


Natural Ventilation in Schools:
Simulation Case Studies
CIBSE-IBPSA May 2010

Edward Murphy Technical Director

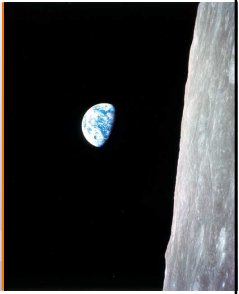


Sustainable Futures


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 Advisor)

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



<http://grin.hq.nasa.gov/IMAGES/SMALL/GPN-2001-000008.jpg>



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...



What is Possible in Africa, Georgia



So where do we start...

What we want our school to be:

- Architecturally Pleasing*
- Integrated Design*
- Protects Occupants*
- Well Ventilated*
- Flexible*
- Open and Spacious*
- Light and Bright*
- Sustainable!*




Quote from Bradford Headteacher in March 2005



Responsibility Matrix

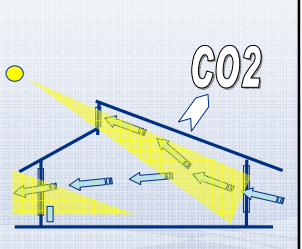

What we want our school to be:

	Arch	M&E	Structural	Escape
<i>Architecturally Pleasing</i>	★	★	★	★
<i>Integrated Design</i>	★	★	★	★
<i>Protects Occupants</i>	★	★	★	★
<i>Well Ventilated</i>		★		
<i>Flexible</i>	★	★	★	★
<i>Open and Spacious</i>	★		★	★
<i>Light and Bright</i>	★	★		
<i>Sustainable!</i>	★	★	★	★



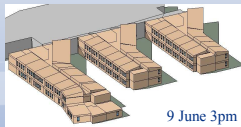
Sustainable Ventilation

- Sustainable Designs insist that we consider:-
 - Orientation
 - Fabric
 - Windows
 - Daylight
 - Heating
 - Acoustics
 - Plant Selection
 - Comfort
 - Energy/Carbon Use
- Demands a holistic approach

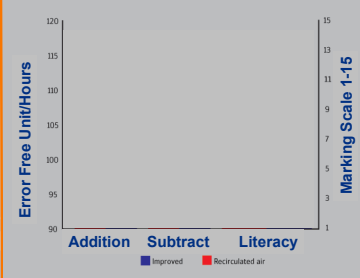
Simulation Modelling

- 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



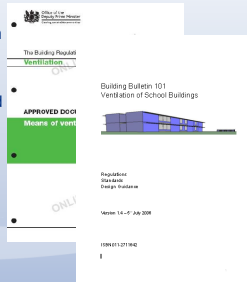
Importance of Ventilation

- For the 2008 study by CO2 and IAQ in the classroom, the installed Ventilation Numeracy and Literacy tests 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-adding to existing cost pressures
- More Maintenance Intensive
- Less Transparent to Control



Sheffield PFI 3-Case Studies

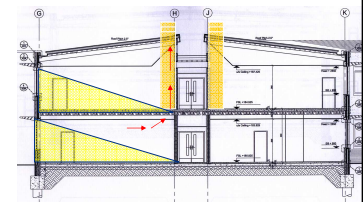
- Sheffield PFI 3
 - £46 Million PFI
 - 2 Secondary schools, 2 Primary Schools
 - Ran between 2004 and 2007
 - Designs pre-date BB101 and Part L2006
 - Similar funding issues to those of current BSF schools



Secondary Schools Section

Initial Scheme had:-

- 2.9m ceilings
- 2.85m high windows
- Non-ventilated stacks
- Inappropriate Daylight
- Lower Energy Use
- £0.5m saving



An uncomplicated integrated section that should work....



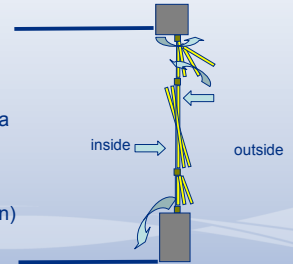
Window Design

- 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)

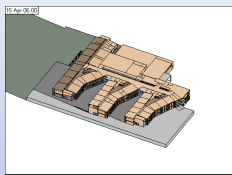


Window Design

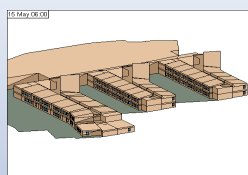
- Caters for most external Conditions
- Windy days (top open)
- Cold days (top open, bottom a small amount)
- Still days (top and bottom)
- Warm Summer Days (all open)



Virtual Models for both Schools



Meadowhead

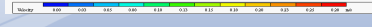
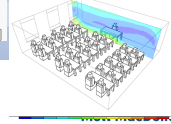
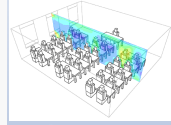
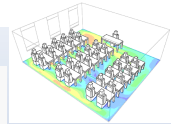
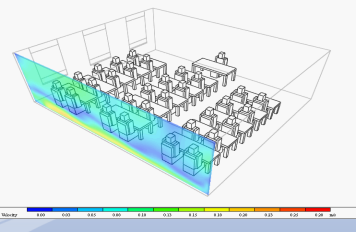


Westfield

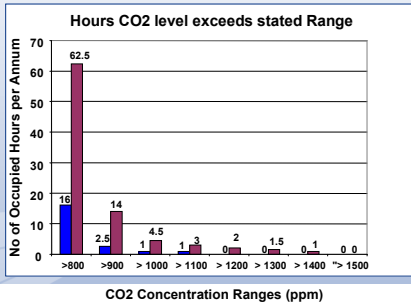


Typical Classroom CFD

Air Flow



CO₂ Statistics

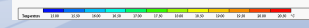
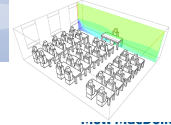
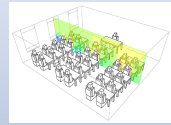
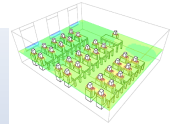
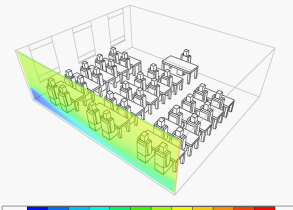


- Science Lab 09
- Humanities 03



Typical Classroom Analysis

Temperature

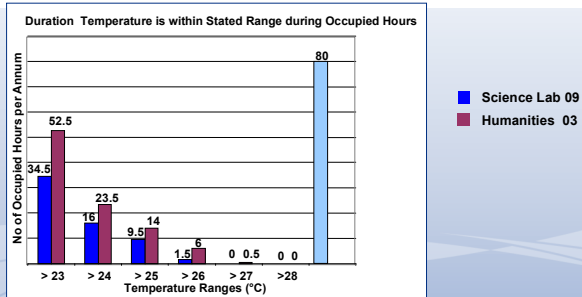


Slide 16

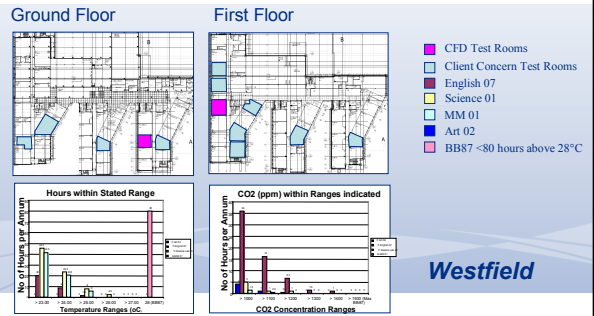
m1

mur24807, 03/11/2008

Temperature Statistics



Client Concern Rooms



Westfield

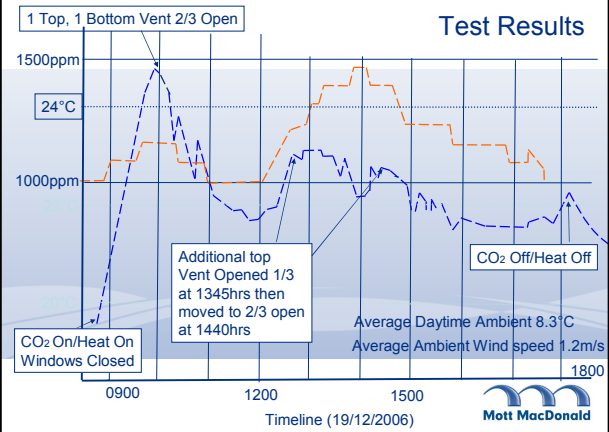


BSRIA Test

- 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



Test Results



Test Results

Class MH 008 (3 windows fitted)

Date	External Temp °C	Internal Temp °C	CO2 Maximum ppm	Average Fresh Air (l/s/p)	Av. Wind Speed
17/12/06	8.7	23.1	969	5.8	2.3
18/12/06	5.2	23.3	1062	5.5	1.1
19/12/06	8.4	23.5	1140	4.8	1.2



Test Results

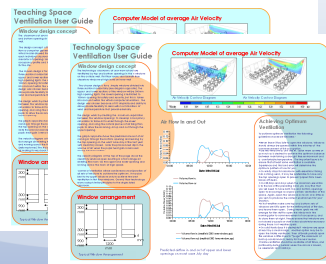
Class WF 31 (only 2 windows fitted)

Date	External Temp °C	Internal Temp °C	CO2 Maximum ppm	Average Fresh Air (l/s/p)	Av. Wind Speed
12/12/06	9.0	24.0	937	5.4	7.0
13/12/06	11.4	24.5	813	6.4	8.2
14/12/06	13.6	25.0	854	6.0	7.6



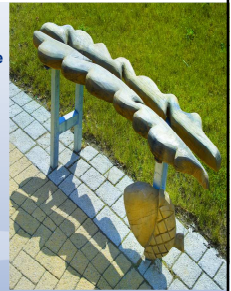
User Guides

- 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

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

