PROJECT MONITOR

Commission of the European Communities

J E L BUILDING

STOCKPORT
ENGLAND

- Low energy and passive solar design to promote client's high-tech business image and provide focal point for industrial park.
- Warm air provided to production area from glazed south facing wall and atrium.
- Overheating from solar gain controlled by blinds or louvres and by natural ventilation.
- Maximum use of natural light and low energy lighting with automatic controls reduce electricity costs.
- Good control over heating provided by zoning the building and use of environmental controls and an energy management system.

Project Monitor is a series of case studies illustrating passive solar architecture in the European Community

DEC 1987 Issue 8

Project Background

The JEL Building is a low energy production and office building designed for a firm which manufactures control and energy monitoring systems. The building has won a number of architectural and low energy awards and has been very successful in promoting the firm's business objectives.

DESIGN OBJECTIVES

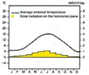
The client wanted a building that not only demonstrated the use of low energy design techniques applied to building form, fabric, lighting and heating, but would also provide a striking showcase for his own computerised control systems. For the architects, it was important to ensure that the achievement of low running costs was not done at the expense of greatly increased capital costs, and that the building's appearance enhanced the client's business objectives of efficiency, innovation and stylishness. It also had to be capable of being readily saleable in the commercial property market.

ENERGY SAVING FEATURES

- Increased proportion of south facing glazing, including rooflights.
- Control of solar gain in both summer and winter to prevent overheating by using blinds, cross ventilation and stack effect.
- High levels of insulation and effective seals and lobbies to reduce air infiltration and draughts.
- Maximum use of natural lighting, use of low energy lamps for supplementary lighting and lighting control systems.
- Use of energy management and boiler control systems.
- Recirculating air within the building to prevent heat stratification.
- Zoning of building for more specific environmental control.

SITE AND CLIMATE

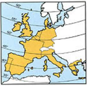
CLIMATE (Bidston)



The building is in Bramhall, a suburb of Stockport which is about 10 miles south of Manchester. The site is approximately 60m × 120m with the longer axis running north/south.
The climate is temperate, but the region is wetter than many other parts of England. The maximum daily average temperatures are 15.5°C in summer and 4.0°C in winter. There are on average, 1450 hours of sunshine a year. The site itself is flat and fairly open, except for some tall trees to the south and another building on the west, which provide some shelter against the prevailing south-west winds. To the east of the site is some traditional low rise housing and to the west are some industrial units.

SITE PLAN
The south elevation is not overshadowed as it faces the entrance to the industrial park and provides a focus for the park.

Design Details



Stockport is on the southern side of Manchester and about 30 miles from Liverpool in the north west of England.

PLANNING

The glazed south elevation faces the road leading into the industrial park and creates a focal point at the entrance to the park.

The road loops around to the east to serve a public car park and this factor determined that the entrance to the building should be on the east side. The building is screened on the west side by mounding and planting. The area at the north end of the building is reserved for expansion of the production area in the future. Inside, in the middle of the building, is a double storey high production space which receives natural light from rooflights. The rest of the facilities are placed around the production space on the ground and first floor levels and receive daylighting from the windows. In the middle of the south facade is a double height atrium space which contains the boiler and control equipment; it also serves to allow more natural light into the production area.

CONSTRUCTION

The building has a steel frame which was chosen in order to reduce construction time and to allow the roof to be erected at an early stage to give shelter to the other trades. The shape of the triangular lattice beam facilitated the incorporation of sloping rooflights. The walls are cavity construction with an inner leaf of thin lightweight concrete block, a 50mm cavity fully filled with glass fibre batts and an outer leaf of 102mm brick. Brick walls were a requirement of the planners who were concerned that the walls should blend with houses around the business park. The ground floor is a concrete slab and the first floor is made of precast and prestressed concrete planks spanning between steel beams.

in the heating season, and which allow hot air to be exhausted by stack effect in the summer.

To control glare and unwanted summer solar gains, the south wall was fitted with internal venetian blinds. The designers wanted to fit the blinds between the two panes of glass and extract heat at the top of the cavity, but this proved not to be cost effective. However, after the building had experienced its first summer, external blinds were fitted to provide better solar control at first floor level.

The south elevation makes the maximum use of solar gains by having the roof as well as the wall fully glazed. In the centre is the double height atrium which acts as a plenum for collecting solar heated air before it is ducted to the production area in winter or vented in summer.

PASSIVE SOLAR DESIGN

The building has a fully glazed south facade. In the centre of this is the two storey high atrium, which contains the boiler and control plant. The glazed wall is a sun trap to capture solar radiation and the top of the atrium serves as a collection point for the solar heated air. From this point, the air is transferred to the production area directly or, if necessary, after being heated by heater batteries. The atrium has mechanically activated louvres which let in make up fresh air for the production area

The blinds are opened on summer nights to allow radiative cooling and a fan is used to draw cool night air into the production area. Natural cross ventilation can be induced by opening the windows on both sides of the building. This is a manual operation.

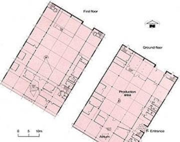
Not only does the design attempt to exploit solar gains to the full, but it also makes the most of the warm air within the building by recirculating it to prevent stratification.

Design Details

AUXILIARY HEATING AND VENTILATING SYSTEMS

Three 50kW boiler modules provide hot water for radiators and for an air heater battery. The radiators heat all parts of the building except the production area. This area is supplied with air taken from the top of the atrium and warmed, if required, by the heater battery. The two systems operate separately, and the division of the building into zones makes greater control possible.

The fan that blows the warmed air into the production area can also be used to extract hot air from the top of the atrium and discharge it to the outside.



The plan provides as much natural lighting as possible to all areas. Rooflights illuminate internal areas. The grouping of offices etc. overlooking the production area helps to promote a feeling of togetherness.

Glazed louvres from the upper corridor and offices allow visual control over the production space and provide cross ventilation.

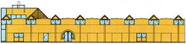
NATURAL LIGHTING

Maximising the use of natural daylight goes well with trying to maximise solar gains. However, solar gain through the large south facing glazed facade is required to be controlled in order to avoid discomfort, glare and an uneven distribution of heat. The glazed wall was therefore fitted internally with full height reflective venetian blinds which reflect the light onto the ceiling. In the summer, they are angled at 45-60° to reflect the sunlight back through the glazing. The blinds are motorised and are controlled from the central energy management unit according to lighting levels and the internal temperature. In addition to daylight from the rooflights, natural light from the atrium also helps to light the production area and the internal offices. The effect is enhanced by light coloured walls and ceilings which ensure a good light spread and high internal reflective component.

LOW ENERGY LIGHTING

The original design intended to use task lighting beside each work station, uplighters for background lighting in offices, canteen and other areas with a false ceiling, and high bay luminaires in the production area using high pressure sodium lamps. However, this was thought not to be cost effective and the false ceilings were omitted. Fluorescent fittings with polylux tubes were used instead to maintain a low energy scheme. VDUs with non-glare screens were used to prevent problems with these overhead fittings. Using a

The glazed walls and rooflights are fitted with internal blinds. It was intended that they should be in between the double glazing with air extracted at the top. Cost limitations prevented this but external blinds were fitted on the south elevation at first floor level after the first summer to prevent excessive solar gains.



The east elevation is constructed mainly of brickwork to reflect the housing opposite.

The south elevation is fully glazed.

system developed by JEL, the levels and times of illumination are controlled according to the building's occupancy pattern.

AUTOMATIC CONTROLS

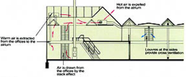
The building is divided into zones to facilitate greater control by the energy management systems located in the atrium. The system ensures a zone by zone balance and maximises plant efficiency.

OPERATING MODES

Autumn/spring: Excess heat from south wall is extracted by fan to top of atrium. Air from atrium is heated further if necessary before being distributed to production area. The blinds on the south wall are set automatically at an angle to admit or reflect solar radiation. Automatic louvres at top of atrium admit fresh air to be mixed with warm air going to production area. Fans circulate air within production area to prevent stratification. Glass louvres between offices and production area are open to allow air to return to atrium via offices. Radiators operate independently according to the temperature in each zone.
Winter: Blinds are set to 10° to allow maximum solar gain. Air at top of atrium is ducted to heater battery, then to production area. Anti-stratification fans in production area are on. Glass louvres between atrium and production area are open to allow air to return. Radiators operate independently.
In summer, hot air is drawn out of the office into the atrium where it is discharged to the outside. External blinds prevent excessive gains. Opening windows on the east and west elevations allow cooler air into the offices.

OPERATING MODES

AUTUMN/SPRING



SUMMER

Performance Evaluation

MONITORING

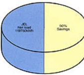
The firm uses its own equipment to provide close monitoring of temperatures and of the consumption of gas, (which is used for space heating only) and electricity (which is used for all other purposes).

USER RESPONSE

The business of the client helps to ensure that energy saving measures are more readily accepted by employees. In this building, controls are all centralised leaving little that an individual can do to control his own conditions except to open a window. During the first summer, discomfort was experienced in some south facing zones which led to the decision to install external blinds at first floor level.

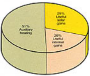
COMPARISON WITH CONVENTIONAL DESIGN

240,000 kWh/yr of fuel would be required to heat a comparable building.



JEL design uses 50% less energy than a comparable conventional building.

CONTRIBUTIONS TO SPACE HEATING DEMAND



Nearly a third of the total energy needed to heat the building is supplied by useful solar gains. Auxiliary heating provides only 51% of the total.

The production area is double height and occupies the centre of the building. Offices and other facilities are arranged around it on the ground and first floor, in order to provide a strong link between all parts of the company. Rooflights provide natural lighting which is supplemented by task lighting. Fans recirculate air to prevent stratification. The louvres in the surrounding wall allow air to return to the atrium through the offices.

PERFORMANCE OF PASSIVE DESIGN

The building has functioned extremely well and has experienced very few problems.

Passive solar gains are making a significant contribution to the energy saving measures. The large area of south facing glazing and rooflights create a light, pleasant atmosphere within the building. The automatically opening internal blinds both control the working environment and create a high-tech image reflecting the nature of the company. The potential of the energy saving features designed by the architects has been fully realised by a client who is keen to promote the benefits of low energy design and is one of its leading exponents in Europe. To increase efficiency, the boilers have been kept small and this, combined with the high thermal capacity of the production room slab, has led to longer warm-up times than would be expected normally. No lobby was fitted to the insulated loading bay doors as deliveries of large items are rare. However, when they are opened, they can cause draughts so deliveries are timed to avoid working hours. The anti-stratification fans pushing warm air downwards were found to be noisy and therefore the system has been slowed down and reversed, which has the same effect but is less disturbing.

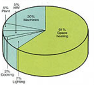
COST EFFECTIVENESS

The building cost about 3% more than a conventional building of the same size, but achieves a 50% saving of energy worth around £3,000 a year. The cost of the services is no greater than normal and it includes an energy control computer system. The additional insulation and glazing is counted as an extra cost but the atrium, which is part of the energy saving system, is not counted as an extra cost because it is also the plant room. The payback period is estimated at 6 years.

Brick walls were a requirement of the planners who wanted the building to be sympathetic to the surrounding houses. The rooflights provide daylight and solar gains to offices and the internal production area.

AUXILIARY ENERGY USED

195,635 kWh was used for all purposes.

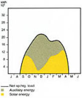


The savings made on space heating make the use of energy for equipment more prominent.

The entrance area includes a covered porch and a draught lobby.

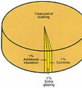
NET MONTHLY SPACE HEATING DEMAND AND SUPPLY

Solar gains provided 36% of the net space heating requirement.



COST OF ENERGY SAVING DESIGN

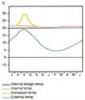
The whole building including energy saving measures cost £600,000 in 1983.



The additional cost was 3% and the saving achieved worth about £3,000 a year.

AVERAGE TEMPERATURES

The temperature rose to unacceptable levels during the summer and external blinds have now been fitted to the south wall at first floor level.



The atrium is a double height space. It contains the boiler and control equipment at ground floor level (see front cover photograph). Warm air is collected at high level and then ducted into the production space. When the warm air is not required it is ducted to the outside through the roof.

PROJECT DATA

Building

Building volume	7,100 m³
Floor area	2,067 m²
Roof area	1,316 m²
External wall area	800 m²
Window area: total	325 m²
south	235 m²

Atrium

Atrium volume	410 m³
Floor area	72 m²
Glass area: roof	10 m²
wall	36 m²

Cost £600,000 (1983)

Thermal

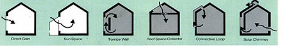
U value: roof	0.36 W/m²K
floor	0.11 W/m²K
external walls	0.34 W/m²K
glazing	2.80 W/m²K
Mean U value	0.62 W/m²K
Global heat loss coefficient	2617 W/K
Infiltration rate	0.5 ac/h
External design temperature	0 °C
Heated floor area	1,899 m²
Heated volume	6,065 m³
Net heat load	57 kWh/m²

Site and climate

Altitude	75 m
Latitude	53°21′N
Longitude	02°16′W
Average ambient temp: Jan	4 °C
July	15.5 °C
Degree days (base 18.3°)	3158
Global irradiation	950 kWh/m²
Sunshine hours	1450 hrs

Information

TYPES OF PASSIVE SOLAR SYSTEMS



Project Monitor case studies are published in Directorate General XII of the Commission of the European Communities to show how architects and other building designers can successfully apply passive solar principles to produce attractive energy efficient buildings.

Further information or copies of case studies can be obtained from J Owen Lewis, School of Architecture, University College Dublin, Richview, Clonskeagh, Dublin 14.

J E L CREDITS

Client
JEL Energy Conservation Services Ltd
Bramhall Moor Industrial Park
Pepper Road
Stockport
Cheshire

Architects and Mechanical Engineers
Dominic Michaelis Associates
(Now Michaelis Francis Le Roith Architects Ltd)
Bay 8
16 South Wharf Road
London
W2 1PF

Structural Engineers
Anthony Hunt Associates
West End House
37 Chapel Street
London
NW1

Energy Consultants
Dominic Michaelis Associates and
JEL Energy Conservation Services Ltd

Monitoring Organisation
JEL Energy Conservation Services Ltd

Quantity Surveyor
Peter Dudley Associates
Hawthorns
Brookledge Lane
Adlington
Macclesfield
SK10 4JU

Contractor
W Snape and Sons Ltd
Clifton House
Clifton Road
Eccles
Manchester M30 9QR

PROJECT MONITOR PARTICIPANTS

Project Director
Theo C Steemers
Directorate General XII for Science Research & Development
Commission of the European Communities
Wetstraat 200
1049 Brussels, Belgium

Project Coordinators
David Turrent and Simon Burton
The ECD Partnership
11-15 Emerald Street
London WC1N 3QL, UK

Belgium
André de Herde & Anne Minne
Centre de Recherches en Architecture
Université Catholique de Louvain
Place du Levant 1
1348 Louvain-La-Neuve

Denmark
Poul Kristensen
Esbensen
Havnegade 41
1058 Copenhagen K

France
Eric Durand
Service Habitat et Tertiaire
Agence Française pour la Maîtrise de l'Energie
Avenue Emile Hugues
06565 Valbonne Cedex

Germany
Ulrich Luboschik
IST Energietechnik GmbH
Ritterweg 1
7842 Kandern — Wollbach

Italy
Gianni de Giorgio e Paola Fragnito
Progettazione e Ricerca
C so Como 9
20154 Milan

Netherlands
Ton Trijssenaar
Provinciaal Bureau Energiebesparing Noord-Holland
Postbus 633
2003 RP Haarlem

Portugal
Eduardo Maldonado
INEGI
Faculdade de Engenharia
Rua dos Bragas
4099 Porto Codex

Spain
Albert Mitjà i Sarvisé
Direcció General d'Energia
Departament d'Indústria i Energia
Generalitat de Catalunya
Av Diagonal 449-7e
08036 Barcelona

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Future Issues
Further projects, including schools, offices, factories and housing, will be published in the next two years.