildings.mottmac.com
  - www.bsria.co.uk/news/classroom-ventilation-testing-of-alternatives/