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Air movement in & about buildings 8 of 9 + Q&As

© NGS GreenSpec 2007 CPD in 10 parts

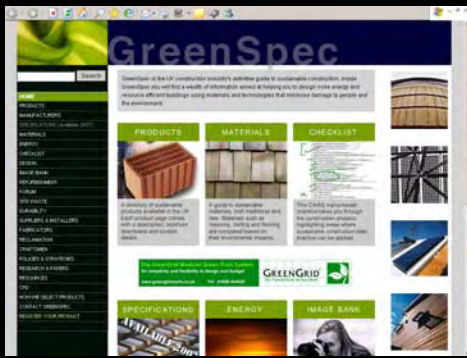
GreenSpec CPD Seminar Series

- **Educational Objective:**
 - Comprehensive introduction to subject: from wind to air-conditioning and a lot more in between
 - emphasis on environmentally sustainable solutions
 - design primer: addressing principles and solutions
 - technically rich: materials, construction, services & testing
 - Related GreenSpec CPD Seminars indicated
 - Questions and answers for each subtopic in file 10
- **Audience:**
 - Architecture Students Part 1 Year 2
 - CPD update for all levels of experience & knowledge
- **Delivery:**
 - 3 to 4 hours depending upon audience participation
 - Reading 1 hour
 - 26 subject breaks to enable subdivision

Air Movement in Buildings: 8 of 9

Sub-topics in 10 separate files

- Principles of Element Design
- Climate Change
- Wind
- Wind Tunnel Testing
- Wind Turbines
- Natural Ventilation
- Moisture Vapour & Condensation
- Thermal Insulation
- Breathing Construction
- Airtightness
- Wind & Airtightness Testing
- Building Elements
- Passive Ventilation
- Active Ventilation
- Stack Effect
- Atrium
- Solar Orientation & Solar Gain
- Conservatories
- Thermal mass
- Conduction, Convection, Radiation
- Solar Shading
- Thermal mass, Passive and active cooling
- Fluid dynamics
- Mechanical Ventilation
- Air-Conditioning
- Questions and Answers



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Solar Shading

Used to shade or permit sun passage



**Solar shading:
Common in
mainland
Europe
Will become
more important
in the UK if only
we knew how**



**100% glazed
façade requires
100% air
conditioned
office**

Operational Energy

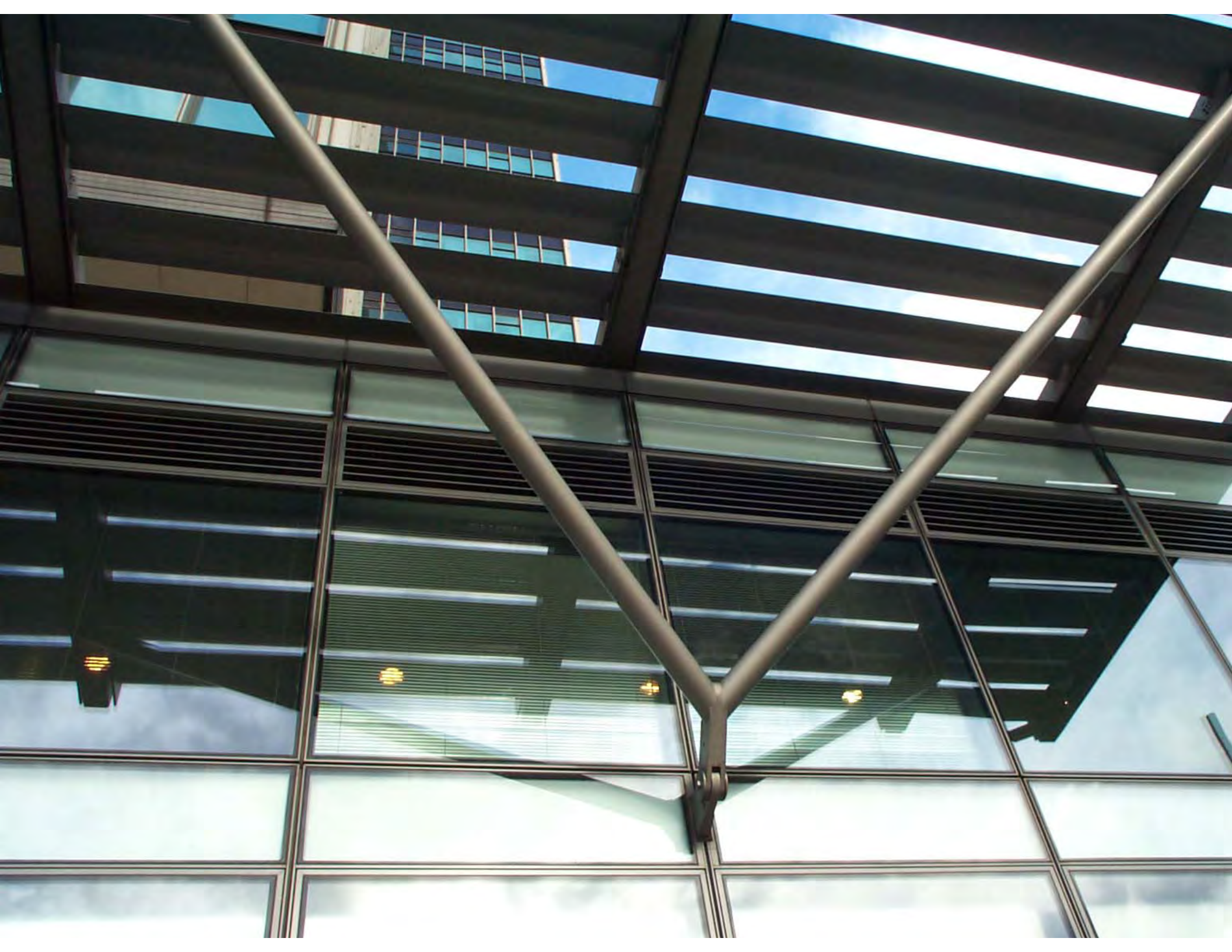
Passive solar control avoids mechanical ventilation and air-conditioning in summer



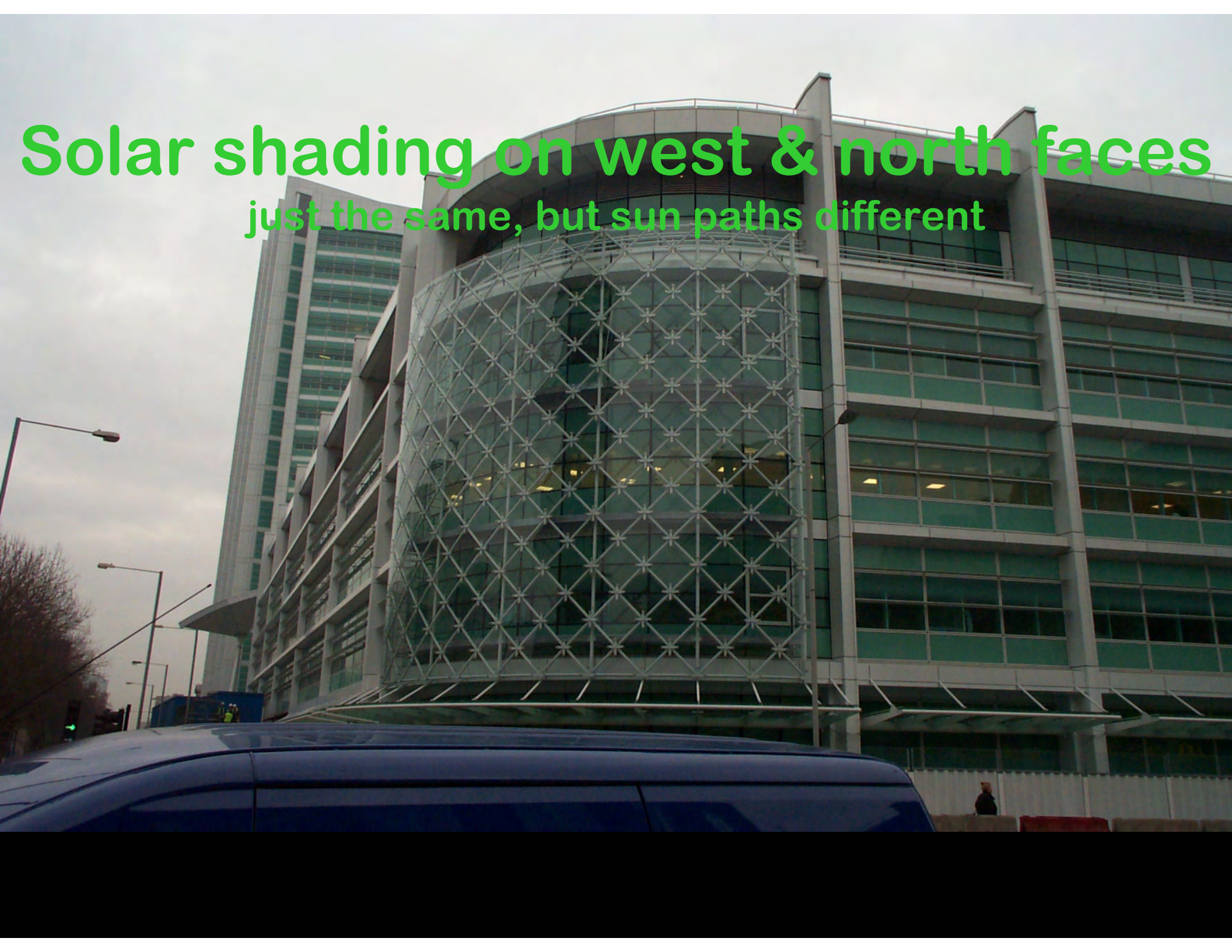
City Place, Gatwick



Wessex Water



Solar shading on west & north faces
just the same, but sun paths different





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- HOME
- PRODUCTS
- MANUFACTUR
- SPECIFICATIO
- MATERIALS
- ENERGY
- CHECKLIST
- DESIGN
- IMAGE BANK**
- REFURBISHME
- FORUMS
- SITE WASTE
- DURABILITY
- SUPPLIERS &
- FABRICATORS
- RECLAMATION
- CRAFTSMEN
- POLICIES & ST
- RESEARCH &
- RESOURCES
- CPD
- HOW WE SEL
- CONTACT GR
- REGISTER YO

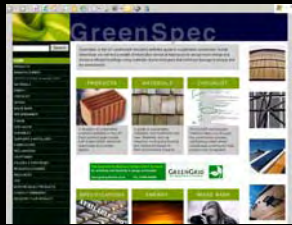
Environmental Building - Windows Internet Explorer

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Done Environmental Building Internet 100%

- IMAGE BANK
- Shorne Wood
- BedZED



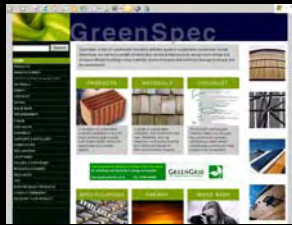


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Solar Shading or Brise Soleil

L15 External Solar Shading

Another GreenSpec CPD seminar to consider



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Alternative Solar Shading

In all its forms

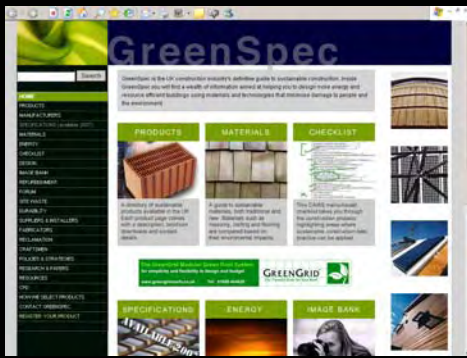
Another GreenSpec CPD seminar to consider

Solar Shading: Trees

- Trees also create shelter from the sun in the summer
- Deciduous trees drop leaves in autumn and allow sun to pass in the winter
- Trees can protect from summer solar gains and permit winter solar gains
- Solar gains can be manipulated to create internal air movement and exploited thermally

Deciduous tree belts in winter



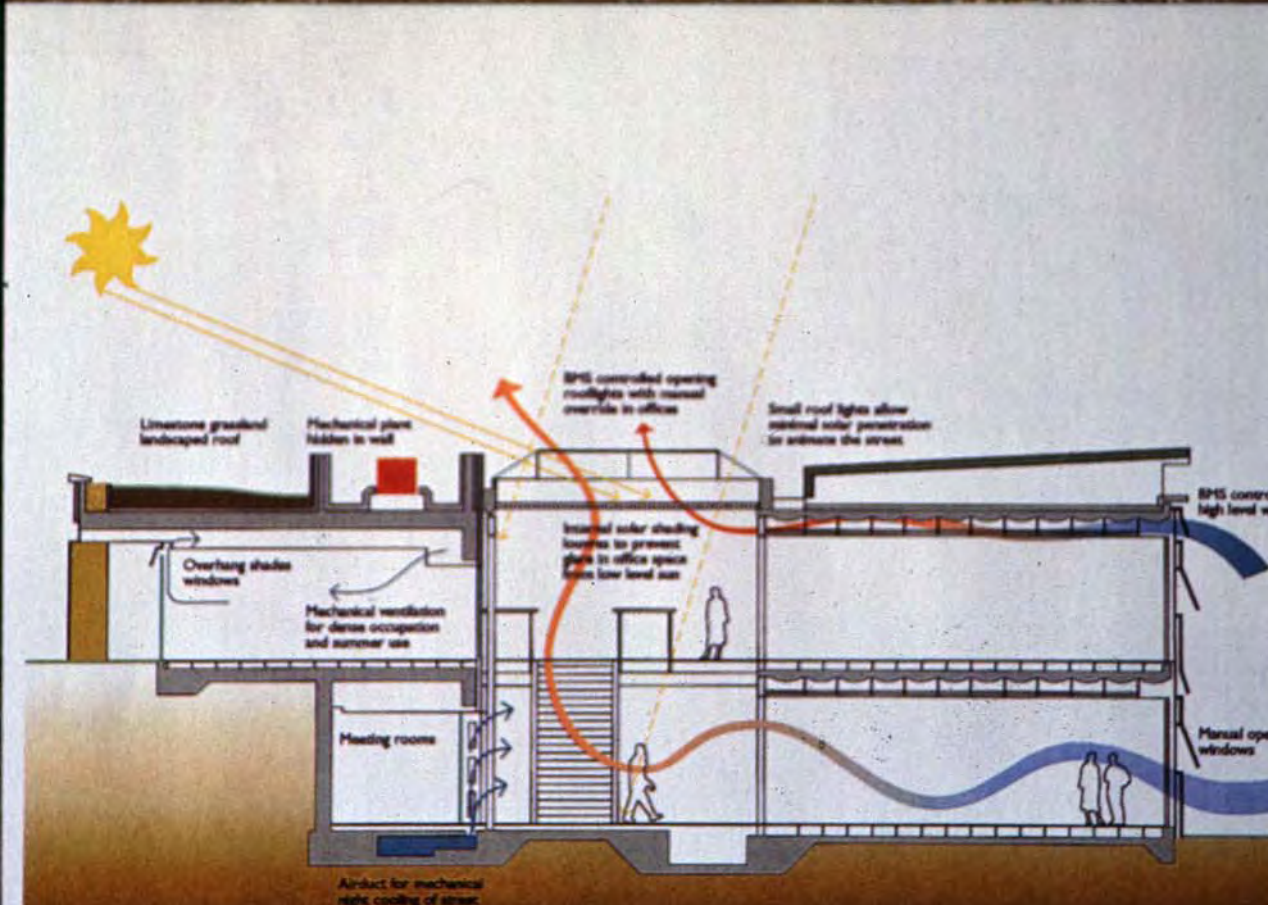
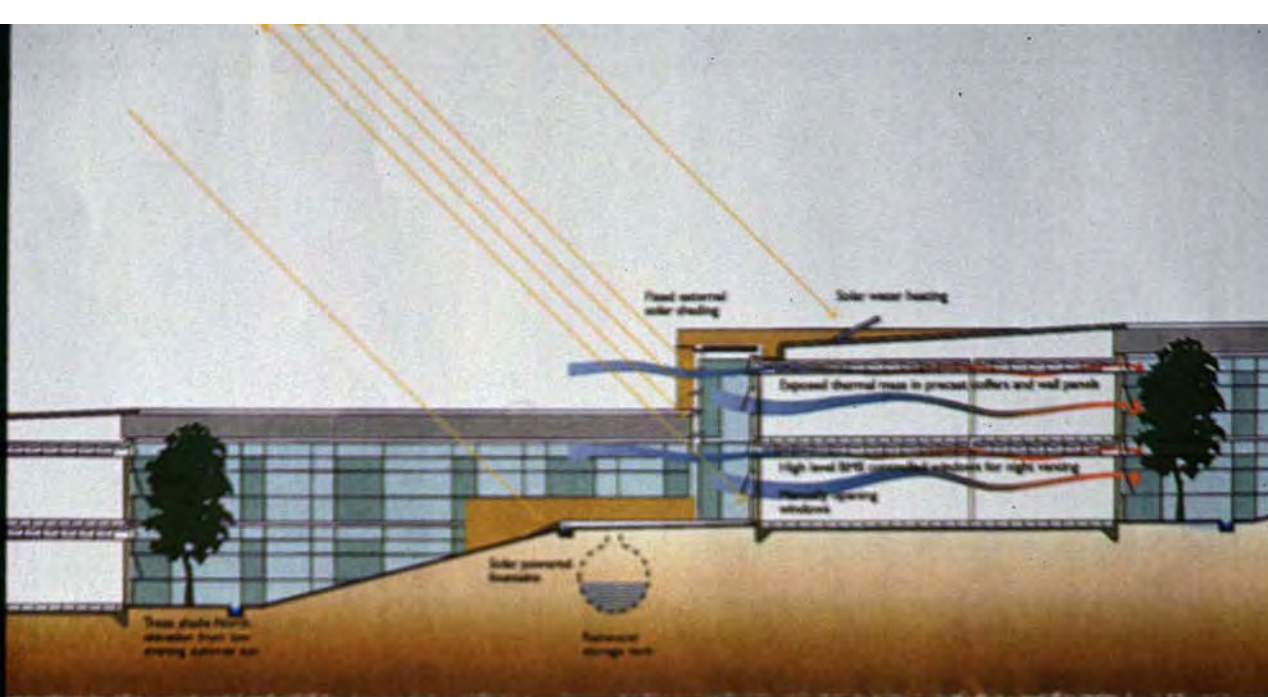


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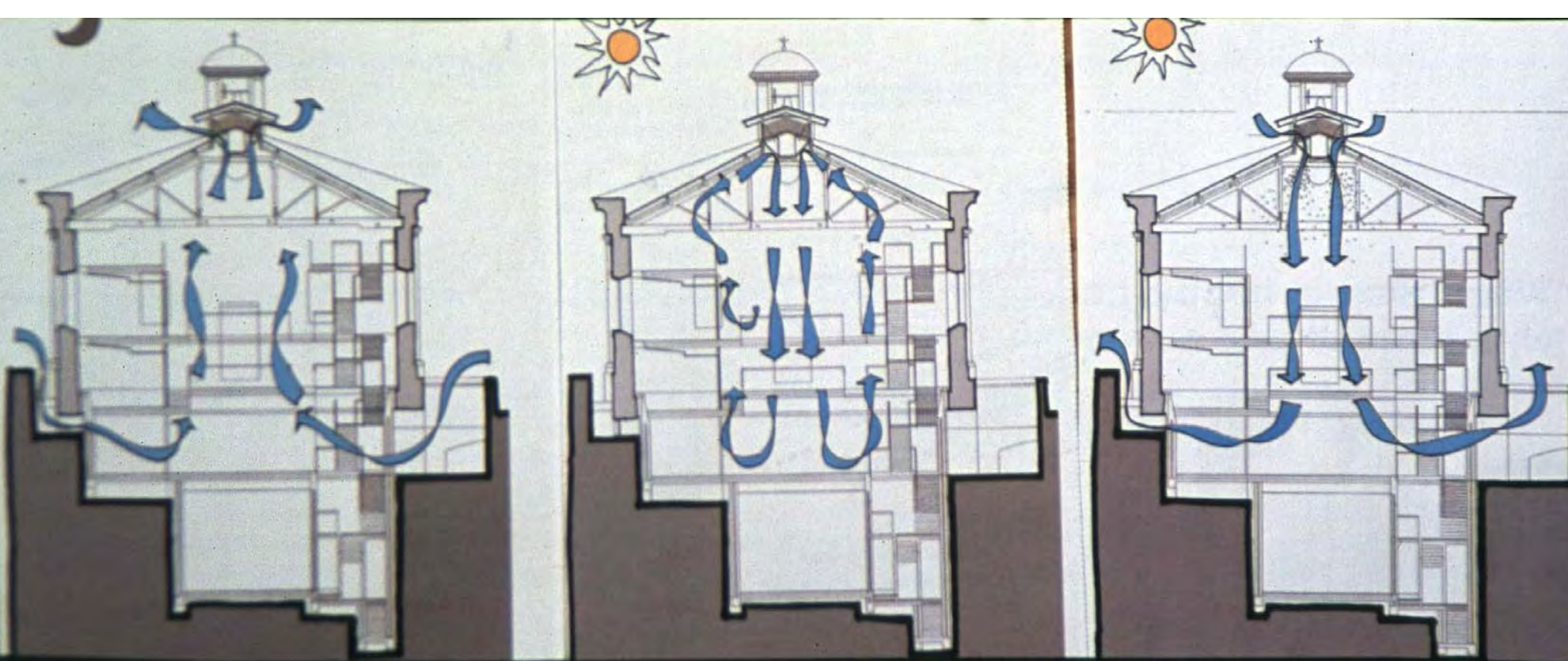
Thermal Mass

Passive and active cooling

Wessex Water: Bennetts Associates



Cross ventilation or cooling via atrium



Sophistication in ventilation is possible with controlled vents

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BRE Environment Building



Done Environmental Building Internet 100%

- IMAGE BANK
- Shorne Wood
- BedZED

Solar shading



Passive stacks



Office Corridor Open plan



Top Floor



Perforated Floor slab support beams



OFFSITE

Building on the success
OFFSITE03, this event will
feature full scale interac
demonstrations and disp
from the world's leading
experts of offsite
technology and modern
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ARE

Floor slabs



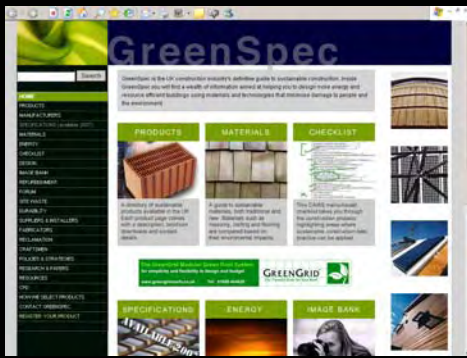
Air passages



15. 2. 2001

3D view of floor soffit





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Fluid Dynamics

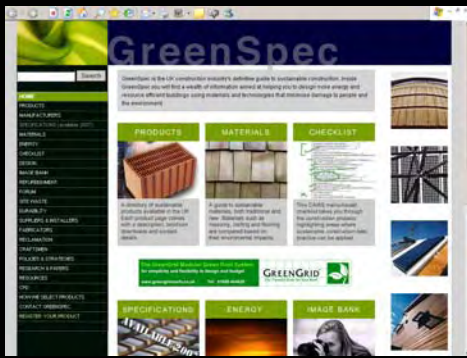
Understanding how a building works
or solving problems that arise

Conventional Mechanical Engineers

- Do not understand: passive ventilation stack effect and what can go wrong
- They are actively discouraging these techniques
- And opting for the safe understood mechanical ventilation, heating and cooling or air conditioning
- So prove the design first

Computer simulation

- This is possible
- but there have been examples of computer simulation not working in reality

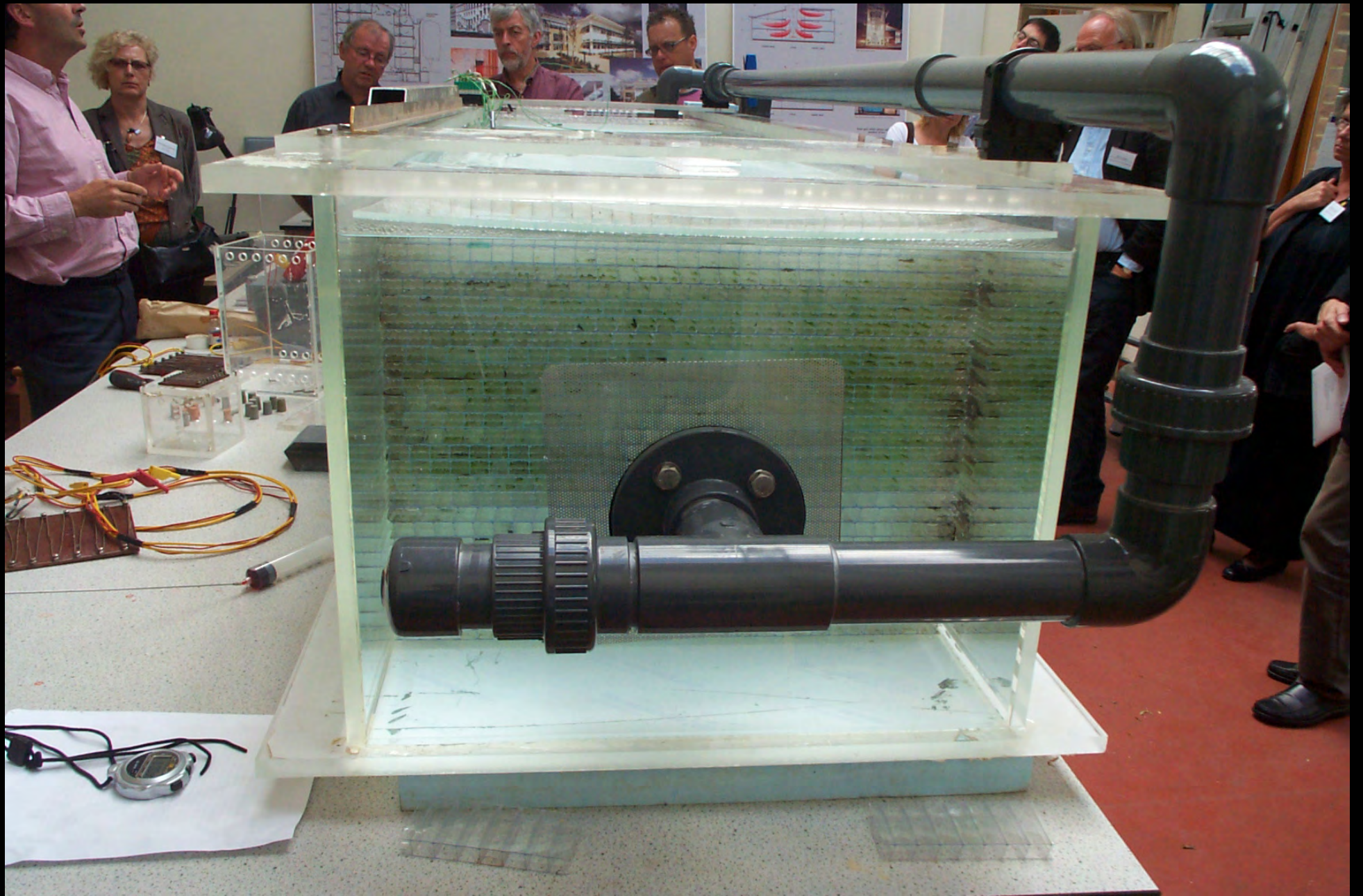


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Fluid dynamics

- Method of predicting air movement in buildings especially those with atrium
- Like wind tunnel testing but with liquids and smaller scale
- Test models in water tanks with heat input & coloured liquids to highlight movement
- Identify weakness in design
- Prompt and test possible solutions







University College London, Bloomsbury

Aldwyck House
Passively Ventilated
Houghton Hall

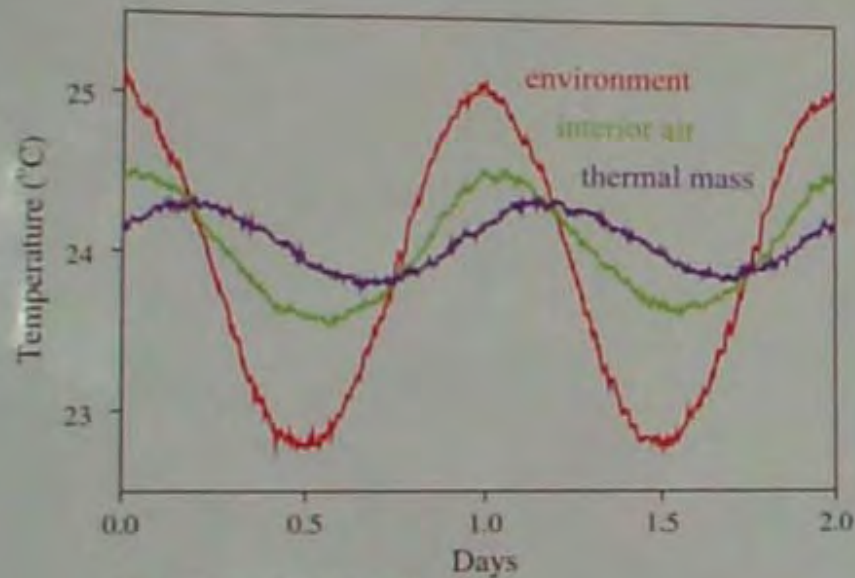


Ventilation of a Building with Thermal Mass

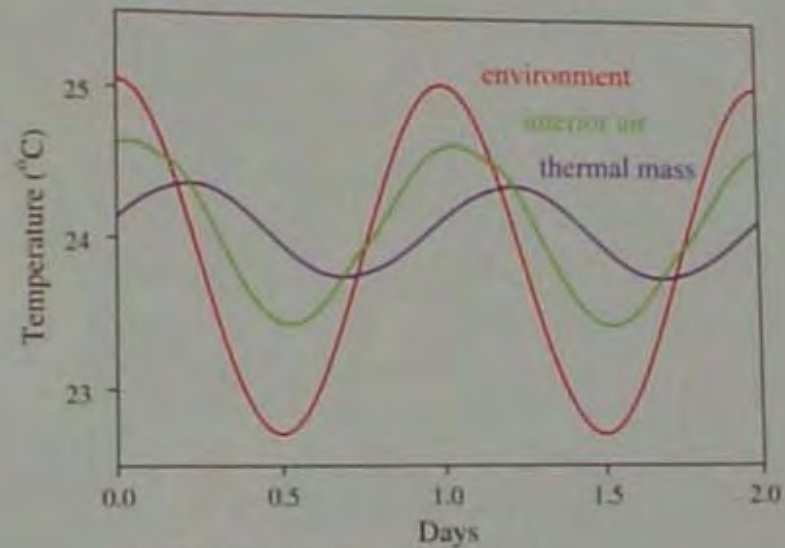
Joanne Holford and Andrew Woods (BP Institute, Madingley Rise, Cambridge, UK)

Time evolution

- Heat stored in a building's structure buffers interior air temperature.
- Can reduce energy use and CO₂ emissions by mechanical cooling and heating.



Experimental results,
from laboratory analogue of thermal mass.

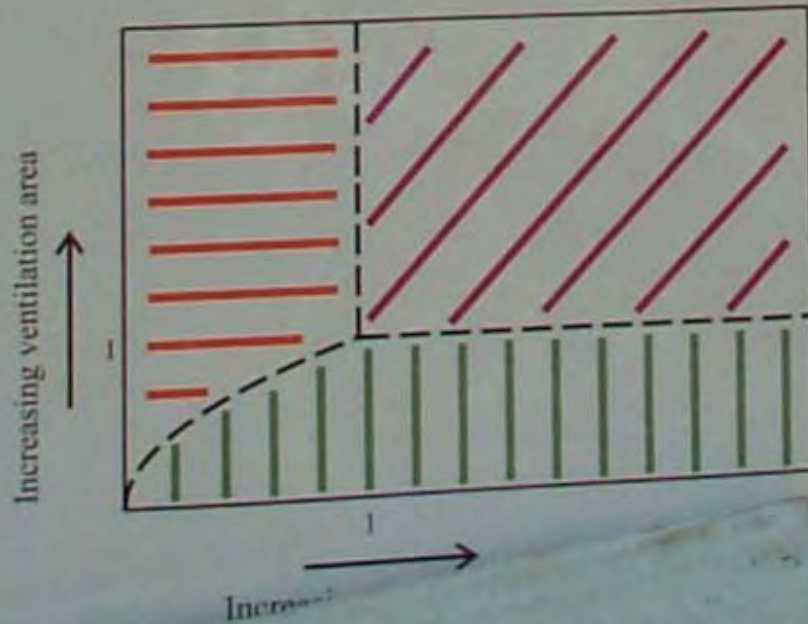


Numerical results,
neglecting thermal capacity of interior air.

Three limiting regimes

With low internal heat gains, and natural ventilation:

Interior air and thermal mass temperatures follow environment



Interior air temperature follows environment, little variation in thermal mass temperatures

Large variation in interior air or thermal mass temperatures

The Cambridge-MIT Institute



UNIVERSITY OF
CAMBRIDGE



Natural Ventilation with Wind

Ben Lishman and Andy Woods
BP Institute, Madingley Rise, Cambridge

WEAK WIND, STRONG HEATING



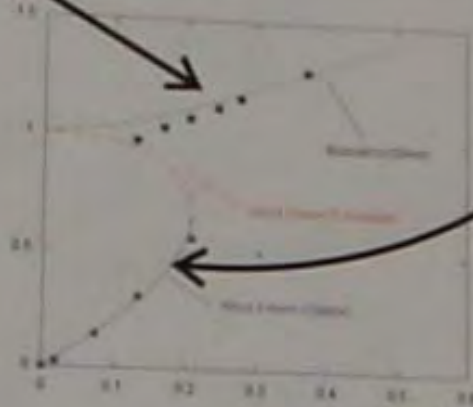
BUOYANCY DOMINATED

STRONG WIND, WEAK HEATING

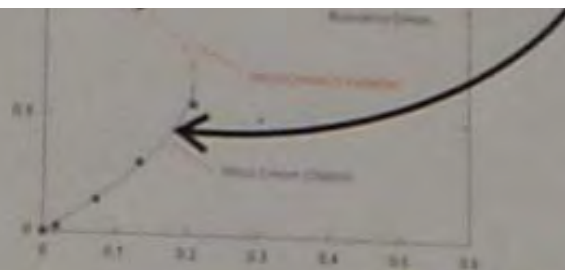


WIND DOMINATED

TEMPERATURE
IN EXCESS OF
EXTERIOR



HEAT FLUX



HEAT FLUX



WIND: STRONG WIND, WEAK HEATING

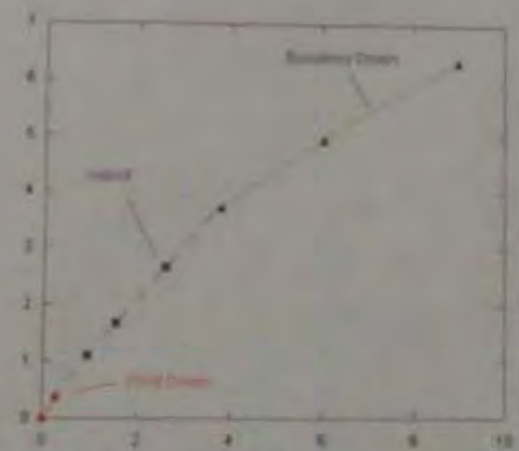


HYBRID: MODERATE WIND, MODERATE HEATING



BUOYANCY: WEAK WIND, STRONG HEATING

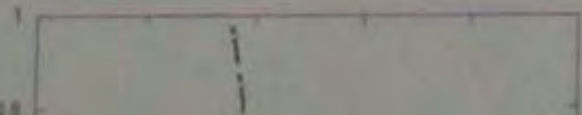
TEMPERATURE IN EXCESS OF EXTERIOR



HEAT FLUX

CONTROL SYSTEM (CONCEPT)

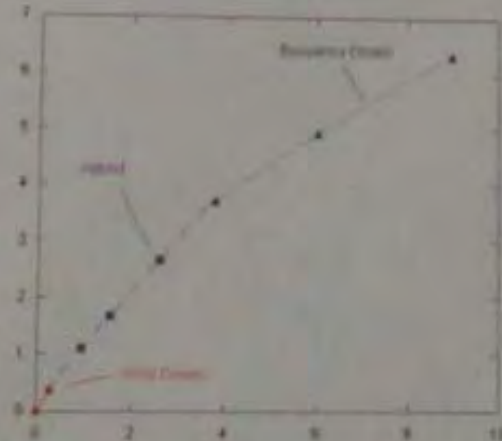
AREA RATIO



Dimensionless area



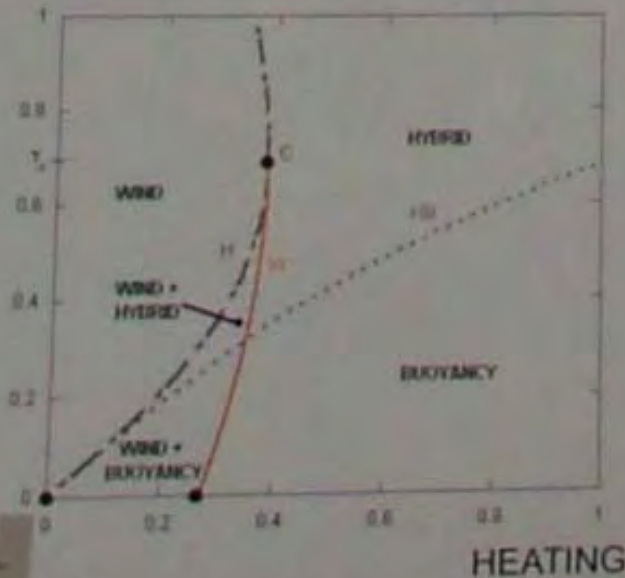
TEMPERATURE
IN EXCESS OF
EXTERIOR



HEAT FLUX

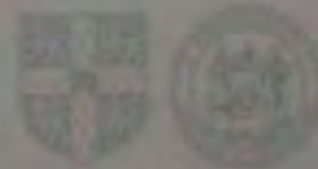
CONTROL SYSTEM (CONCEPT)

AREA
RATIO
 $A2/A1$

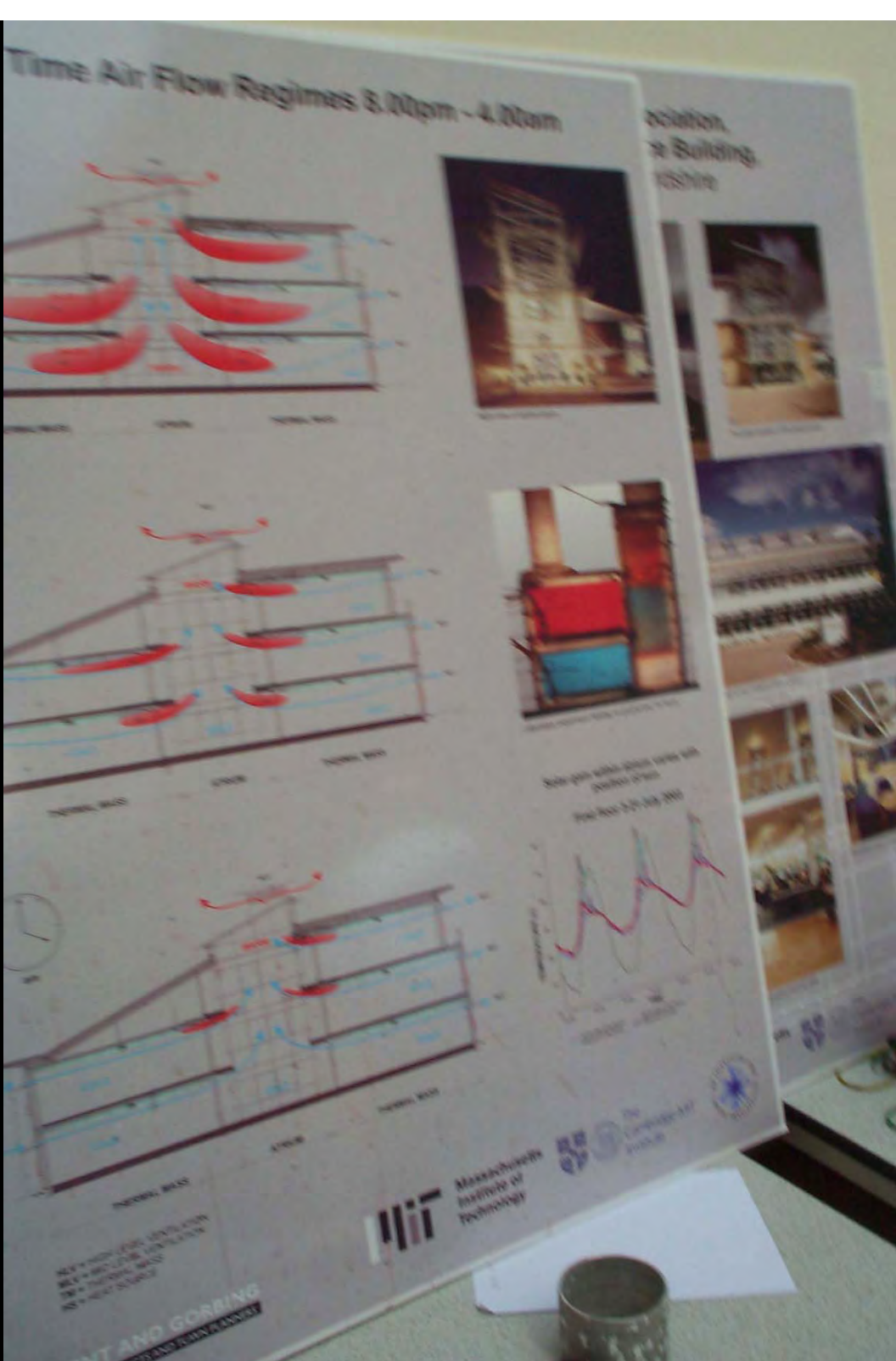


Dimensionless area

$$\alpha = A2/A1$$



The
Cambridge-MIT
Institute



Lower floors can ventilate into atrium blocking upper floor air upper floor overheats. More window ventilation on upper floor can overcome this.



Lower floor can short circuit back into upper floor not into atrium, feeding hot stale air to an already hot stale space

Test Yourself Part 8

- When would a building be purged of heat?
- How can atrium help to cool buildings?
- What can go wrong with atrium cooling effect?

How did you do? Part 8

- Overnight in summer to remove heat using cool night air
- Air from floors can be drawn from the floors to the atrium using stack effect
- Air from lowest floors can block the air from upper floors or short circuit into the upper floors

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