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An Innovative Low Energy Integrated Health and Social Care Building for a Deprived Community

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ABSTRACT: The Braunstone Health and Social Care Centre will deliver an integrated service to one of the top ten deprived wards in the UK. Until now, the provision of health and social care was provided by separate services in discrete locations. This paper describes a project to house an integrated service model within a new sustainable building, exploiting passive solar principles and natural ventilation. The building has a deep plan punctuated by courtyards. Its section is configured to admit winter sun through controllable south facing rooflights. The building is of lightweight construction. Pre-cooling of ventilation supply air in summer is proposed via a below-floor labyrinth. The risk of summertime overheating and the potential contribution of the pre-cooling is tested by computer simulation. The design, and in particular its energy aspects, is the product of widespread consultation with the public and the stakeholders.

Conference Topic: Design Strategies, Case Studies, Low Energy Architecture
Keywords: Natural Ventilation and Daylight, Ground Cooling, Design Tools and Sustainability

1.0 INTRODUCTION

1.1 The Programme and Social Context

This paper describes the unique social context of this project, the arrangement of the building in plan and section, its seasonal modes of ventilation operation, the analysis of the thermal behaviour of south facing spaces and the potential cooling benefit offered by a below-slab labyrinth.

Programmatically, the new Health and Social Care Centre is a new building type for the UK,

integrating primary and primary/secondary interface healthcare, with Social Services provision and the work of the Mental Health Trust, focusing in particular on care for the elderly. Some seven services, all currently housed in different parts of the city, all using different IT systems, will be gathered under one roof in Braunstone.

Their interrelationships are defined in an intricate National Health Service (NHS) Service Model, which also prescribes floor area entitlements and necessary and desirable adjacencies.

The extended user group is large & complex and is inevitably competing within itself for dedicated space, aspect, adjacency, light, views, privacy and prominence, but it will be the 'spaces' between that become the 'glue' holding the ambitious model together. The Centre will serve an estate of 11,000 citizens, but some services will cater to a broader community of at least 40,000.

With the deprivation comes theft, violence, arson and vandalism. The local Child Protection Agency headquarters was burnt down relatively recently by aggrieved residents. The new Health and Social Care Centre will need to be robust and secure. However, It is extraordinarily important for the success of the Centre that it appears non-institutional and welcoming, despite being physically impregnable. Some visitors may well wish to remain invisible & anonymous and not be identified visiting a particular service.

Clarity in the circulation routes, described as 'wayfinding' by the NHS is critical to the operation of the building. Staff time is saved and clients are calmed. There is a challenge in the superimposition of the exigencies of the programme onto the chassis of a low-tech passive solar environmental strategy, not the least because the strategy demands a significant degree of perforation of the external envelope. The brief prescribes seventy cellular spaces, for most of which acoustic isolation is very critical, and a substantial open space at the heart of the building. Double loaded corridors, thought to be intimidating, are not encouraged.

The entry process is complex. The stakeholders voted to operate a 'triage' system in which new arrivals are diagnosed 'on their feet' by trained 'triage' nurses who nominate the service to be visited. Clients wait centrally until their appointment is 'called'. Up to a hundred clients/visitors may be assembled in the extended reception on any weekday morning, in any season.

The plan is necessarily deep given the limited available site areas and the operational drive to place all publicly accessible areas on the ground floor. Manning the triage desks will be stressful. The nurses will benefit from natural light, views and the passive cooling provided in midsummer.

The funding arrangement is non-typical for the UK and is through a new central government block grant called the 'New Deal'. The non-recurrent funding goes straight to the community who will own and operate the building. It is literally 'their' design. The seven services will be tenants of the Community Association and will bear a proportion of the costs in use.

1.2 The Site

The community's intention to build the centre at its heart in a public park was stymied by the Council's Development Control officers. The final choice of site (Fig. 1) is not ideal, peripheral to the estate, on waste ground with 1metre of fill, and in the lee of a busy road, elevated 2 metres above the site. However, the site is attenuated east/west and offers a wide southerly prospect. None of the fill is removed, it is remoulded into the contours.

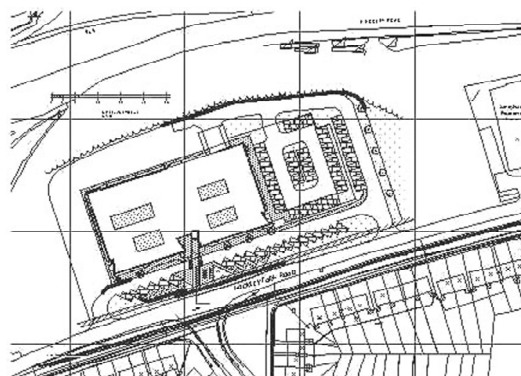


Figure 1: Site Plan

2.0 THE DESIGN

The perspective section (Fig. 2) is taken along the centre line of the plan, through the entrance courtyard, the central organising space, the triage desks, a health promotion pavilion with a staff common room above and the two storey element to the north. The plan form is rectangular, orientated with its long axis running east/west, punctured by four courtyards to provide fresh air and natural light (Fig. 3). Seventy percent of the accommodation is at ground level.

Flexibility is important, within the sites of 'wet' serviced clinical rooms and dry consulting rooms and offices. The Services are in constant flux. Doctors are concentrated to the west, Social Services to the east, and clinical rooms to the north, all directly connected to the central organising space. The plan of the building will be 'ghettoised' on the opening day, but the intention is that the Services will meld together over time.

A low monopitch roof covers the whole plan, tipping up and down as required to admit light into internal courtyards. The roof plane is punctured by south facing controllable rooflights. These are placed in plan (Fig. 4), to boost light levels in the deep open plan areas. Their vertical glazing is shrouded to the south and west to exclude direct sun between March 21 and September 21. A revolving insulated baffle, radiused to reflect direct sunlight, provides further protection against unwanted solar gain (Fig. 2). The rooflights are glazed to the north and south, both windows open to cross ventilate out unwanted heat gains and to enable the rooflight object to stack ventilate the space below. They are also intended to provide solar gain in the heating season and to admit daylight to spaces and first floor administrative areas on the north side.

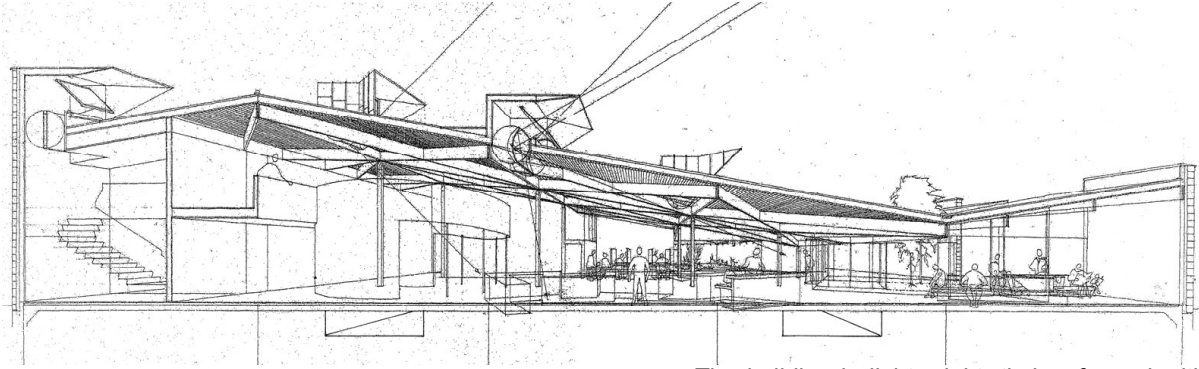


Figure 2: Perspective - Section Taken On North/South Axis

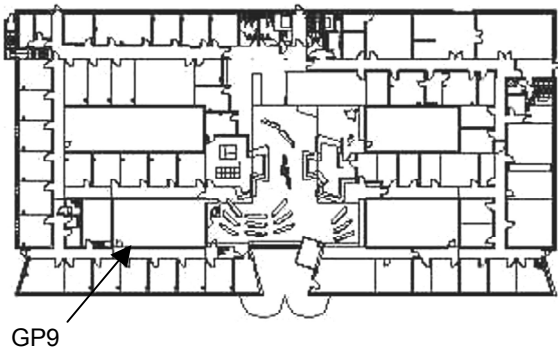


Figure 3: Ground Plan

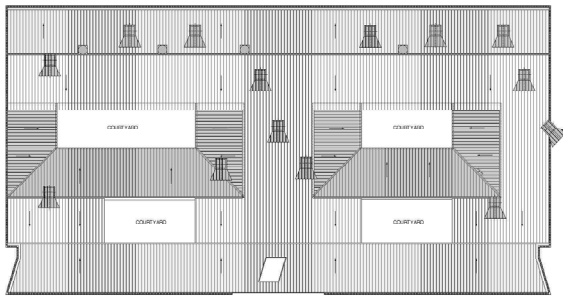


Figure 4: Roof Plan

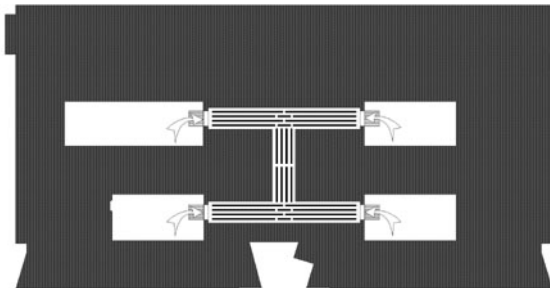


Figure 5: Labyrinth Plan

The building is lightweight, timber framed with a glulam column and beam structure, and composite timber intermediate floor. A concrete labyrinth (Fig 5) is proposed below the ground slab to provide some pre-cooling of supply air in the summer season to compensate for the absence of thermal mass in the superstructure. The labyrinth is fed from each of the four internal courtyards. A solid loadbearing brick masonry wall encloses the plan. The detail of the south elevation (Fig. 6) indicates a significant area of glazing, opening top and bottom to facilitate single side ventilation. This is protected against vandalism and intruders by stacked terracotta cavity duct components which cut off direct sunlight above 45°, but admit winter sunshine.

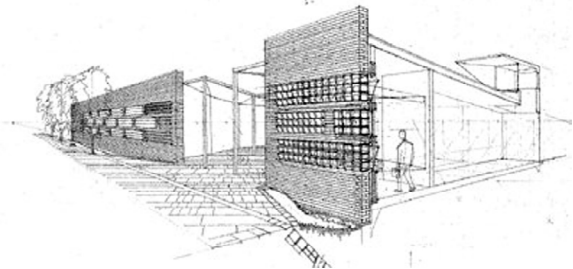


Figure 6: View of South Elevation

The terracotta screen is robust enough to provide security to the frontage, providing almost 50% glazed area.

3.0 VENTILATION STRATEGY

3.1 Intended Operation

Cellular spaces are either single-sided or cross ventilated. In both cases, damper-controlled air inlets admit fresh air into the space (pre-warmed in winter) directly through the wall at low-level while damper-controlled outlets allow warm, stale air to exit either directly to outside (single-sided) or into the adjacent corridor and out of the damper-controlled roof exhaust stacks (cross ventilation). During winter (heating mode), inlet and outlet dampers will open to a minimum fresh air setting. During warmer periods, the dampers will open further to deliver a ventilation flow rate up to 4 air changes per hour. A further (boost) air change rate of 4 air changes per hour is available using openable windows, generating the

desired total air change rate of 8 air changes per hour for peak summer-time cooling.

The damper and heater arrangement enable the fresh air flow path to be closed whilst recirculated air within the space is heated; this operating mode is used for pre-occupation warm up in winter. The low- and high-level damper-controlled openings provide adequate night-time ventilation (up to 4 air changes per hour) without jeopardizing security.

The central reception area is supplied in summer with fresh air from the below floor labyrinth which draws outside air from the four courtyards. Air enters the space below fixed seating units. Warm, stale air exists the space through the roof-mounted stacks. Additional ventilation for summer-time cooling is available via openable windows. Night-time ventilation through the labyrinth cools the thermal mass within the labyrinth and removes the previous day's warm air from the reception area plus any heat generated by permanently operating equipment.

During the heating season, the labyrinth is isolated and fresh air is admitted to the space around the building envelope at low-level through damper-controlled inlets behind heating elements. The exit flow route remains the roof stacks.

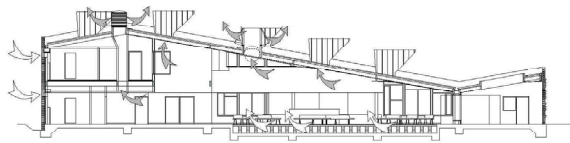


Figure 7: Section through the central space (summer mode)

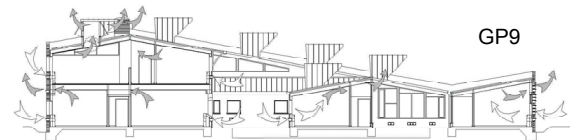


Figure 8: Section through courtyards and medical rooms (winter mode)

3.2 Simulation Analysis

Dynamic thermal modeling has been carried out to investigate two issues: the over-heating risk of a typical south facing office during summer; and the potential benefit of the subterranean labyrinth for passively cooling summertime air prior to entering the core zone of the building.

South Facing Office

Thermal analysis was carried out using the dynamic thermal simulation software ESP-r [1]. The office chosen for the analysis was GP9 (Fig. 8). Construction details used in the model are shown in Table I. The clay flue liners on the external south façade were represented by a single element of horizontal shading which blocked all direct solar radiation.

Element	Construction	U-value
External wall	12.5mm plasterboard 150mm insulation 12.5mm plywood 50mm air gap 102mm brick	0.24W/m ² K
Roof	12.5mm plasterboard 400mm insulation 2mm sheet metal	0.1W/m ² K
Floor	10mm carpet 50mm cement screed 150mm concrete block 125mm insulation	0.25W/m ² K
Internal wall	2 × 12.5mm gypsum 100mm 'soundbloc' 2 × 12.5mm gypsum	

Table I: Building fabric construction and U-values

Occupancy hours were assumed to be 9am-6pm on weekdays. During these times heat gains of 200W (2 people), 116W (1 computer) and 60W (lighting) were modeled.

The climate file used for this simulation was the design summer year for Ringway (near Manchester) supplied by CIBSE. Of the data sets recommended for use with dynamic thermal simulation programs, this is the nearest, geographically.

During occupied hours, fixed ventilation rates of 2, 4, 6, 8, 10 and 12 air changes/hour supplying air at ambient temperature were investigated. During unoccupied hours (including weekends), a fixed rate of 2ach⁻¹ was maintained in all cases.

Results are presented as the number of hours for which the dry resultant temperature inside the space exceeds 25°C (Fig. 9). One of the CIBSE criteria for overheating is that no more than 5% of working hours should exceed 25°C. This amounts to a maximum number of 117 hours. Based on this, the results indicate that 4ach⁻¹ is likely to give borderline performance whereas 6ach⁻¹ and greater is likely to avoid the risk of over-heating. Using this information, it was decided to size the natural ventilation openings based on a desired air change rate of 8ach⁻¹.

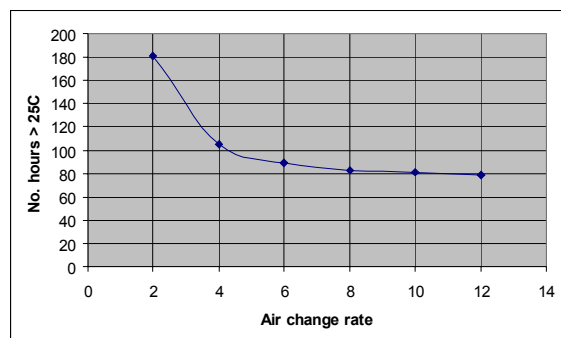


Figure 9: Frequency of temperature exceeding 25°C

Below Slab Labyrinth

To investigate the possible contribution of the labyrinth to passive cooling, an admittance calculation was carried out based on the method described in chapter 8 of CIBSE Guide A [2]. This model was of

one quarter of the labyrinth and was assumed to comprise a 250mm RC slab on the floor of the labyrinth with 100mm mineral wool and a 25mm plywood floor above. A flow rate equivalent to 8ach^{-1} for the core space served from the labyrinth was assumed. This amounted to $0.75\text{m}^3/\text{s}$ for the quarter labyrinth used in the model. The performance of the labyrinth was assessed for a 24-hour period in the UK summer which comprised a hot summer day during which the maximum temperature was 27°C and the minimum was 13°C .

The graph in figure 10 shows the diurnal swings of the ambient dry bulb temperature and the corresponding temperature of the air emerging from the labyrinth. This shows a peak passive cooling potential (during the hottest part of the day) of about 2°C .

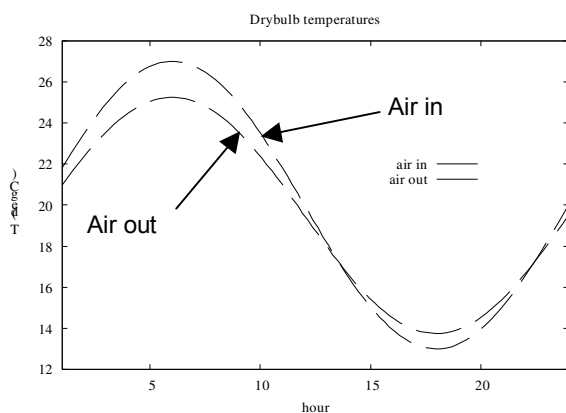


Figure 10: Dry-bulb temperatures for air entering and leaving the labyrinth during summer 24-hour period

4.0 CONCLUSIONS

The complex accommodation programme, the myriad of interconnections it will generate and the need for short journey times between service functions tend to favour a compacted form plan form for this new building type. A lightweight timber frame system with the potential for pre-fabrication would seem to provide the required speed of construction and future flexibility of internal plan arrangements. The profound acoustic requirements of the many cellular spaces can be accommodated by current timber construction technology, but the lack of thermal mass and the responsiveness of the timber construction make the building vulnerable to summer overheating. The design challenge is to capture winter solar gains, but defend the interior spaces against summer solar gain and deliver some kind of passive pre-cooling of supply air.

The proposal attempts to achieve those objectives by orientating glazing to the south in elevation and at roof level, screening it from direct solar penetration beyond the heating season, generally maximising natural light penetration to reduce lighting loads, and delivering ground cooling supply air to the heart of the deep plan. The intention is to reduce 'costs in use' and to marry a sustainable environment to the ideas

of recovery, easy access to coordinated health and social care, and the promotion of healthy lifestyles.

Throughout the many consultations, the Community has engaged positively with the environmental concepts, whilst being very sensitive to the imagery their physical form adopts. Construction is due to complete late 2004.

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- [2] CIBSE, CIBSE Guide Volume A: Design Data, The Chartered Institution of Building Services Engineers, 1986