Conversion of building use at Grove House, UK

UK3

1 Photos

Figure 1: Air is drawn into the building by motorised Passivent window inlets sited within window frames.

2 Project summary

Project objectives: An office building at Thames Valley University was converted into a lecture theatre, computer laboratories and offices.
The building was in a conservation area and the external appearance of the finished building refurbishment was vital to meet planning permission.
The building was to be naturally ventilated where possible to help the university maintain its Energy Efficiency Accreditation. The building has acted as a pilot: for the passive stack ventilation system in the refurbished north wing of the building; for the waterless urinals; and for the vacuum tube solar thermal panels supplying domestic hot water. All these measures have been replicated elsewhere in the university after being proven in this building.

Short project description: The building is a heavy mass 4-storey structure comprising a central corridor and stairwell at one end. The building is ventilated naturally and also contains an integral axial boost fan within the outlet terminal in the staircases to give a mixed mode ventilation solution.
The air transfer into the room, for the lower floors, is via eggcrate grilles within the suspended ceiling. The air is drawn across the room and into the corridor

through acoustically treated vents, then to the stairwells to exhaust through roof mounted terminals. Night cooling control equipment has been included to open the façade vents during lower night temperatures and the air is directly in contact with the large concrete ceiling mass before entering the room.

Stage of construction: Refurbishment completed August 2001

3 Site

London, UK: latitude: 51.5°N, longitude: 0.45°W, altitude: 24 m.
Moderate climate.

4 Building description /typology

4.1 Typology / Age

Typology: An Eco–university, converted 4-storey office block with a central corridor
Educational level: University (Higher) Education

4.2 General information

Year of construction: 1985

Year of renovation (as described here): Spring 2001

Total floor area (m^2): 2500 total
Refurbished Area (north wing) 1250 m^2

Number of students: ~300

Number of classrooms: Refurbished Area
9 Classrooms
1 Lecture Theatre (136 seats)
2 Tech rooms
3 Offices

Typical classroom:	*size (m^2):*	65 m^2
	window/glazing area (m^2):	7 m^2
	number of pupils:	20

Hours of operation: Building is used for 12 hours per day

4.3 Architectural drawings

See Figures 2 – 5

5 Previous heating, ventilation, cooling and lighting systems

Heating: Low pressure hot water perimeter radiators. Gas fired Boiler is located in the roof space.
Before refurbishment there was no ventilation at all except by opening the windows.

6 Retrofit energy saving features

6.1 Energy saving concept

The existing suspended ceiling below the existing concrete waffle type slab was altered to form an air inlet plenum with louvre ventilators installed on the

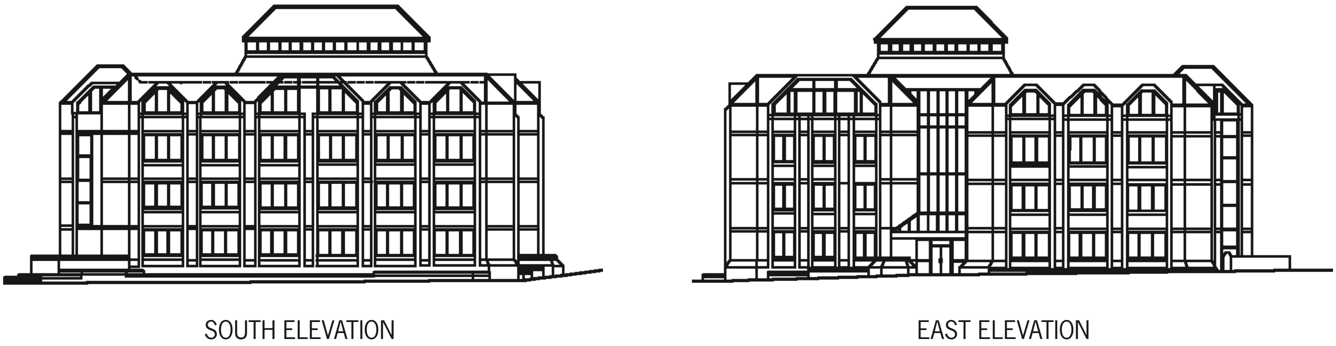

Figure 2: South and east elevations

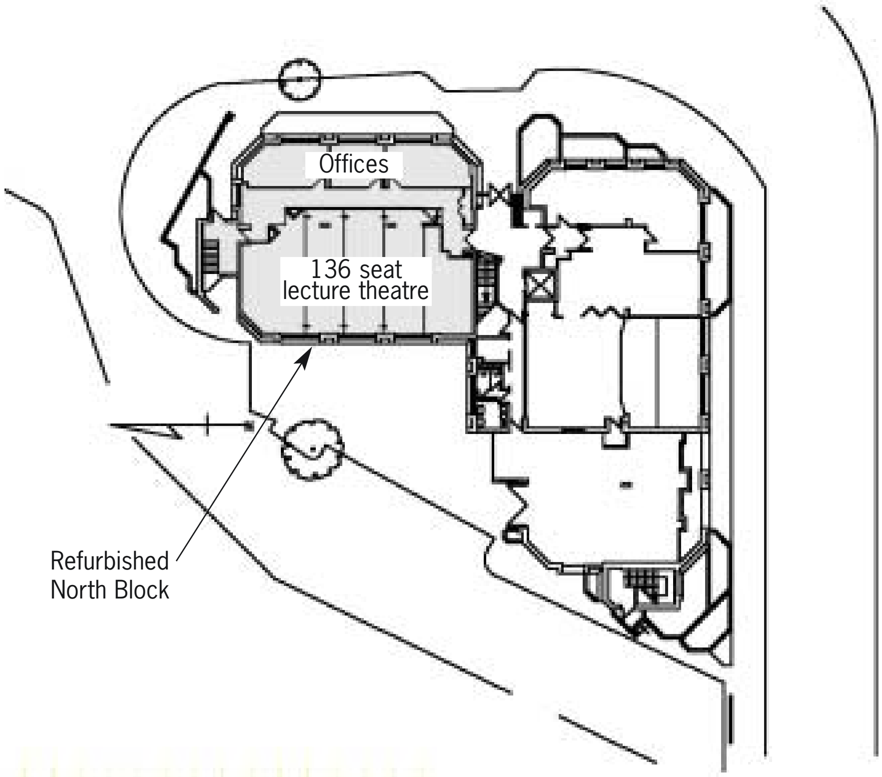

Figure 3: School layout

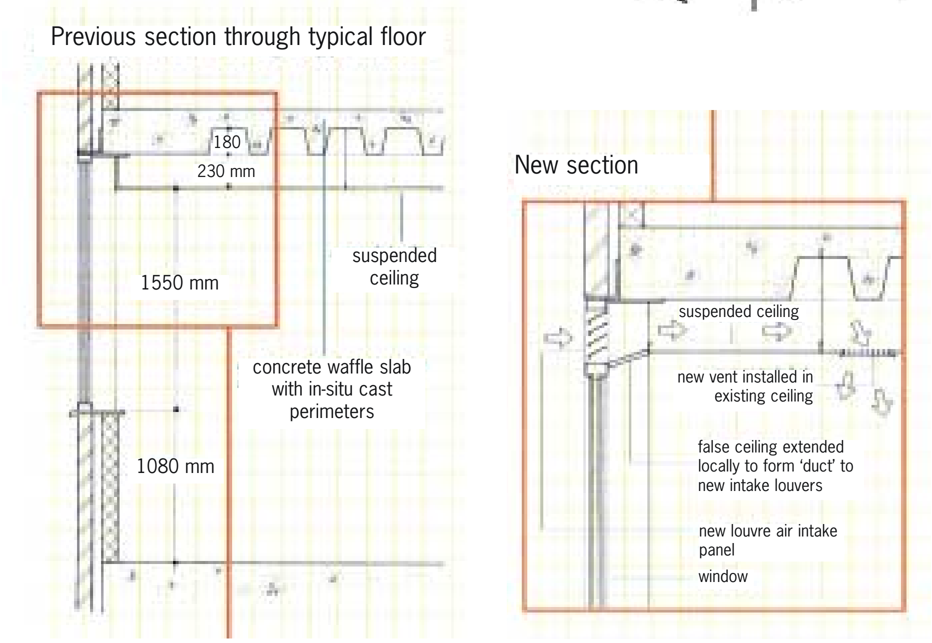

Figure 4: The suspended ceiling was altered to allow entry of fresh air

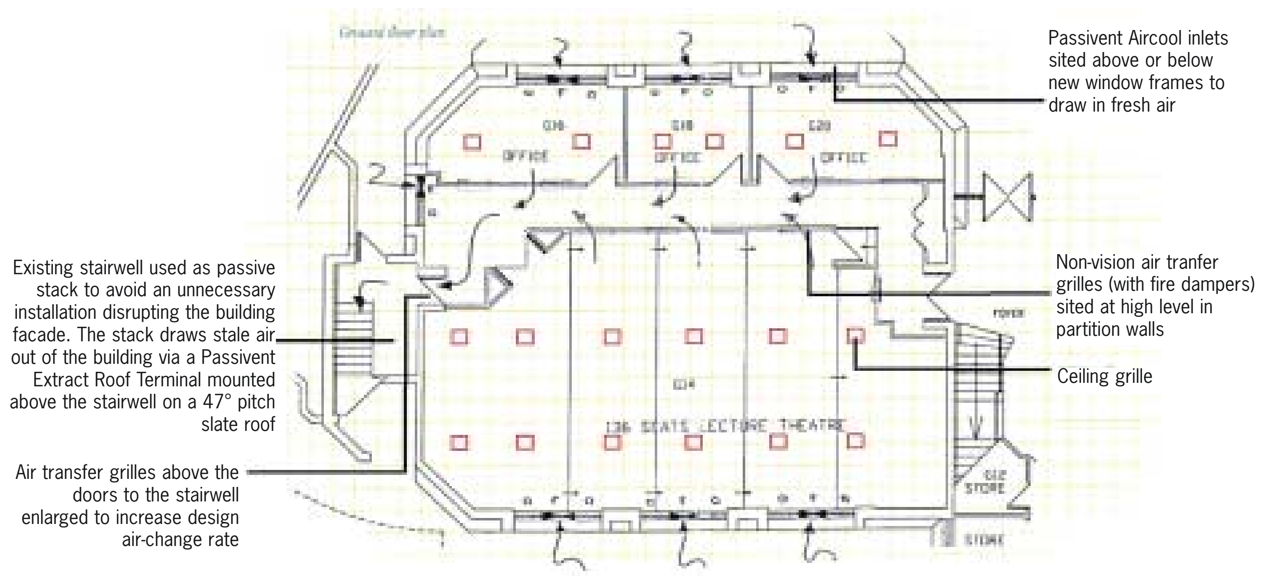

Figure 5: Ground floor plan

façade of the building opening into the plenum and air supply grilles from the plenum to the occupied space, see Figure 4. In this way the waffle slab provides thermal mass coupled to the space by the air supply providing an effective source of night cooling.

6.2 Building

Refurbishment included the replacement of 24 window units on the north wing with modern sealed units and the replacement of the suspended ceiling. Wall transfer grilles were placed throughout the building to allow the flow of air. Low-pressure loss attenuators were placed on the ground floor between lecture theatre and office spaces.

6.3 Heating

The Building Management heating control holds the boiler to the off position when water temperatures are high, and incorporates other energy saving programmes.
All radiators have local thermostatic valves.
All pipes are insulated throughout the building.
The solar water installation supplies both halves of the building. It consists of an array of evacuated glass tube type panels on the roof coupled to an indirect cylinder in the tank room, which also contains a single 3 kW electric immersion heater for boost heating, with mineral oil being pumped around the system by a standard central heating pump. The system was installed in 2001. It was necessary to adapt the existing hot water pipework in the building to form a continuous hot water return feed to the new cylinder. The 3 kW electric immersion heater is programmed to run, two hours every morning in winter to boost the system to provide initial hot water at the opening time for the building. The calculated costs for the electricity to run the boost heater and the circulation pump are £700 per annum. The domestic hot water system serves 17 hand basins in 5 sets of toilets located on all 4 floors of the building. This system replaced 5 similar 3KW electric water heaters, one located in each set of toilets. The heaters were programmed via time switches to run for 7 hours on weekdays and for 4 hours a day on weekends. The annual cost of electricity was £6,500 per annum. The costs have therefore reduced from over £50 to £5 per week, giving a calculated payback period of 2.5 years.

6.4 Ventilation:
Strategy and systems; natural/hybrid

Comfort cooling:	No
Dehumidification:	No
Controls:	Local temperature control of façade opening units and integral boost fan. A BMS operates the heating system

Weather stripping, draft exclusion, draft lobbies – A new porch with automatic door to eliminate cold draughts was installed with the refurbishment.

6.5 Lighting
Electronic lighting control to all rooms.
New 600 mm square inset fluorescent luminaries in the new suspended ceiling with high frequency ballasts.
Rolling changeover of all lights to more energy efficient units.

6.6 Other environmental design elements
Introduction of air at high level into ceiling void to remove local heat from luminaires. Waterless urinals have been installed.

7 Resulting Energy Savings

		ELECTRICITY		
Year	Consumption (kWh)	Total cost	kWh/m^2/a.	Opening hours
1997	270,664	£20,503.01	108	2950
1998	293,338	£18,719.56	117	3147
1999	303,895	£19,310.06	121	3343
2000	321,511	£18,244.09	128	3540
2001	355,017	£16,575.58	141	3737[1]
2002	321,486	£16,642.91	127	3945[2]

1 Passive-ventilation commissioned September 2001
2 Solar-Water commissioned July 2001

Electricity Trends:
a Consumption increases reflect continuing development of building as computer system based faculty.
b 1997-2002 electricity consumption increased 31%. This must be set against the fact that the building operating hours increased 26% over the same period.
c Reduced totals in 2002 reflect energy savings made in first full year of passive ventilation and solar hot water heating.

		GAS		
Year	Consumption (kWh)	Total cost	kWh/m^2/a.	Opening hours
1997	278,550	£3,243.70	111	2950
1998	222,433	£2,403.02	88	3147
1999	165,261	£1,418.39	66	3343
2000	150,405	£1,250.52	60	3540
2001	152,961	£1,865.52	61	3737[1]
2002	140,522	£2,317.71	56	3945[2]

1 Major gas price increase
2 Major gas price increase
Gas Trends:
a Major purchase price increases evident in 2001 & 2002 – set to continue 2003
b Consumption reducing despite continuing increase in building operating hours – quantifiable savings in real terms.

Heating:	No major changes to system during refurbishment, 8–10% reduction in gas use from magnets and BMS system.
Solar hot water:	Electrical costs reduced from £12,500 p.a. to £700 p.a. giving a payback period of only 2.5 years.
Cooling:	Little change, there was no cooling strategy before, now an axial boost fan runs during peak temperature conditions.
Ventilation:	Little change as a natural ventilation system was introduced. An axial fan runs during peak temperature conditions rated at 0.13 KW.
Lighting:	Tube life longer and reduced maintenance, 150W to 75W rating for same illuminance levels.

7.1 Resulting water savings

WATER & SEWERAGE				
Year	Consumption (kWh)	Total cost	cu m^3/sq m^2/a.	Opening hours
1997	n/a	n/a	n/a	n/a
1998	n/a	n/a	n/a	n/a
1999	2,007	£2,405.91	0.80	3343
2000	2,299	£2,536.97	0.91	3540
2001	2,110	£2,444.79	0.89	3737
2002	1,009	£1,226.49	0,39	3945[1]

1 Waterless urinals installed throughout

8 User evaluation

Temperatures: Measured temperatures of 100F (38°C) + in computer labs, have now been reduced closer to 70F (21°C), without the use of night cooling control.
In general terms: Air quality has improved greatly, from humid conditions to fresh and comfortable conditions. Before refurbishment the air was humid and contained odours.
Complaints of irritation were common before the refurbishment.
No such complaints have been made since the work has been completed.
Bronze tinted glazing has been used but little effect on internal lighting levels.
Artificial lighting system has been described earlier.
Noise from the axial fan mixed mode system cannot be heard in the rooms. Sound has been reduced with attenuators on the fans.
The ground floor areas have had wall transfer attenuators fitted to reduce noise between the lecture theatre and offices, which has proved very successful, even with music playing in some of the rooms.

General feeling:

General well being:	Complaints of irritation and general discomfort have been eliminated since the natural ventilation system was introduced.
Headache:	Complaints of headaches, that were common, have now stopped.
Difficult to concentrate:	Concentration issues have now been eliminated.

The high temperatures used to crash the main laboratories' computer monitors, but this has been eliminated with reduced temperatures.

Architectural quality: Technically sound. The natural ventilation system is easy to use. No concerns with planning permission as the site is in a conservation area. The planning permission was granted for roof terminal and window inlet units without complications.

9 Renovation costs

Specific cost per technology (as specific as possible):

Envelope:	Window replacement £35K Ventilation system components and controls £68K Building works £30K
Systems:	Installed cost of Solar water heating installation £12,500 plus 17.5% VAT £14,700 (gross) installed, Lighting control £250 per room (42 rooms), Porch £5.5K. Waterless Urinals installation cost of 5 units at £35 per urinal, £175 Annual service charge for 5 units £549.90 Cost saving on water supply £800 per annum Payback period 8.4 months (0.7 years)

10 Experiences/Lessons learned

10.1 Energy use

The hot water solar panels have proved very successful in energy reduction. The local natural ventilation controls have been altered to anti-tamper devices as occupants were altering the settings. This leads to clashes in the heating and cooling systems.

10.2 Impact on indoor climate

Thermal:	The temperatures in the classes have been reduced to comfortable ranges. Before refurbishment during the summer there were 6 complaints a week about overheating. In 2002 there were just 2 complaints in the summer. One was simply because the master switch controlling the ventilation had been accidentally switched off. In 2003 there have been no complaints even during the heat wave in August when outside temperatures reached 33-37°C.
IAQ:	Better IAQ. The system has removed the stagnant air that was present.
Draughts:	No draught problems, air introduced at high level into the ceiling void in most cases. The porch entrance to the building reduced draughts and energy losses.

10.3 Economics

Option appraisal showed that the installation of an air conditioning system would be more expensive. It would involve modifications to the building for running ducts and the annual running costs would be high.

The natural ventilation system required no structural alterations to the building, has low maintenance and the running costs are very low. The inlet louvers and controls have performed well and have experienced no problems in the first two years.

A Win – Win situation.

10.4 Practical experiences of interest for a broader audience

It worked! – Natural ventilation has been introduced into a heavy mass building with computer suites and has been shown to provide a comfortable working environment with good IAQ. A further passive stack ventilation system for a very large computer suite is now in design and 2 more are planned to follow.

The client has identified the manufacturer as a major contributor to the success of the ventilation scheme through the provision of good design advice and a good range of ventilation products including most importantly, 100% waterproof inlet louvers.

10.5 Resulting design guidance
Control setting of ventilation systems should be removed from occupants. Manual override is suggested but the occupants should not be able to operate the actual auto mode set points.
The large ventilator openings have not caused any draught issues in cooler periods and can be used in future projects.
In a heavy mass building; passing air over the concrete structure with cross and stack ventilation can substantially reduce internal temperatures. Especially when compared to the previous system of single sided ventilation.
Noise transfer can be eliminated between rooms by carefully designed transfer grilles and still be suitable.

11 General data

1.10.1 Address of project
Grove House, Thames Valley University, St. Mary's Road, Ealing, London, UK.

1.10.2 Project dates
Project initiation: Nov 2000
Design completed: March 2001
Renovation construction completed: Aug 2001
Monitoring and evaluation completed: Controls issues were initially a problem. The client is using this scheme as a pilot model for other works within the university.

10.3 Date of this report/revision no.
12th August 2003/rev 3

12 Acknowledgements

Builder:	James Taylor Builders Ltd
Architect:	Thames Valley University Estates
Engineer:	Thames Valley University Estates
Ventilation Design:	Passivent Ltd

National, international support programmes:
Author (of this description): Mr Nick Turner of Thames Valley University, Head of Estates; Wayne Aston of Passivent, Technical Manager; Richard Daniels of Department for Education and Skills, Schools Building and Design Unit.

13 References

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Passive ventilation systems:
Passivent Ltd., 6 Tonbridge Chambers, Pembury Road, Tonbridge, Kent
www.passivent.com
Contact: Mr Wayne Aston

Waterless urinals:
Future Environmental Services (Hygiene Products) Ltd,
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