Trying to have it all – School Design
1905
Examples of what the Building Bulletins say

**BB90 Daylight** – “Natural Lighting during daylight hours should always be the major source supplemented when it fades by electric light which will take over during hours of darkness”

**BB90** “Interiors with an average daylight factor of 5% or more are considered to be day-lit rooms and will not normally require electric lighting”
“……third, the improvement in performance of pupils appears to be related to the level of daylight in the classroom.”

Brian W. Edwards 2006
Solutions

- **a)** thermal mass; **b)** soft surface for acoustic absorption; **c)** hard surface for acoustic reflection; **d)** acoustically attenuated air intake with heating coil for winter; **d)** acoustically attenuated air extract with fan for higher levels of ventilation
Key recommendations of the Guidance

Pre-Engineering Consultation
Informed client
Audit Scotland recommend adoption of it’s principles
CFD Study

A Case Study in Single Sided Natural Ventilation
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…
ODPM Study

Windows are effective in providing the required ventilation

Teachers feel unable to use windows:-
  – When outside temperatures perceived to be cold
  – If winds are causing cold draughts
  – When it is noisy outside
  – Unless they actually perceive room to be stuffy
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 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 Study

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
Case Study

Initial Scheme had:
- 2.7m ceilings
- 2.5m high windows
- Ventilation Stacks
- Unaffordable

Final Scheme:
- 2.9m ceilings
- 2.85m high windows
- No Ventilation Stacks
- Improved Daylight
- Lower Energy Use
- £0.5m saving

Secondary Schools Section
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)
Typical Classroom CFD

Air Flow
Typical Classroom Analysis

Temperature
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
24°C
22°C
20°C

0900  1200  1500  1800
Timeline (19/12/2006)

Gas On Heat On
Windows Closed

Gas Off Heat Off

Average Daytime Ambient 8.3°C
Average Ambient Wind speed 1.2m/s

1 Top, 1 Bottom Vent 2/3 Open

Additional top Vent Opened 1/3 at 1345hrs then moved to 2/3 open at 1440hrs
# Test Results

Class MH 008 (3 windows fitted)

<table>
<thead>
<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>
</tr>
</thead>
<tbody>
<tr>
<td>17/12/06</td>
<td>8.7</td>
<td>23.1</td>
<td>969</td>
<td>5.8</td>
<td>2.3</td>
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<tr>
<td>18/12/06</td>
<td>5.2</td>
<td>23.3</td>
<td>1062</td>
<td>5.5</td>
<td>1.1</td>
</tr>
<tr>
<td>19/12/06</td>
<td>8.4</td>
<td>23.5</td>
<td>1140</td>
<td>4.8</td>
<td>1.2</td>
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</tbody>
</table>
## Test Results

Class WF 31 (only 2 windows fitted)

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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>
</tr>
</thead>
<tbody>
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<td>12/12/06</td>
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<td>24.0</td>
<td>937</td>
<td>5.4</td>
<td>7.0</td>
</tr>
<tr>
<td>13/12/06</td>
<td>11.4</td>
<td>24.5</td>
<td>813</td>
<td>6.4</td>
<td>8.2</td>
</tr>
<tr>
<td>14/12/06</td>
<td>13.6</td>
<td>25.0</td>
<td>854</td>
<td>6.0</td>
<td>7.6</td>
</tr>
</tbody>
</table>

*Westfield*
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
Summary

Simulation can assist in solution finding – especially in the case of natural ventilation solutions.

User interfaces need to be considered and education is needed.

Sensitivity testing should be undertaken and shared with the client and users.

Create an informed client.