Designing natural ventilation for thermal comfort in buildings

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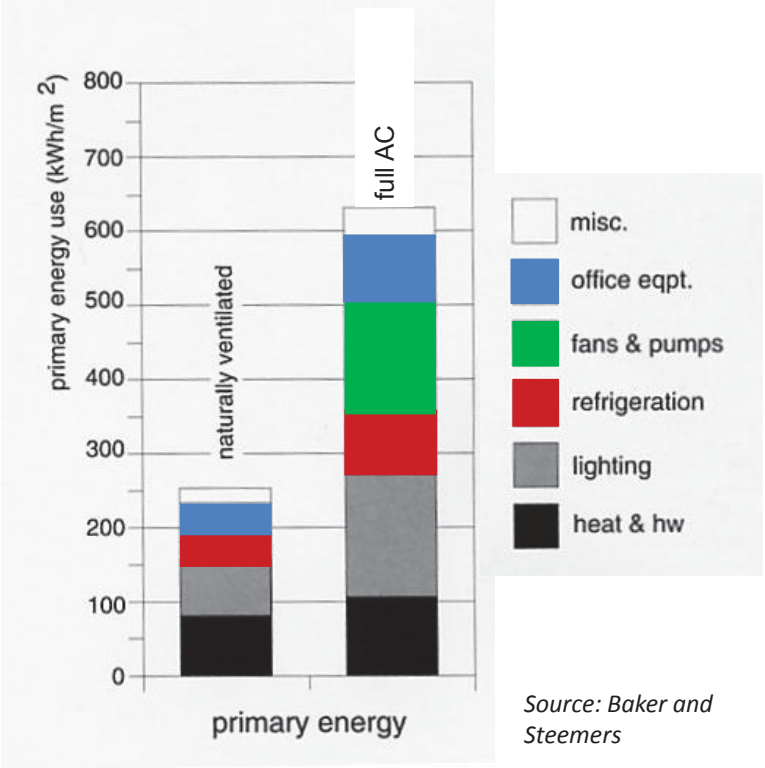
Energy Use In Buildings



Source: Baker and Steemers

HOUGHTON HALL

HOUGHTON HALL

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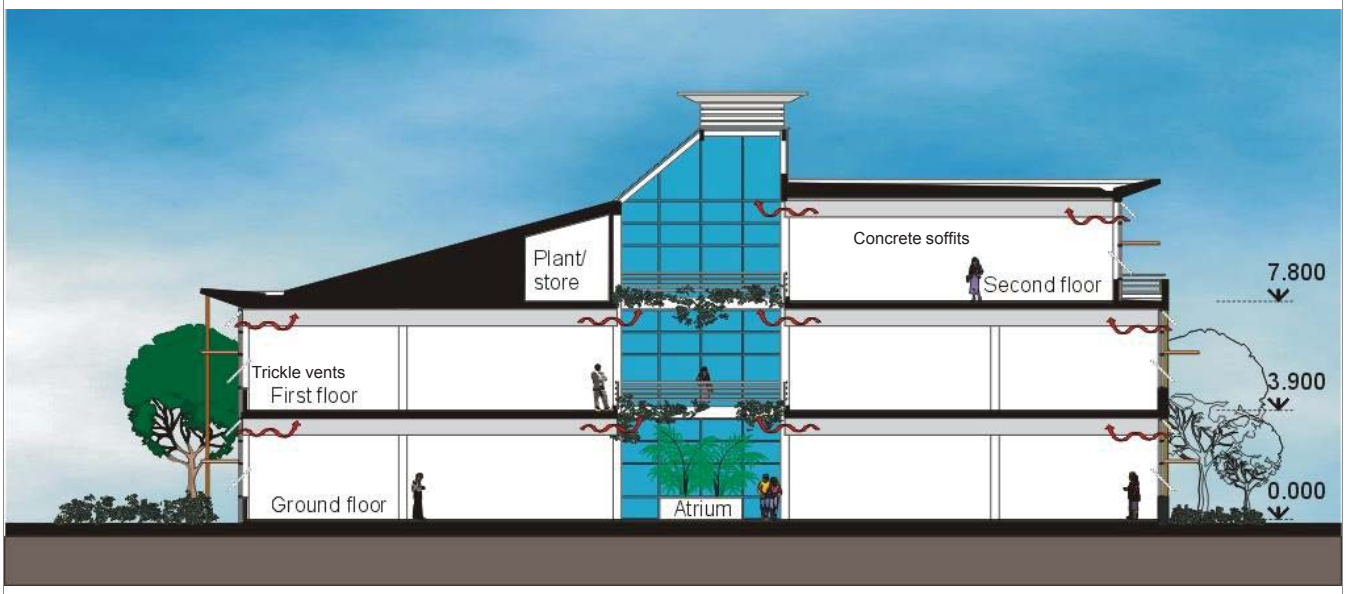
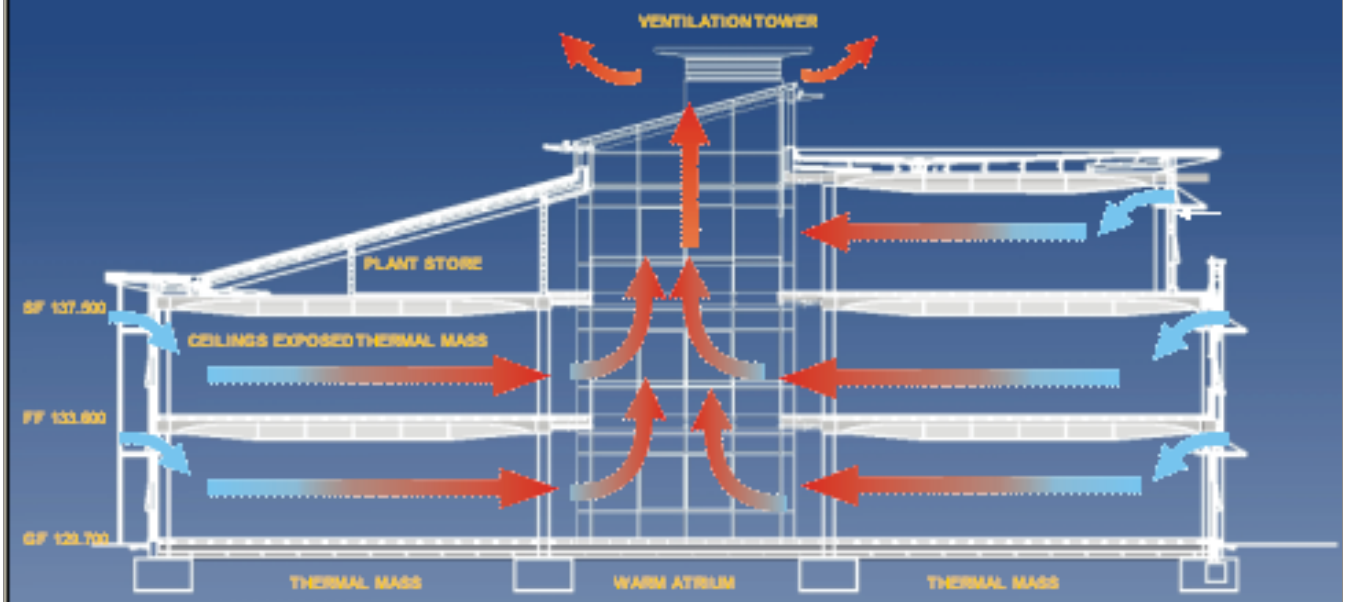


Building designed for outflow through stacks



Complex Spaces – Houghton Hall

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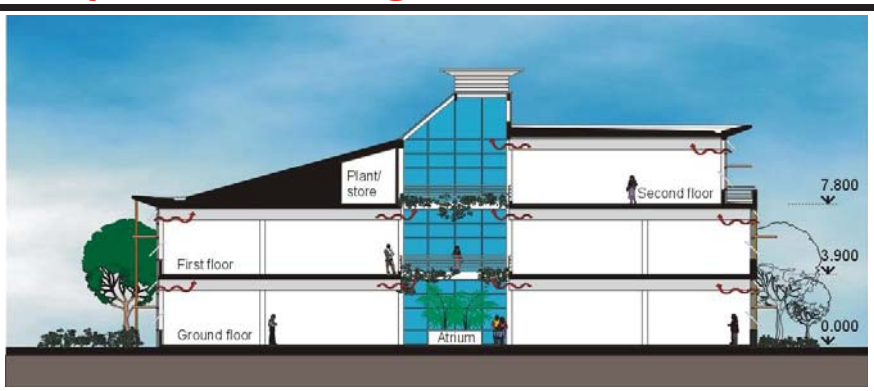
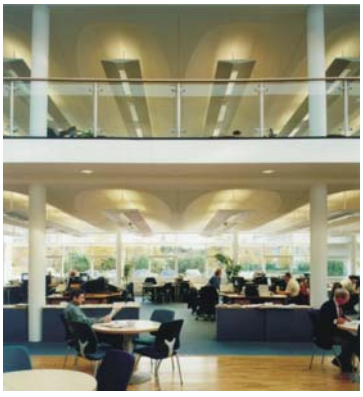
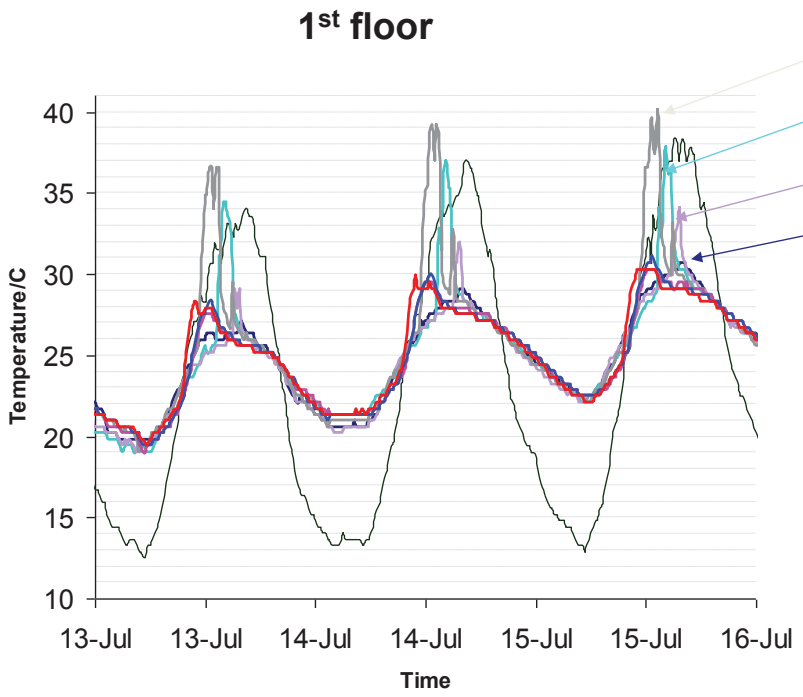




Temperature Measurements

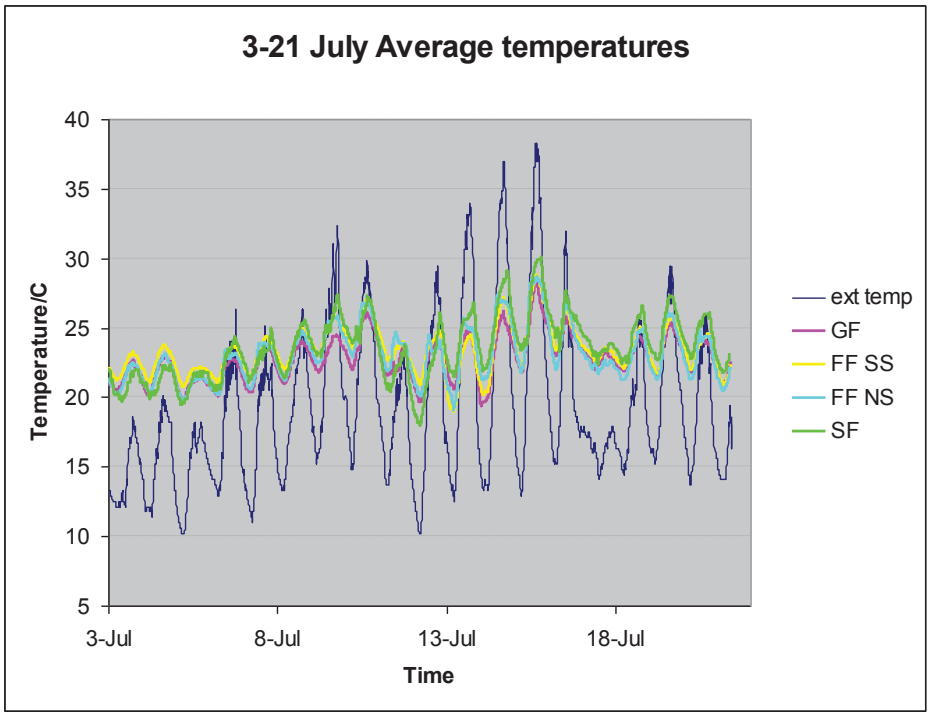


- North side of the atrium
- East end of the atrium
- South side of the atrium
- West end of the atrium (dark blue line, very small peak)
- Within main floor

Atrium peak temperatures follow exposure to sun

Region near/within atrium hotter than desk area under exposed concrete → benefit of thermal mass

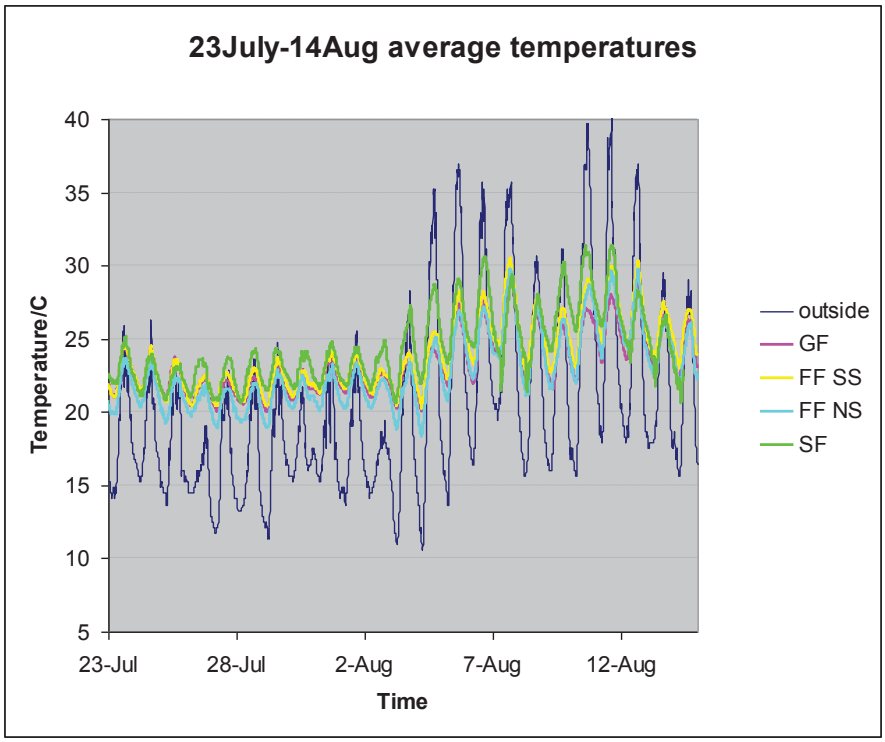
Temperature Measurements



Main floor temperatures less than outside and buffered by thermal mass…

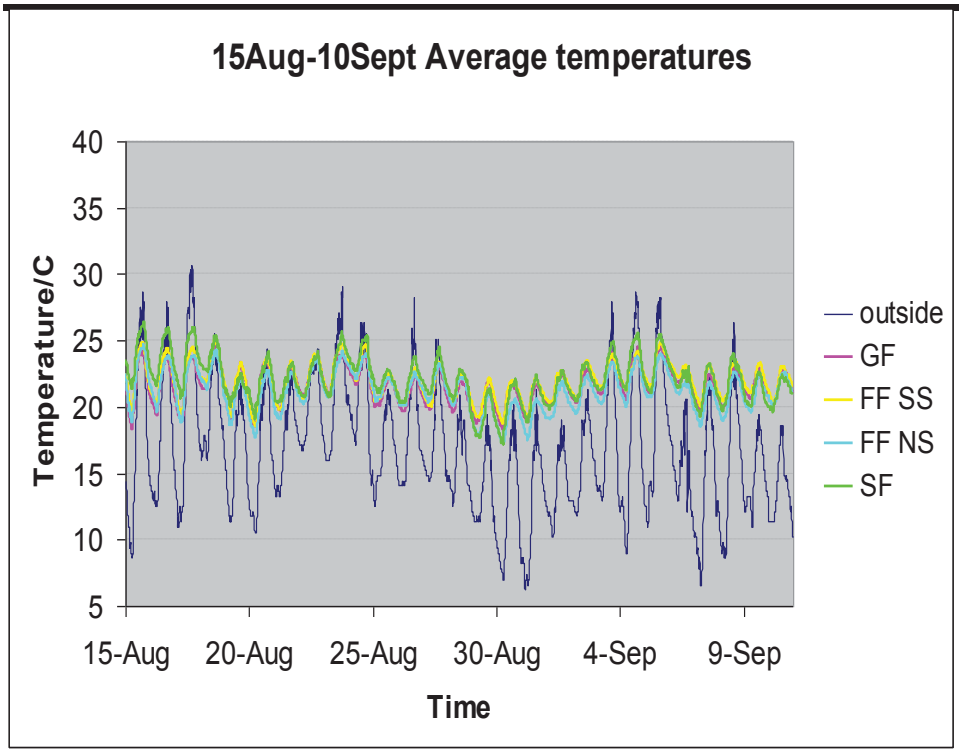
but still rather warm mid-July

Temperature Measurements



Warm inside again in early August

Temperature Measurements



Cooler after mid-August

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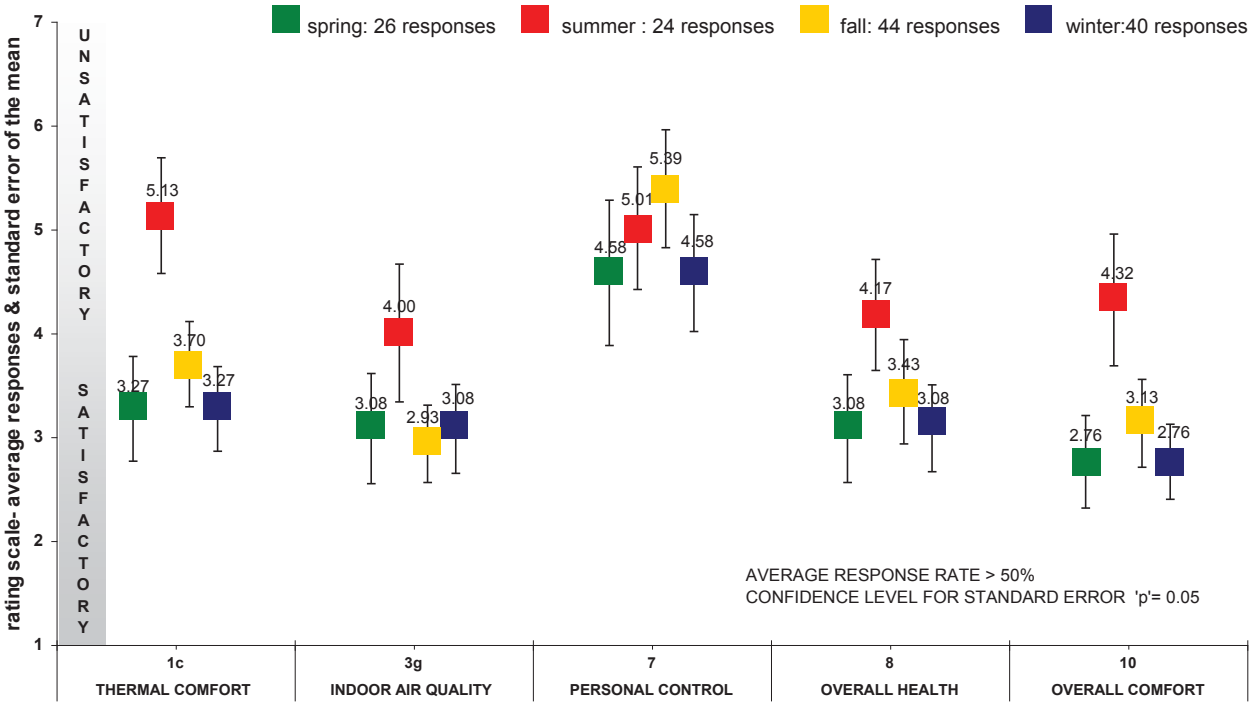
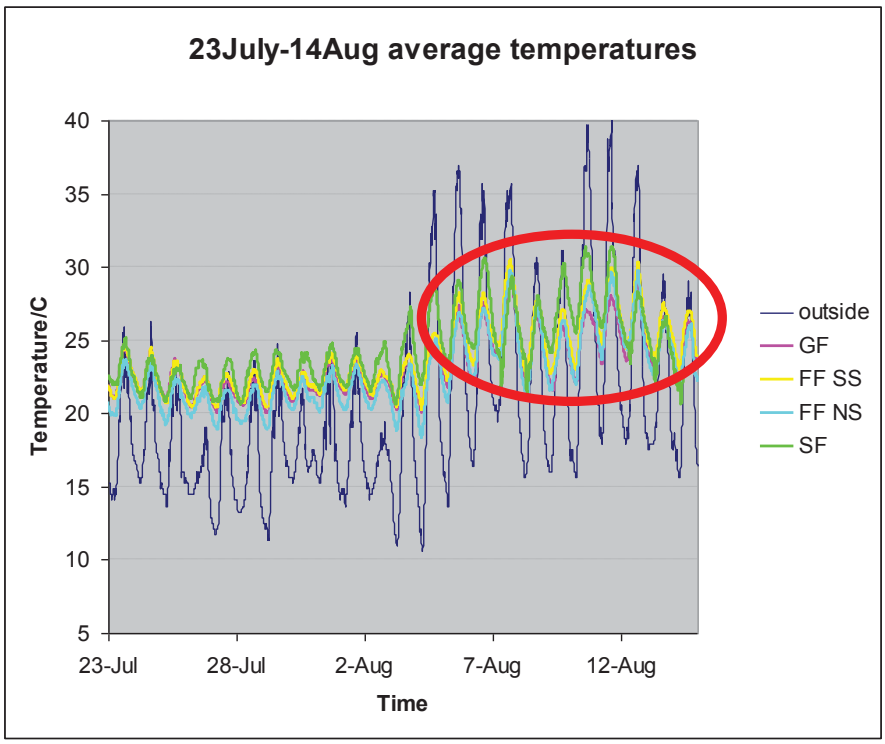
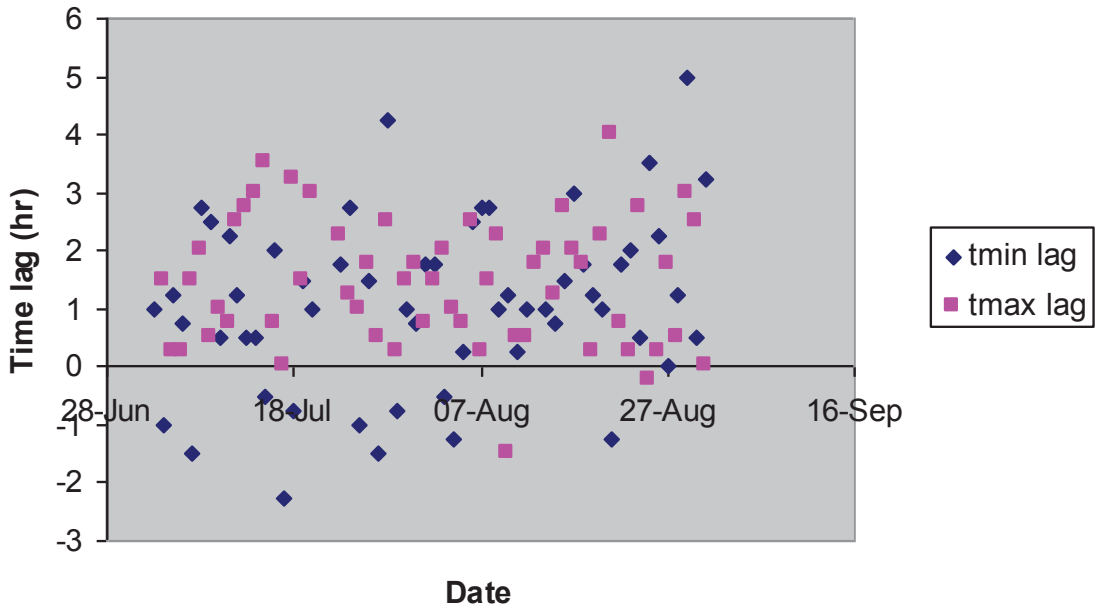
Survey Results



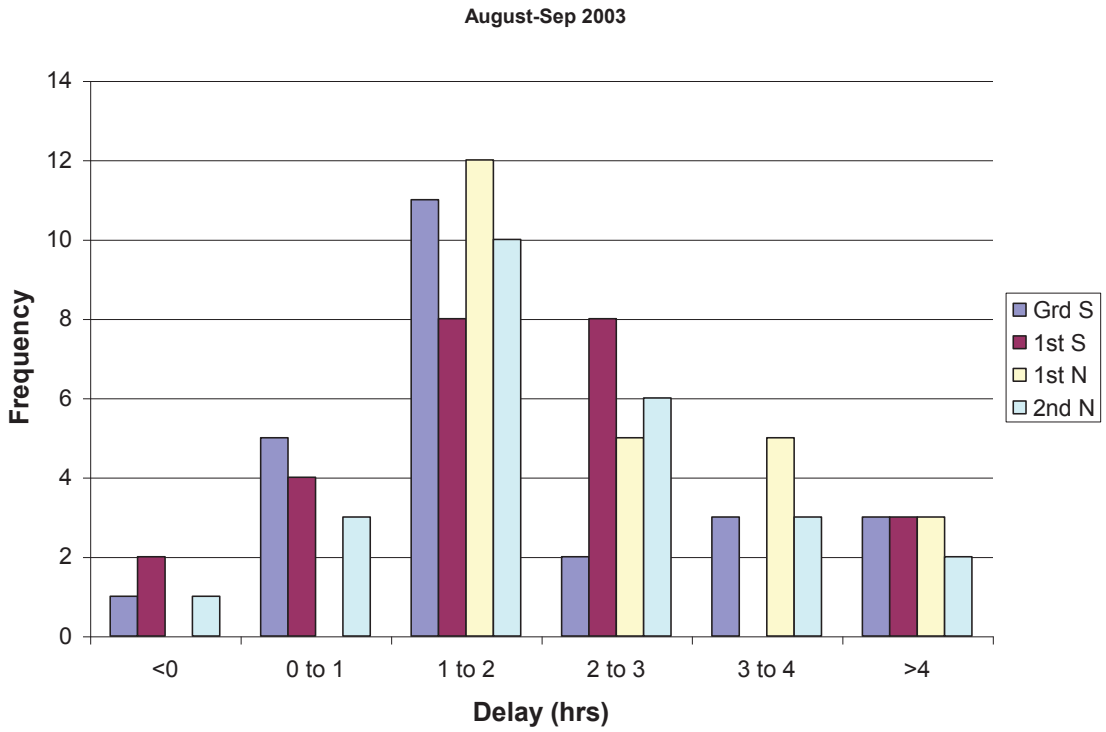
Can we improve performance?



Time Lags

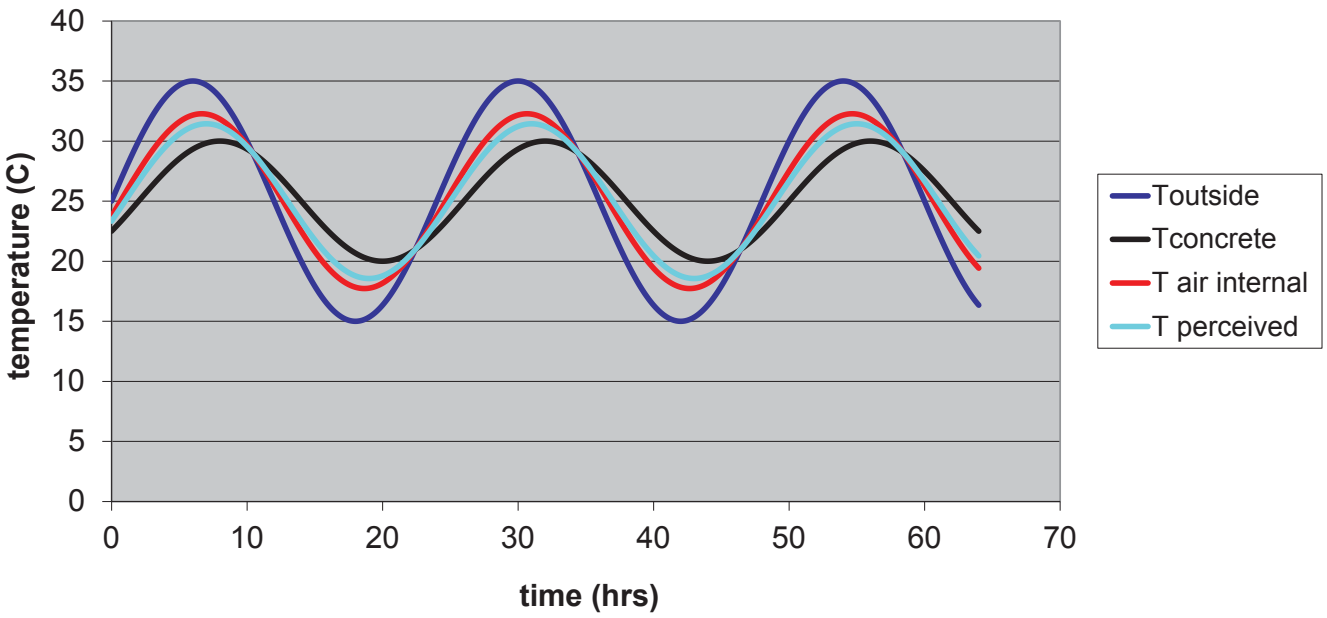


Range of time lag for building to reach max or min temp

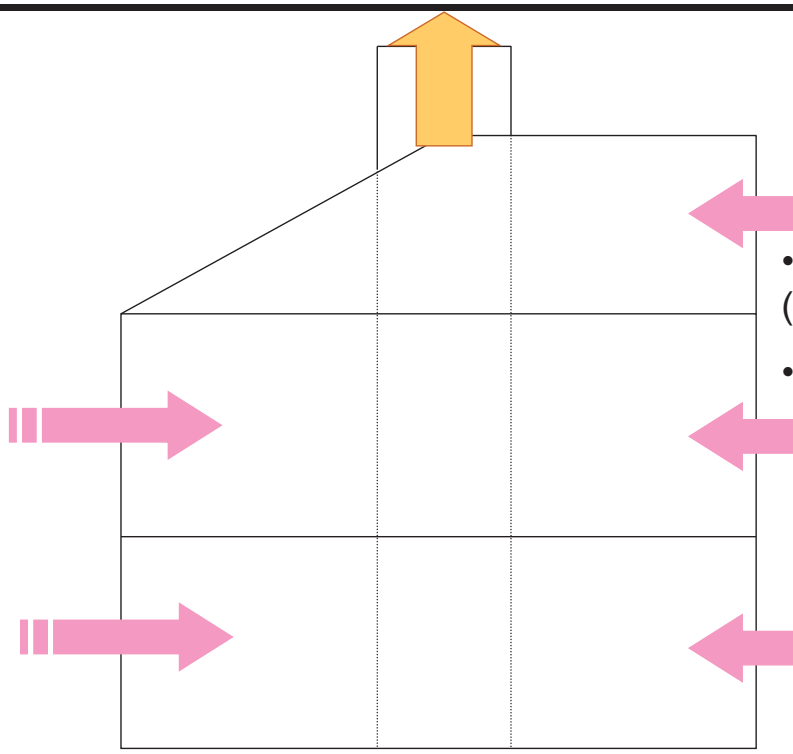


Buffer for max temp 1-3 hours

Maximising Effectiveness of Thermal Mass

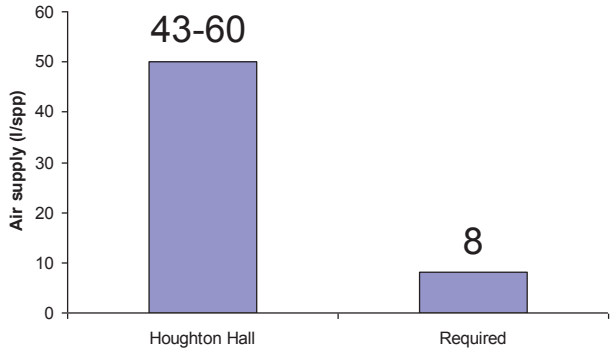


Air Flow Results



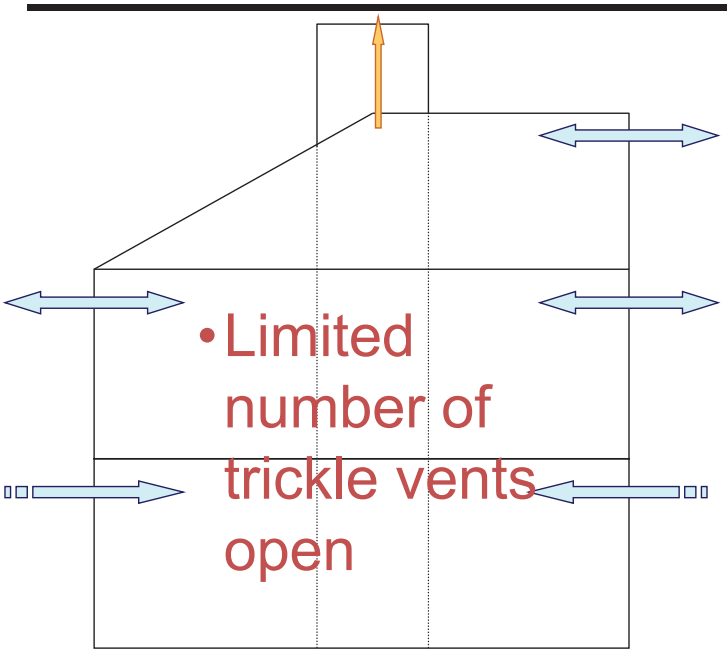
- Hot and still day (06/08/03)
- Fans are operating all day
- All windows open

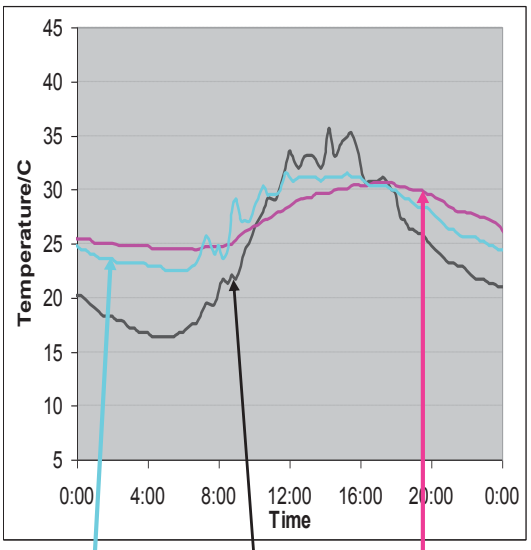
Air Quality



Measurements show fresh air supply well in excess of minimum required

Night Time Operation



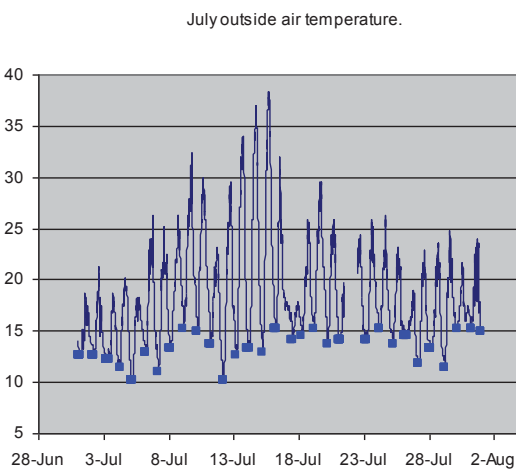


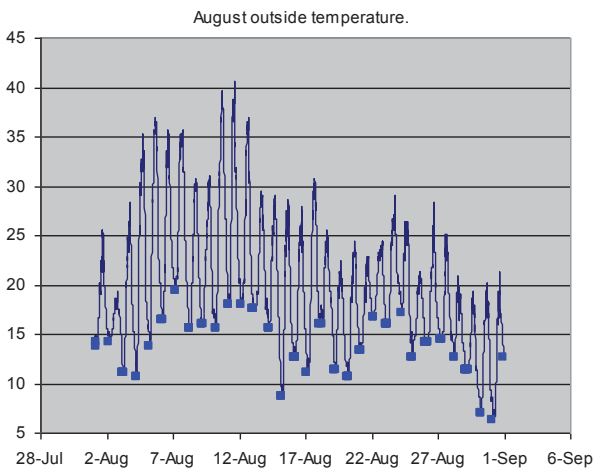
outside

Second floor

Upper part of atrium (2nd floor)

Opportunity for Improvement

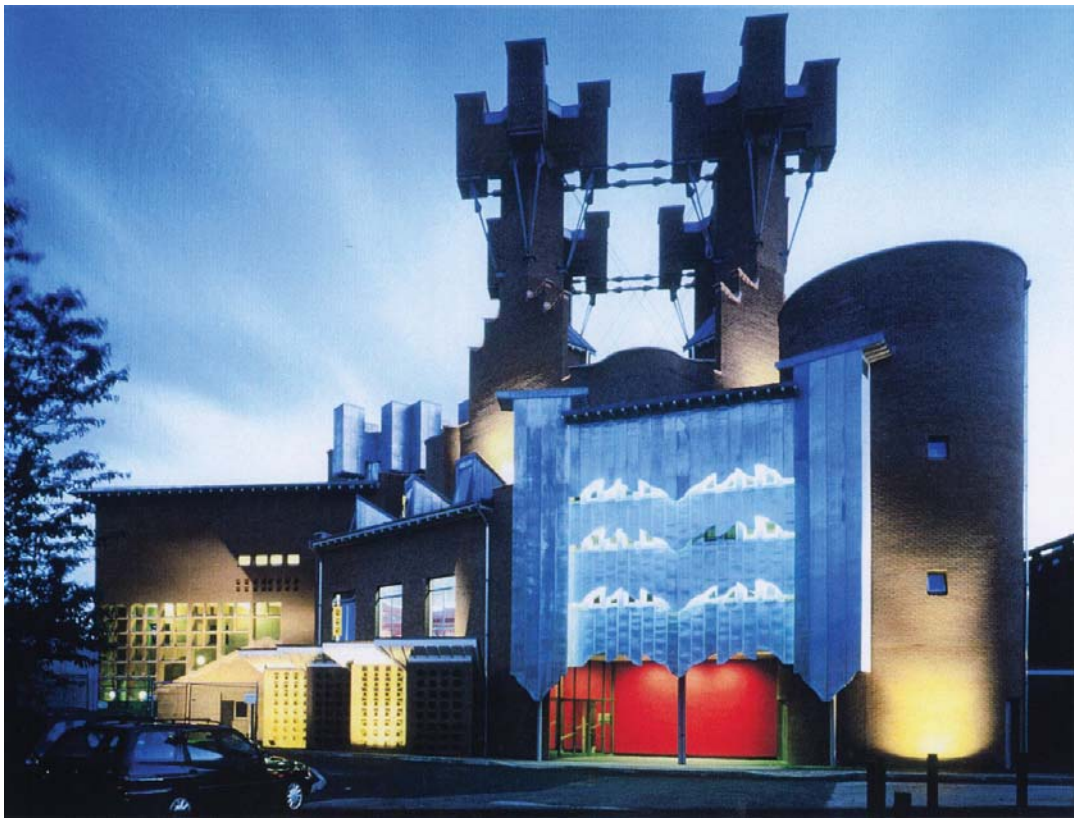




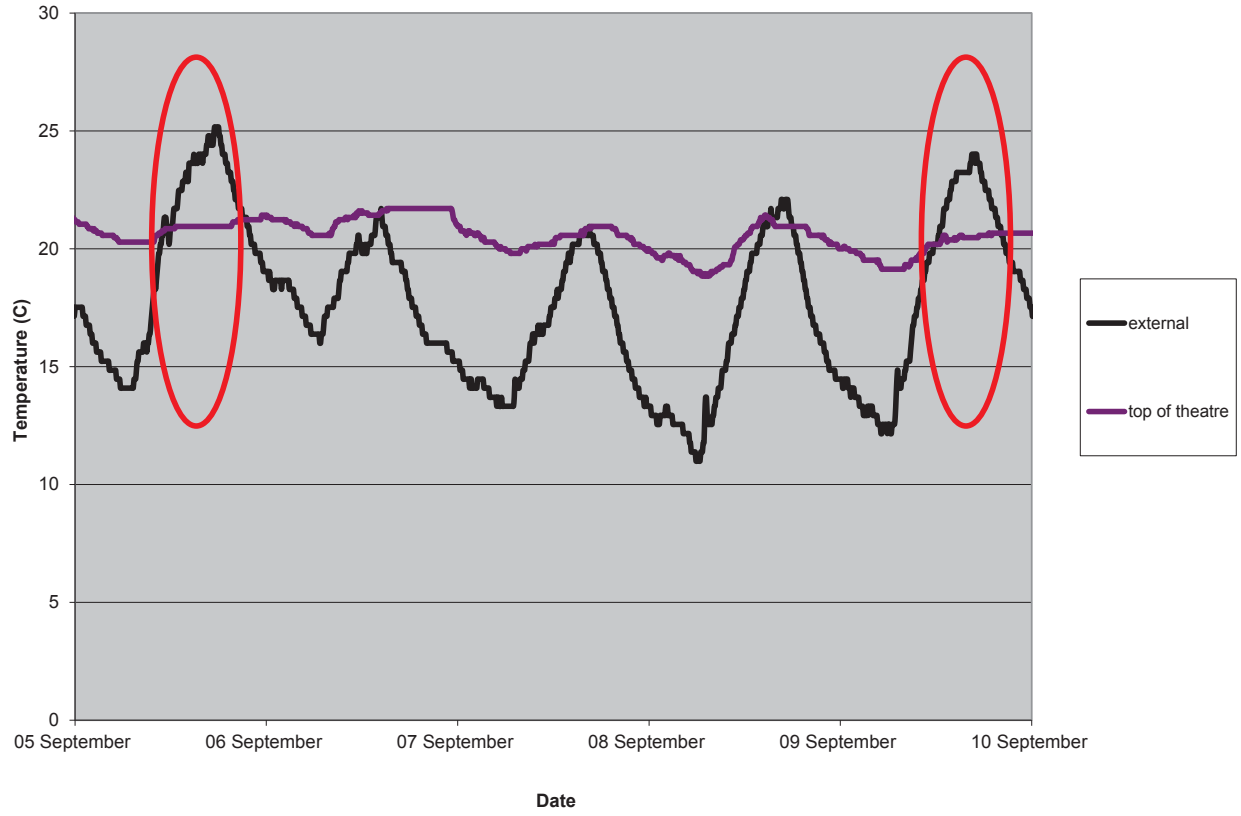
1. Opportunity to use cool air from outside during night **even more effectively** to reduce building temperature

2. Reduce window openings during summer day to **maximise benefit of thermal mass**

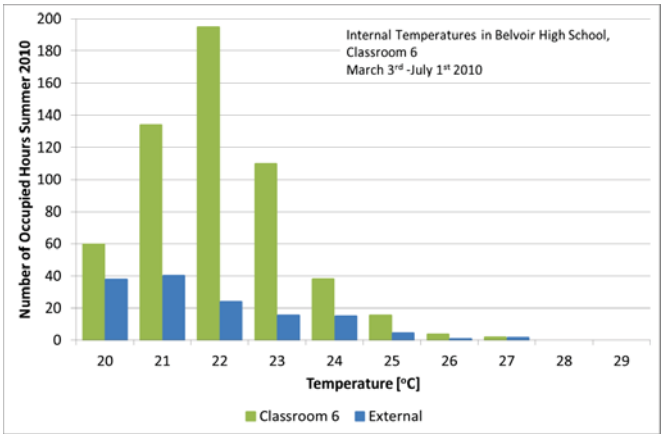
Contact Theatre, after renovation



Contact Theatre, Studio



Belvoir High School



BB101 Standards

120 hours for which T_{room}>28°C

$(T_{room})_{max}$ = **32°C**

$(T_{room} - T_{external})_{max}$ = **5°C**

Belvoir High School

0 hours for which T_{room}>28°C

$(T_{room})_{max}$ = **27.5°C**

$(T_{room} - T_{external})_{max}$ = **2.3°C**

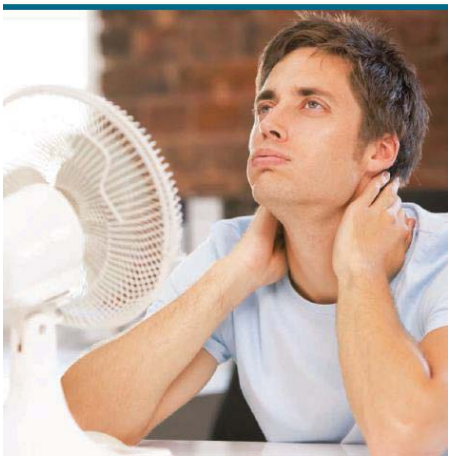
Internal Comfort

Priority School Building Programme

Making sense of the new Priority School Output Specification from the Education Funding Agency. How is the output specification different from previous guidelines, how do the standard school designs meet the output specification and how Breathing Buildings can help you model the ventilation system energy use in IES.

The limits of thermal comfort: avoiding overheating in European buildings

CIBSE



Hybrid Designs

Summary

- Natural ventilation low energy
- Exposed thermal mass
- Fan driven ventilation not “free cooling”