

# Design and Evaluation of a Low Carbon Emitting Naturally Ventilated Student Health Centre

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**ABSTRACT:** The new Student Health Centre at the University of Sheffield has won two prizes at the annual Royal Institute of British Architects' (RIBA) Yorkshire Awards 2005. This building was designed specifically to be naturally lit, incorporate an energy efficient natural ventilation system and the use of environmentally friendly components and finishes. This paper outlines the method by which the design was developed and implemented. After completion, a post occupancy analysis was carried out and aimed at determining the effectiveness of the design brief with respect to the design aspirations. This analysis involved monitoring internal conditions in specific rooms and carrying out a walk round survey to determine the users reactions and window opening strategies.

These measurements were backed up by computer simulations which afforded the opportunity to evaluate alternative operating strategies. The results of the monitoring and the survey have indicated that there are some weaknesses in both the design strategies as well as operational methods. By accommodating the results of the computer simulations with the results of the survey a modified operational strategy is suggested.

**Keywords:** Energy, Daylight, Natural Ventilation, Comfort

## 1. INTRODUCTION

The new Student Health Centre at the University of Sheffield has won two prizes for design at the annual Royal Institute of British Architects' (RIBA) Yorkshire Awards ceremony in 2005. This building was designed specifically to be naturally lit, incorporate an energy efficient natural ventilation system and the use of environmentally friendly components and finishes. An external view of the building is shown in figure 1.



**Figure 1:** A general view of the Health Centre Building.

The University has in place an Environmental Policy [1] with respect to the procurement of new buildings and aims to achieve the following:

- It states that new buildings should 'aspire' to obtaining a BREEAM rating [2].
- They should also be designed to better than Building Regulations Standards [3] and as far as possible be naturally ventilated.
- Materials should be selected according the Green Guide for construction – 'A' rating ones preferred.

To ensure that the above are delivered (within the cost budget) a Project Management Team oversees the project.

This case study looks at the method by which the design was developed and implemented, and carries out a post occupancy analysis aimed at determining the effectiveness of the design brief with respect to the design aspirations.

## 2. BUILDING ENVIRONMENTAL ANALYSIS

### 2.1 Initial Design Strategies

To ensure that the above targets are delivered a Project Management Team oversaw the project: Environmental systems/Natural ventilation was specified; window openings and room depths designed according to BRE [4] published information (see figure 2).

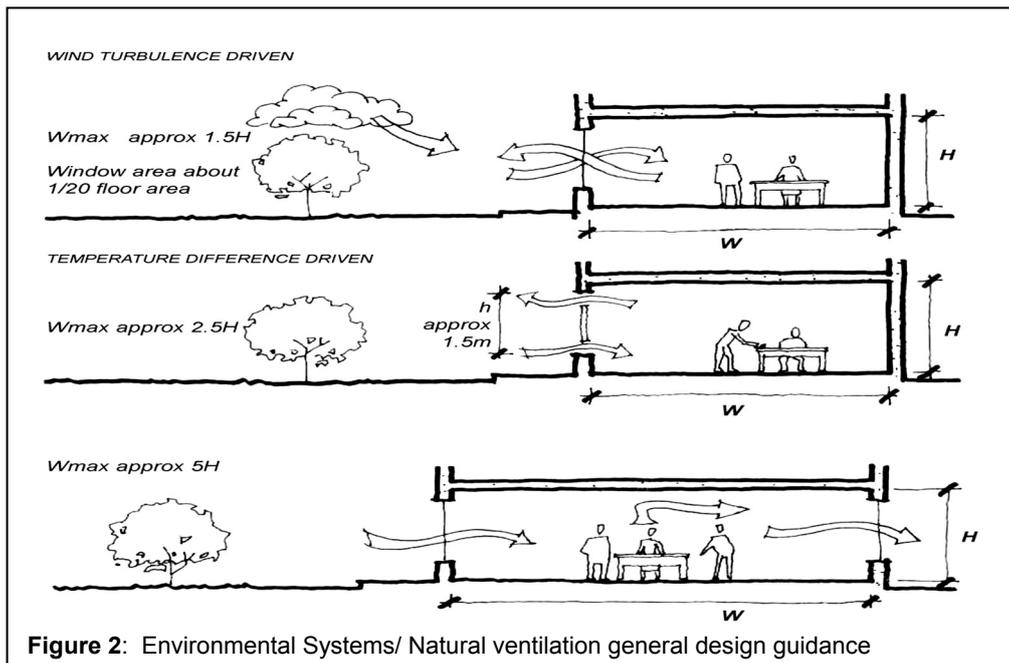


Figure 2: Environmental Systems/ Natural ventilation general design guidance

## 2.2 Further Concerns and Analysis

### Overheating

During the initial stages of the design, the overheating potential of the building was of major concern and steps taken to minimise the occurrence. This was carried out by running the EU developed LT for Europe [5] simulation programme and modified outputs for it are shown in figure 3.

This analysis demonstrated the value of providing night cooling which was then taken on board by the designers of the building.

### Natural Ventilation

Based on design guides [6] the appropriate openings were made to ensure adequate natural ventilation. It was also specified that automatic opening devices should be fitted to the windows which would be activated when the need arose.

### Material Selection

As sustainability was considered one of the drivers for the design it was necessary to select materials which did not impact adversely on the environment. To this end the Green Guide to Construction [7] was used very early on in the process to select appropriate materials. Table 1 shows an example of the materials used in the building.

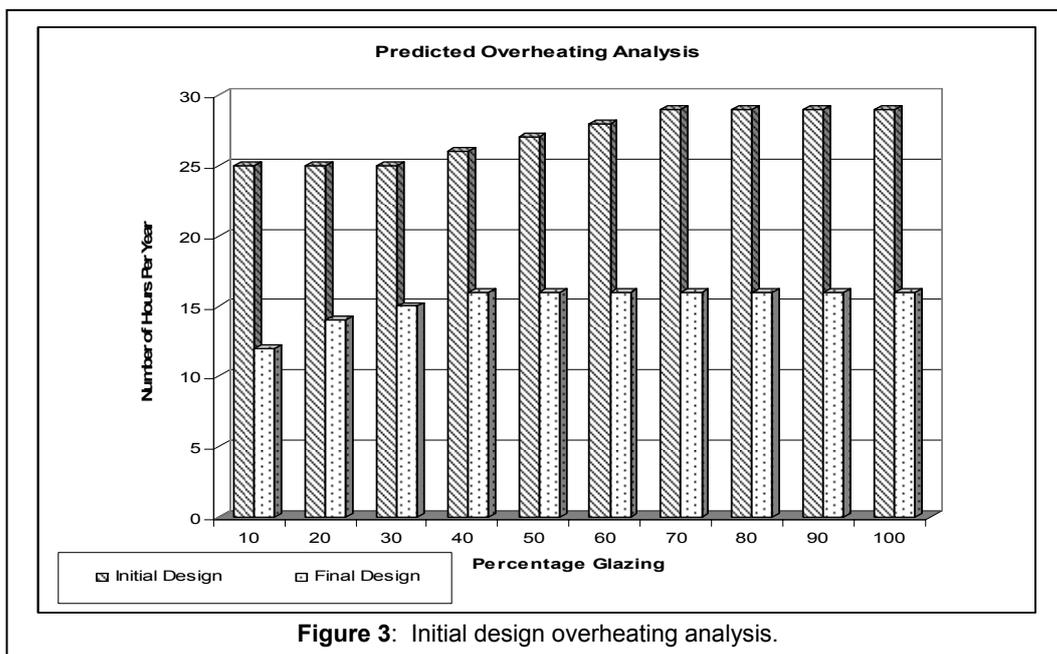


Figure 3: Initial design overheating analysis.

**Table 1:** List of materials used.

Carpet	in Reception area, made of recycled car tyres
Paint	non toxic
Timber	from managed forests
Lighting	low wattage and compact fluorescents
Furniture	contains 40% recycled materials

### 2.3 Walk Round Survey

A walk round survey was carried out to determine the users reactions and to establish if the window opening strategies were in place and operating as intended. The reason for carrying out this work was to be able to inform both the occupiers and designers of any shortcomings in the design or good points which could then be incorporated in future developments.

Contrary to the design brief not all windows were operated automatically and many relied on the occupants manually opening and closing them.

Figures 4 to 9 show photographs of some rooms highlighting specific environmental issues.



**Figure 6:** Left: Waiting area, Right: Changing room.



**Figure 7:** Light domes.



**Figure 4:** Windows with normal operation.



**Figure 8:** Ground and first floor hallway.



**Figure 5:** Left: Consulting room, Right: Office.



**Figure 9:** Operation room.

## Analysis of the Photographs

**Figure 4** Illustrates the attempts made to shield the west façade from afternoon sunlight - this has severely restricted the view out of the windows but the average daylight factor was measured at 7% which is above the standards required [3]. The windows were opened manually to provide extra natural ventilation.

**Figure 5** Shows a consulting room and an office space on the east façade, both of which have high glazing ratios thus providing good daylight quality. However the office space does not have openable windows and natural ventilation is provided by opening the door - clearly not a good design solution in cold and wet weather. The consulting room has very good daylight but the large window detracts from privacy when examining a patient and therefore the internal translucent blinds are permanently closed which has detrimental effect on both the daylight quality and the natural ventilation potential.

**Figure 6** The waiting area of the health Centre is a double story height space with plenty of openable windows at both levels. However the openable windows at the top of the space were not automatically controlled and therefore there was no way in which they could be opened. The ones lower down were automatically controlled. The changing room again had two levels of windows, the top level were on automatic controllers but the lower ones were not, however, due to the position of the furniture staff could not reach the to open them.

**Figure 7** This is a long narrow administration space which has roof lights which provide a good distribution of daylight, however, the natural ventilation provision is via the door at the end of the space.

**Figure 8** This figure shows the access corridor to the doctors' surgeries, the intention of the designers was to use clearstory lights as a high level extract route for air. The supply air was to be via the doctors surgeries. The vertical stacks from ground floor to first floor are clearly visible in the right hand photograph. However due to acoustic privacy requirements of the surgery rooms extra seals were positioned on the doors which reduced the ability of air to move from the surgery to the corridor. Natural ventilation transfer grilles above the doors were omitted for the same acoustic reasons.

**Figure 9** Again daylight and ventilation requirements are compromised by privacy concerns.

## 2.4 Post Occupancy Monitoring

A monitoring exercise was carried out over the warm summer period of July and August 2005 in rooms which were identified by the staff as possible problem areas. This analysis was involved monitoring

internal conditions of temperature, humidity and lighting levels. Figures 10 and 11 illustrate some of measurements taken highlighting that in these two spaces there was a degree of overheating.

From the monitoring exercise there appeared to be some spaces which suffered a degree of overheating in July and August. This was primarily caused by a lack of control over the natural ventilation strategy. No information was given to the occupants about how to ensure that night ventilation could 'cool' the fabric thus delaying the build-up of temperature in the rooms.

## 3. COMPUTATIONAL FLUID DYNAMIC (CFD) ASSESSMENT OF PART OF THE BUILDING

The problems highlighted in the lack of natural ventilation caused by a failing of the window opening strategy were of concern to the operation of the building. One area of particular concern was the waiting area and this part of the building was modelled using the CFD package within the Integrated Environmental Solutions software package [8].

The results of this analysis indicated quite clearly that it would be possible to provide adequate natural ventilation during warm periods. Sample outputs from the simulations are shown in Figures 12.13 and 14.

## 4. CONCLUSIONS

The following are the main findings from this case study:

- There is a conflict between ventilation/daylighting requirements and privacy, particularly in the doctors' surgeries.
- Due to a lack of understanding between the designers and builders there was no consistency in the use of electric openers to the windows.
- No information was provided to the users of the building on when to open windows.

The measurements taken, and the computer simulations carried out indicate that although the building suffered from some overheating problems, due to lack of air movement, there is the possibility to rectify the situation by; installing automatic controllers on the high level windows and install sound proof air transfer grilles above the doors to the surgeries.

It would also be recommended that the staff were issued with an operating manual outlining under what conditions the windows should be opened.

## REFERENCES

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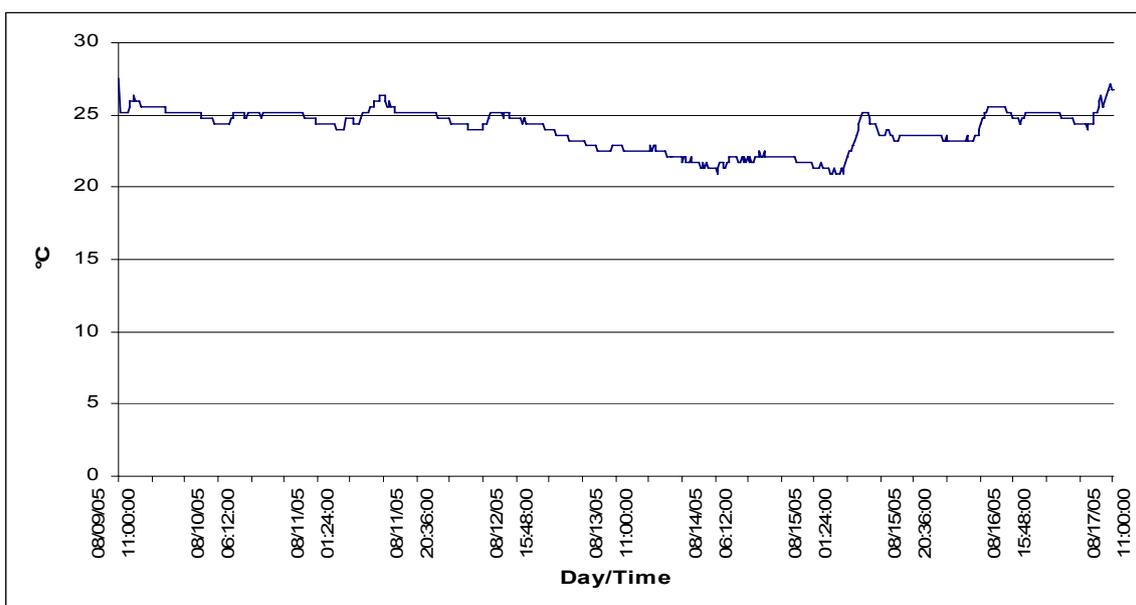


Figure 10: East facing Office space temperature 9<sup>th</sup>-17<sup>th</sup> August 2005

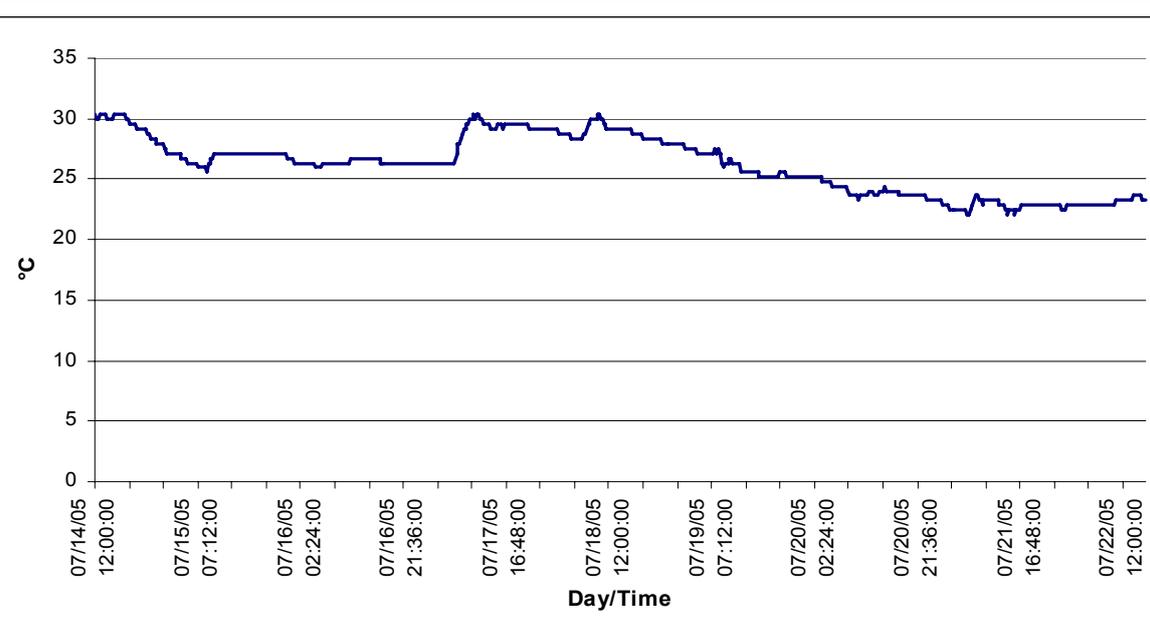


Figure 11: East facing Office space temperature 9<sup>th</sup>-17<sup>th</sup> August 2005.

