#6295

DESIGN OF A NATURALLY VENTILATED LABORATORY BUILDING IN LEICESTER, ENGLAND

BRIAN FORD AND ALAN SHORT
Peake Short & Partners
15 Prescott place
London SW4 6BS
United Kingdom

ABSTRACT

This paper provides an overview of the design of the new School of Engineering and Manufacture for Leicester Polytechnic, incorporating new laboratories for electrical and mechanical engineering students plus general teaching spaces and two auditoria. The site for the new building is at the heart of the Polytechnic's city centre campus. Its urban location has placed particular demands on the design. Nearly all laboratory, teaching and offices are naturally ventilated and daylit. Detailed design is nearing completion and construction on site is due to start in June 1991.

1. Building Brief

The new School of Engineering and Manufacture at Leicester Polytechnic has been designed to combine the two Departments of Electrical and Electronic Engineering and the Department of Mechanical and Production Engineering (Fig. 1). The School has become a focus for research and innovation in the field of 'Computer Integrated manufacture'. The activities of both departments overlap in many areas and computer workstations (rather than experimental rigs) occupy much of the laboratory space. There are a range of activities which have fundamentally different environmental requirements. For example, the main Mechanical Laboratory includes a two-storey volume to accommodate large machines for experiments in hydraulics, thermodynamics, etc. The activities and machinery here generate high periodic internal heat gains (> 100 w/sqM), intermittant high noise generation (110dBA +), and require high light levels (1000 lux) for safe operation.

S. Alvarez et al. (eds.), Architecture and Urban Space, 319–324.

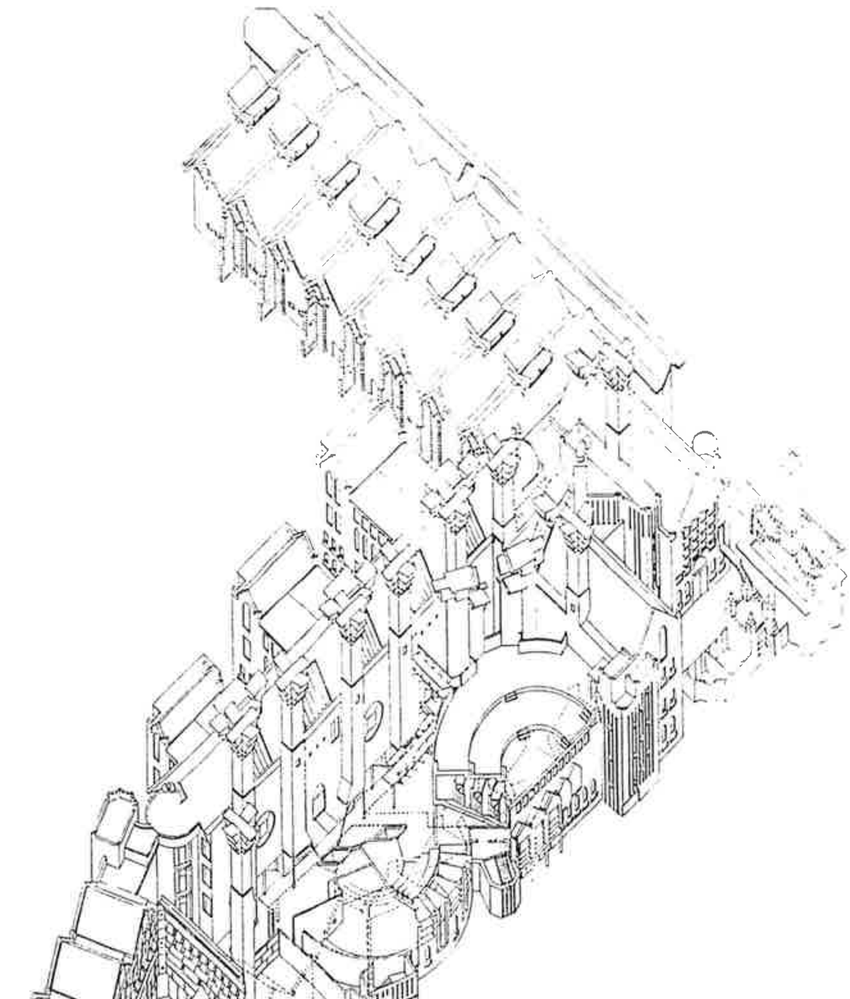

Fig.1. Axonometric of new school of Engineering, Leicester Polytechnic.

This contrasts with the Electrical and Electronic teaching laboratories which generate almost constant high internal heat gains (85 W/sqM), require generally low-level controlled lighting (min 300 lux) and are generally quiet apart from the chatter of keyboards.

2. Environmental Strategy

From an analysis of the nature of the different activities which are to be catered for it became apparent that most laboratory, teaching and office areas could be naturally ventilated and daylit. This avoids the provision of mechanical ventilation and permanent artificial lighting to most areas, with the advantage of reduced capital and running costs and a more pleasant working environment for students and staff. This strategy has had a profound influence on the form of the building. The extended perimeter allows good daylighting and cross-ventilation to many parts of the building, while shaded courtyards provide reservoirs of cool air which is pulled into the deepest parts of the plan in summer.

Internal heat gains from people, computers and other machinery have such a significant influence on the internal thermal environment, that the avoidance of over-heating in summer is a major design consideration. The potential for stack ventilation of each area has been assessed by a series of specialist studies using both physical and computer based models.

Preliminary calculations and simple performance modelling was undertaken by the architects as part of the development of the initial design. Assessment of the detailed design was undertaken after funding approval had been obtained, and included both physical and mathematical modelling. A description of this detailed modelling, and the contribution it made to design development is described elsewhere in papers by Dr Paul Linden of Cambridge University, and Dr Kevin Lomas of Leicester Polytechnic. This paper describes the initial design and how this developed into the final solution.

3. Electrical Laboratories.

There are many precedents which achieve the broad intention of providing daylit, naturally ventilated interiors by means of a narrow section which facilitates cross ventilation and well distributed daylighting. Two narrow section 'wings' on four storeys, with a narrow courtyard between, were designed to accommodate the Electrical Laboratories (Fig.2). Low and high level openings are sized to provide sufficient ventilation to remove high internal heat gains from computers and other small machines. Daylight is controlled partly by 'light shelves' which protect occupants from direct sunlight and reflect light onto the ceiling, providing an even destribution of light across the lab.

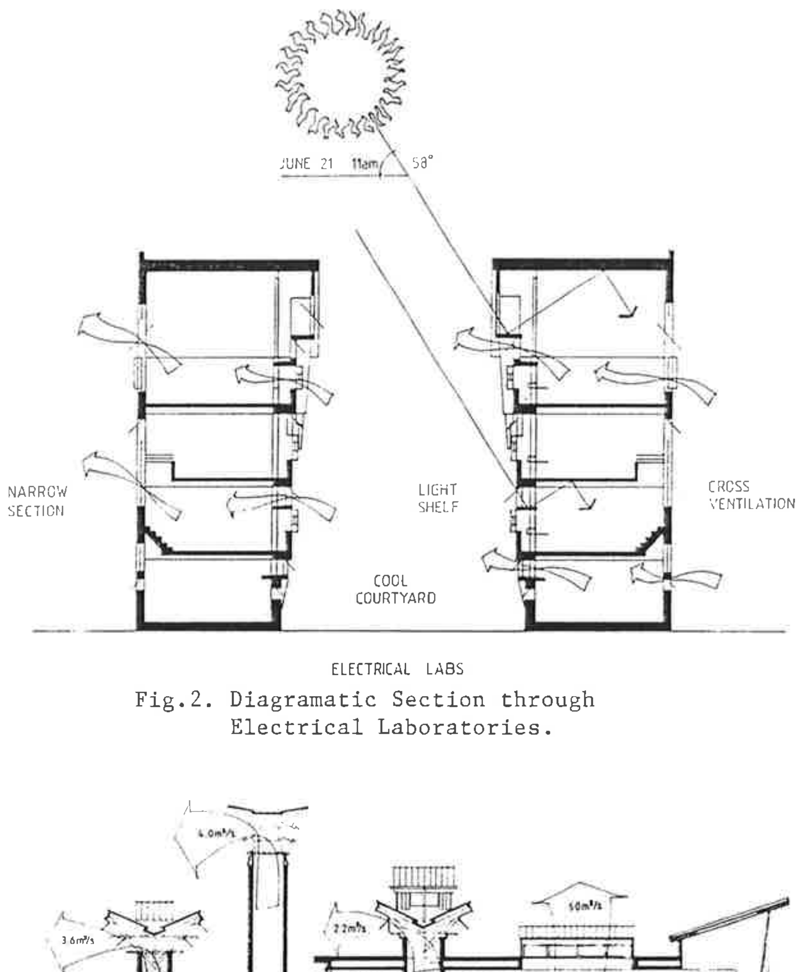

Fig.2. Diagramatic Section through
Electrical Laboratories.

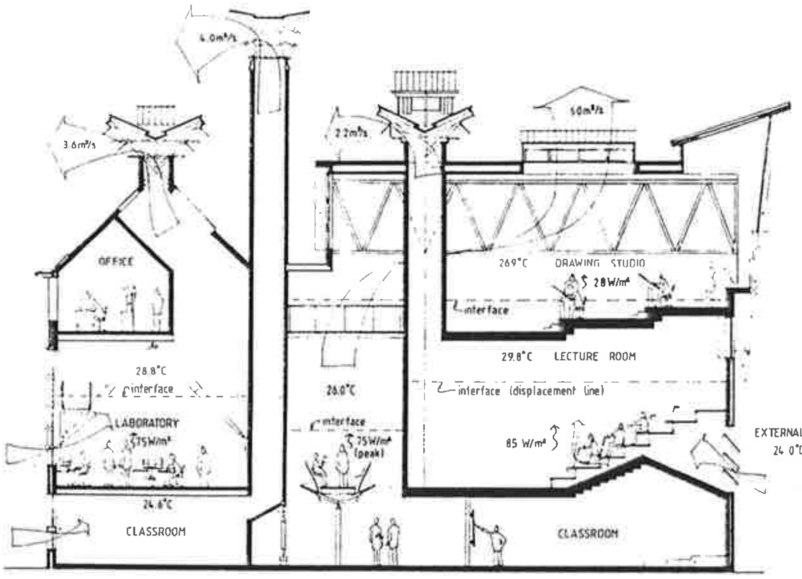

Fig.3. Diagramatic section through central building.

The narrow shady courtyard between the 'wings' provides in summer a source of cool air for the central building and in winter protection from the wind in approaching the entrance.

4. Central Building

The provision of all the accommodation in narrow section buildings would result in a highly extended perimeter, increase capital cost and involve a considerable energy penalty in winter. The main part of the building has therefore been folded back on itself, giving rise to the problems of a deep plan. The provision of natural ventilation and daylight to every part of such a deep plan, can generate a range of formal solutions. In this case, each activity has been treated separately, promoting stack ventilation through each area from ground to third floor. Ventilation shafts from the general lab. also allow light down into the deepest part of the plan.

The main body of the building was originally conceived as five zones, each of which was to be ventilated by separate shafts which rise above the general roof level: 1. Concourse; 2. Classrooms; 3. General Laboratory; 4. Offices; 5. Drawing Studios (Fig.3). A preliminary evaluation of heat gains and summertime temperatures in zones 2, 3 and 4 indicate the importance of avoiding solar heat gains in summer and the importance of high air change rates in maintaining comfortable internal temperatures. The concourse and drawing studios are now one zone, ventilated via ridge vents. This general arrangement can be seen in Fig.3, which is a section through the main part of the building.

5. Mechanical Laboratories

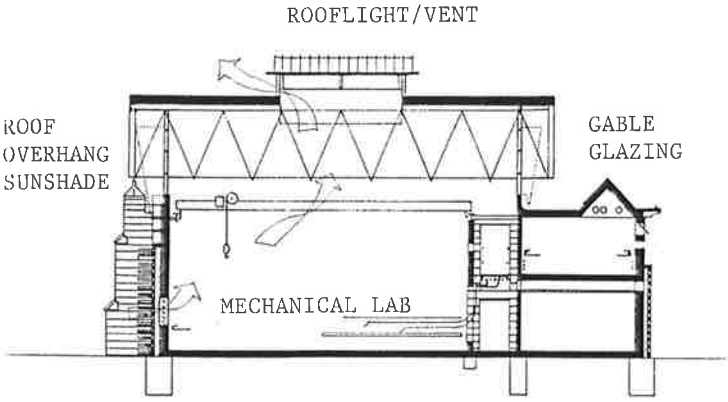

FIG.4. Section through Mechanical Lab.

The main hall of the Mechanical Laboratory has high periodic internal heat gains from large machines. Ventilation is introduced at low level via 'perforated' buttresses, which incorporate acoustic quilt to reduce noise transfer. The buttresses' primary structural function is to absorb the thrust from a travelling crane gantry. High light levels are achieved by gable glazing and rooflights, which also act as ridge ventilators. Roof overhangs and deep reveals prevent penetration of direct sunlight onto the floor of the laboratory.

Conclusion

The design of the new School of Engineering for Leicester Polytechnic demonstrates that highly sophisticated mechanical and electrical engineering laboratories and associated teaching spaces can be designed to be naturally ventilated and daylit. This is achieved in an urban environment and using traditional building construction providing a building which is economic in both capital and running costs, and which will hopefully be a pleasure to its occupants.

Design Team

Architects:	Peake Short & Partners London, UK Alan Short, Brian Ford, Anne Goldrick and Catherine Hoggard, with Mark Hewitt, Mike Betts, Joseph Ki, Garry Stewart, Bruce Graham, Peter Sharratt, Oliver Chapman.
Structural Engineers:	YRM Anthony Hunt Associates Sheffield, UK.
M & E Engineers:	Max Fordham Associates London, UK.
Quantity Surveyors:	Dearle & Henderson London, UK.
Landscape Architect:	Livingston McIntosh London, UK.

LIBRARY AND CULTU

DIETER
Design: F
Cooperati
LOG ID C
Sindelfing
D-7400 Ti
Federal R

1. Introduction

LOG ID is an interdiscipl
heating of buildings. O
function for the most par
time offer a high living qu

2. Architectural Concep

The building was planned
We solved the problem o
shady sites and estates b
between roof and building

Via a system of pipes, the
there are absorbers, suppl
domestic use. Silicon ce
and lighting system. Th
massive brick walls, cap
plants. This type of build

LOG ID develops arch
employment of solar ener
structure and a glasshous
Subtropic plants make po

Prior experience in the c
to draw upon this experie
library and cultural cente

The massive building is
generous floor space.
library and indoor/outdo

S. Alvarez et al. (eds.), Architect