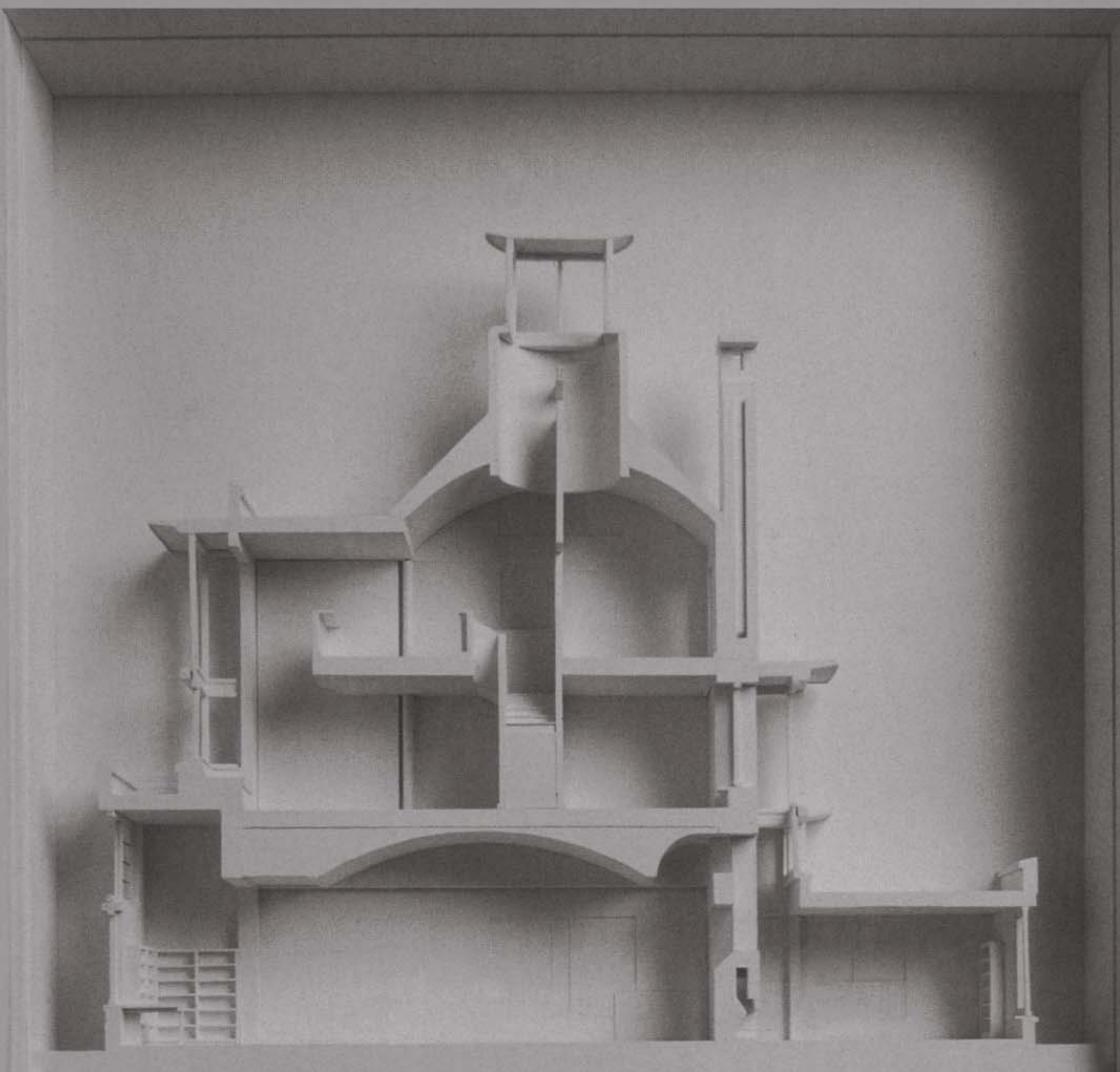
THE **SELECTIVE ENVIRONMENT**

An approach to environmentally responsive architecture

Dean Hawkes, Jane McDonald and Koen Steemers



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Preface

> As life has arisen through the hidden aspects of natural laws, so for better or worse the laws of nature command that life make a close adjustment to natural background. The setting is impartial: it can be cruel or kind, but all living creatures must either adapt their physiology, through selection or mutations, or find other defences against the impact of the environment.
>
> (Victor Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism*, New York, 1963)

This book is about humankind's relation with nature as expressed through the fundamental function of building, of architecture, as a defence against the impact of the environment. Since Victor Olgyay wrote his important book nearly 40 years ago, the tables have been turned. The term 'environmental impact' is now more commonly used to describe the damage that humankind's actions wreak upon nature. The process is now reciprocal. In the past, in seeking to protect ourselves against the rigours of the natural environment, we have slowly, but surely, damaged nature itself. Buildings and the activities performed in them have contributed significantly to this damage.

The aim in writing this book was to show how the buildings that contemporary society inhabits might be brought into a more responsive and responsible relationship with the natural environment. The idea of 'selective' design has its origins in Olgyay's pioneering work and Rayner Banham's seminal account of *The Architecture of the Well-Tempered Environment* (1969). It proposes that the environmental processes of a building should be achieved primarily through its form and construction, and that these should be organised *selectively* to filter the natural environment as the first step in the process of adaptation. The intention is to minimise dependence upon mechanical systems of environmental control and, hence, to limit negative environmental impact.

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undertaken at the Martin Centre for Architectural and Urban Studies, Department of Architecture, University of Cambridge, with the generous support of a grant from the Mitsubishi Corporation. The authors offer particular thanks to Mr David Pownall for his support throughout the project and at other times. They also thank Eleena Jamil, Welsh School of Architecture, Cardiff University, for her painstaking help in the collation of the illustrations. We would like to thank the relevant individuals and organisations for permission to reproduce the illustrations and have made every effort to contact and acknowledge copyright holders. If any errors have been made we would be happy to correct them at a later printing.

The book is dedicated to Janet Owers, who, in her capacity as Librarian at the Martin Centre, from its foundation in 1967 to her retirement in 2000, contributed so much to the work of the Centre and was of inestimable help to us in this project. We wish her a long and active retirement.

Dean Hawkes, Jane McDonald and Koen Steemers
Cambridge
2001

1 Introduction

The complex art of architecture embraces all of the concerns of the world's cultures. It meets the fundamental need for shelter from the elements, but, almost from its origins, has acquired other purposes and meanings. The Selective Environment is an approach to environmentally responsive architectural design that has developed over a number of years through research which originated in the Department of Architecture at the University of Cambridge. It seeks to make connections between the technical preoccupations of architectural science and the necessity, never more urgent than today, to sustain cultural identity through a time of rapid, global, technological change.

Research towards design

In writing of the development of architectural research at the Cambridge School of Architecture in the 1960s, under the inspiration and direction of Leslie Martin, the architectural critic Robert Maxwell observed that the approach was founded on the belief that research in *architecture* has a separate existence from the associated field of architectural or building science and that, in its fundamentals, the Cambridge approach, as defined by Martin, 'condensed as a love of architecture . . . [that there should be] no artificial opposition between the invention of architectural form and the rational analysis of what had been invented . . . [that] practical reason led on to speculative reason without a break'.[1] In evaluating the environmental strand in the work of the Cambridge school, Maxwell observed that it acknowledged the 'loose fit, that architects know only so well, between form and performance: a space in which cultural pressures can produce strange distortions'.

This book grows out of this tradition of balancing analysis and synthesis in the architectural enterprise and sets out to define a set of simple principles that may guide the design of environmentally responsible buildings appropriate to all cultures and climates.

Architecture and environmental impact

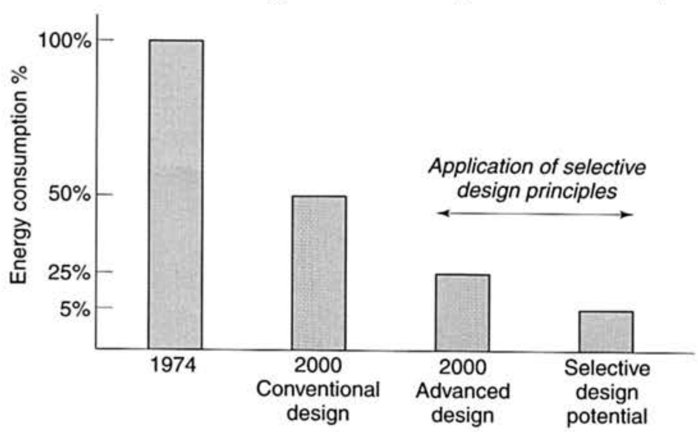
It is now well known that in the countries of the industrialised world, buildings account for a substantial proportion of gross energy consumption. In providing services such as space heating, lighting, ventilation and air-conditioning, buildings may, as is the case in the UK, account for up to 50% of the total energy consumed. As the growing economies of the Third World embrace industrialised technologies, there is a danger that they also will become profligate in their demands for energy.

As a direct consequence of this level of energy demand, buildings have become one of the major sources of environmental pollution. Whether primary fuel is converted into energy via a gas, oil or solid fuel plant within a building, or is converted remotely in electricity generation, it contributes to global levels of environmental pollution.

Buildings and energy demand

The nature of the problem of building energy demand has been recognised since the so-called 'energy crisis' of the 1970s. The connection between buildings and environmental pollution, however, has been acknowledged only in recent years. Consequently, the regulation and practice of building design has changed. In most of the developed world, building regulations concerned with standards of thermal insulation and the efficiency of plants have been improved. In addition, many national and international research and development programmes have led to the development of new components, materials and design concepts for the realisation of low-energy, 'environmentally responsible' buildings.

The result of all of this has been to produce progressive improvements in the performance of buildings. Typically, a conventional building of the 1990s, built to satisfy building



1.1 Energy consumption trends in non-domestic architecture.

regulations, will consume only 50% of the energy of its equivalent of the 1970s. More advanced designs, which apply more sophisticated design approaches and incorporate improved specifications and materials, can achieve a considerable improvement on this figure. Through these measures, a further 50% saving of energy is quite possible. However, as we move into the new millennium and as the global economy continues to expand, even greater savings will be necessary (Figure 1.1).

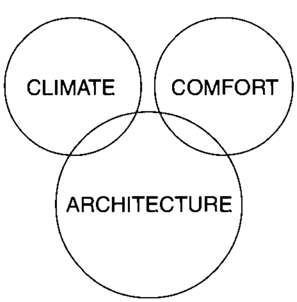
To deliver these savings, it is essential that established knowledge should be communicated to general design practice and that the principles developed in the industrialised world be translated into procedures for use in the emerging economies.

The Vitruvian model

Providing shelter from the rigours and unpredictability of the natural environment is one of the most fundamental functions of building. The transition from the unselfconscious building of primitive societies to the self-conscious art of architecture was marked by the codification of the knowledge embodied in vernacular buildings to allow its transmission and application in the design of buildings for many purposes. The earliest surviving account of codified environmental principles in architecture is in Vitruvius's *De architectura*.[2] In Book VI, Vitruvius provided guidelines for the design of houses in the diverse climates embraced by the geographical span of the late Roman Republic. He wrote:

> In the north houses should be entirely roofed over and sheltered as much as possible, not in the open, though having a warm exposure. But on the other hand, where the force of the sun is great in the southern countries that suffer from heat, houses must be put more in the open and with a northern or north-eastern exposure. Thus we may amend by art what nature, if left to herself, would mar.

1.2 Vitruvian Tripartite Model of Environment.



Implicit in this statement, and in much more of the discussion of Book VI, is a simple, lucid model of the environmental function of architecture in which the form and fabric of the building acts to mediate between the naturally occurring environment – *climate* – and the conditions within which human activity may most effectively be conducted – *comfort*. This model, named the 'Vitruvian Tripartite Model of Environment' (Figure 1.2), establishes the principal components of environmental control in all buildings until the development in the eighteenth and nineteenth centuries of new sources of power and the means to harness and deliver them.

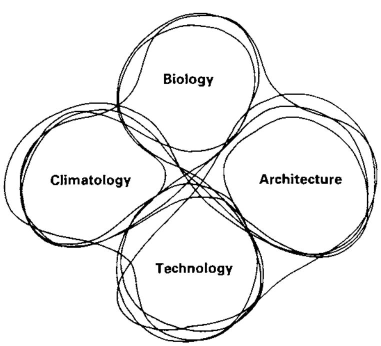
The application of 'power-operated' systems in environmental control in buildings was first recorded by Rayner Banham in his seminal work *The Architecture of the Well-Tempered Environment* (1969).[3] There, in his history of environmental design, he defined three distinct 'modes' of environmental control: the 'Conservative', the 'selective' and the 'regenerative'. The regenerative mode is that in which external power is delivered to a building to operate mechanical systems of environmental control. As Banham observed:

> it is clear that by the later nineteenth century, the North Americans had acquired habits and skills in the deployment of regenerative environmental aids that were beginning to add up to an alternative tradition.

It was at this moment that buildings became significant consumers of energy and the history of architecture, thereby, entered a new and decisive phase.

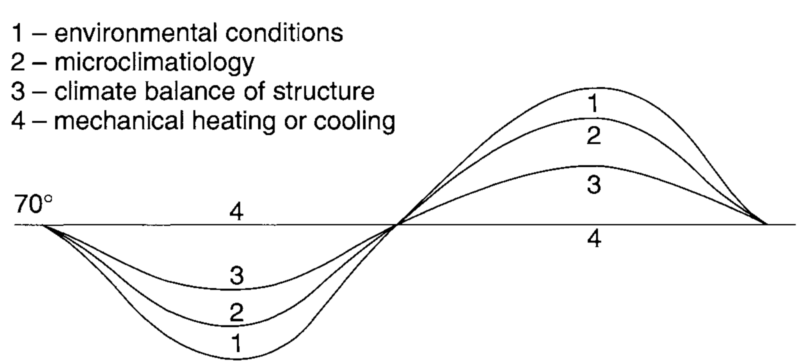
Another significant book of the 1960s was Victor Olgyay's *Design with Climate: Bioclimatic Approach to Architectural Regionalism* (1963).[4] In this he acknowledged the significance of the relationship between fabric and plant in modern architecture. Using the terminology of the period, Olgyay offered a model in which the fundamental relationship between 'climatology' and 'biology' was now mediated by the combined processes of 'architecture' and the new component 'technology' (Figure 1.3). By emphasising 'design *with* climate', Olgyay made one of the first significant gestures of resistance to the common assumption in mid-twentieth-century thinking that technology provided the solution to most problems. As an illustration, take Thomas Maver's observation of 1971:

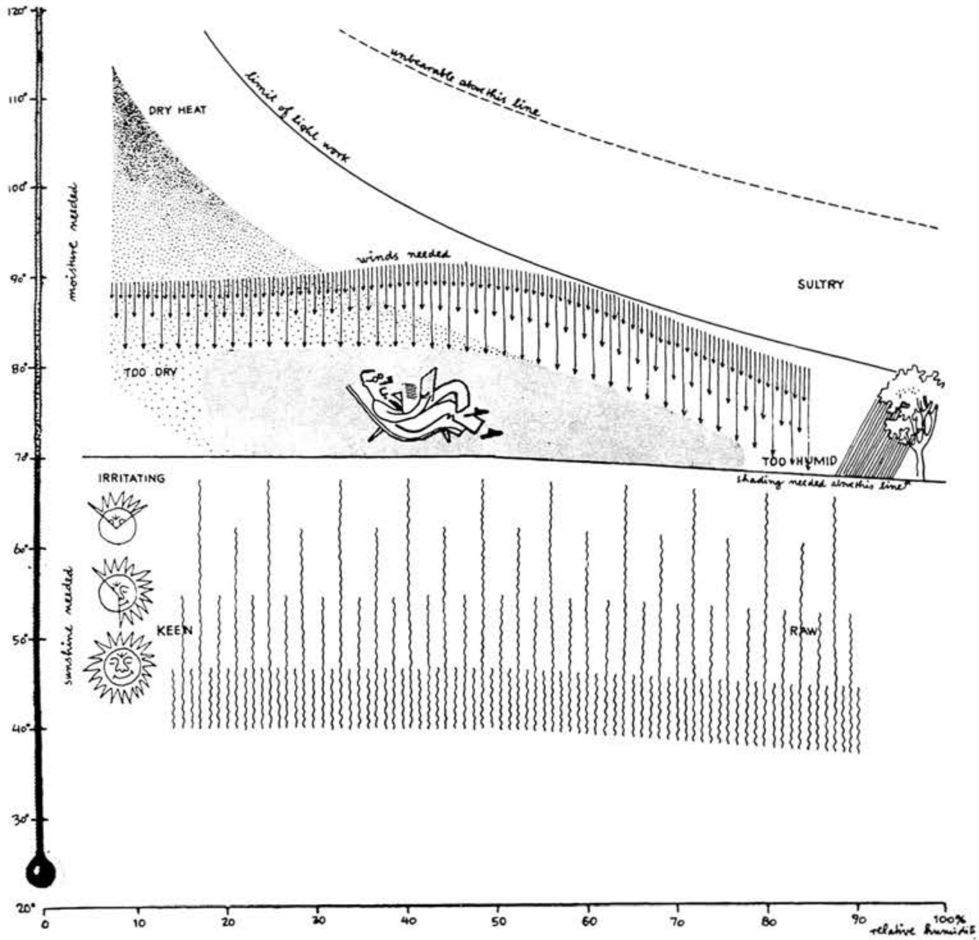
1.3 Model of environmental processes (after Olgyay 1963).



> One of the most marked trends in architecture over the centuries has been that of replacing the functions of the building structure by engineering service systems . . . The trend is not likely to be reversed . . . All the evidence points to pressure for greater control in the future.[5]

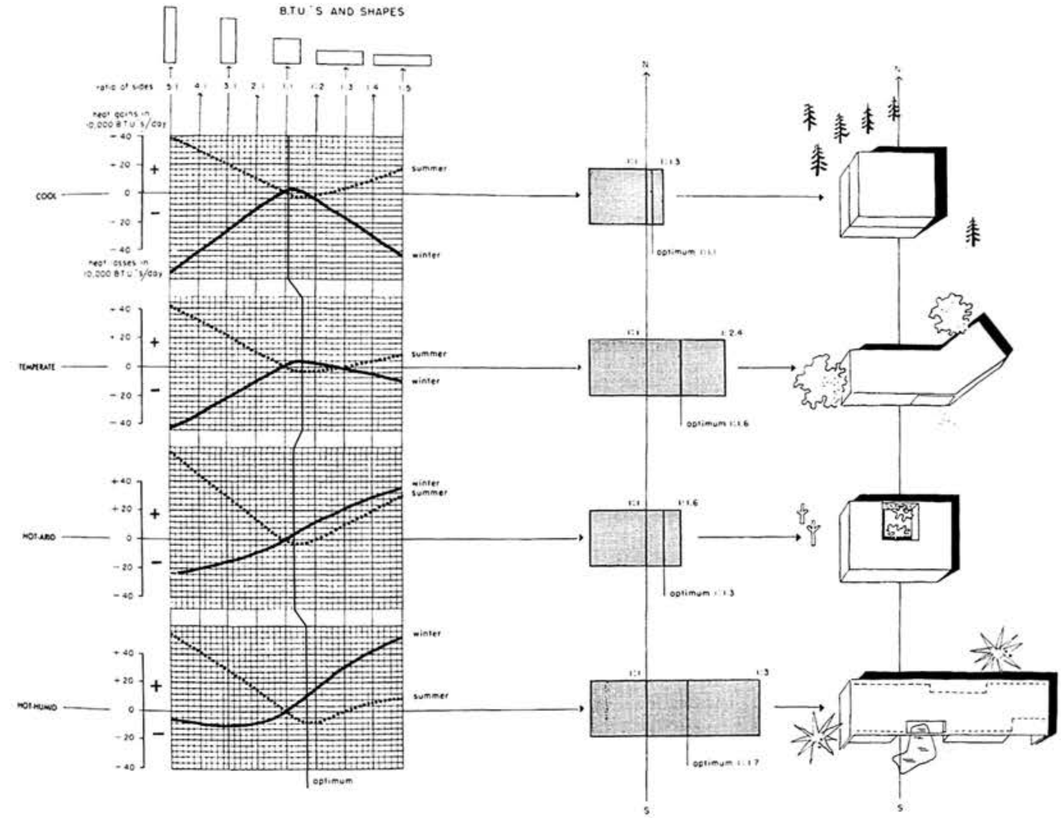
1.4 'Flattening the curve' (after Olgyay 1963).





1.5 Bioclimatic Chart (after Olgyay 1963).

But Olgyay, with his 'bioclimatic' approach, argued that the most effective role for mechanical systems is in the final stages of 'fine-tuning' the environmental capability of building structure, not as the primary instrument of mediation. This is elegantly shown in his 'Flattening the curve' (Figure 1.4), which proposes a distinct sequence of actions in proceeding from the varying external environment to the more stable condition of comfort. In his invention of the 'Bioclimatic Chart' (Figure 1.5), Olgyay provided an analytical system by which the relationship between climate and comfort can be clearly established for any given conditions. Then, a simple taxonomy of environmentally determined building types (Figure 1.6) makes it possible to initiate the development of an appropriate design. The idea of 'type' occupies a significant position in the theoretical debate in architecture and, as we will try to show, has particular value in the field of environmental design. In addition, Olgyay – in his wise book – was one of the first to propose the potential of an architecture of *regionalism*, a theme that has since received



1.6 Taxonomy of environmentally determined building forms (after Olgyay 1963).

much critical attention, particularly in the writings of Kenneth Frampton,[6] and which has much significance in the field of environmental design. This, again, is a matter to which we will return.

Selective environmental design

The principles of 'selective' environmental design have their origins in the work of both Banham and Olgyay. Two important ideas come from Banham. First, the conviction that the problems of the present must be illuminated by a historical sense, that solutions in architecture cannot be fashioned only by the application of pragmatic, analytical processes. Second, the notion of 'modes' of environmental control and, in particular, the term 'selective' itself. From Olgyay, the greatest lesson is the fundamental principle that architecture is at its best when it is working *with* not *against* nature. That the severance of the historical symbiosis with climate was achieved at a cost to both architecture and nature.

In the definition used here, the term 'selective' was first juxtaposed with the alternative, and opposite, category of the 'exclusive' mode of environmental control. This distinction is summarised in Table 1.1. In this definition, the selective mode denoted the possibility of making a return to a rich relationship between climate and comfort in which a building is understood as a complex system of interrelated uses, spaces, materials, components and sources of energy.[7] The approach had the following principal aims:

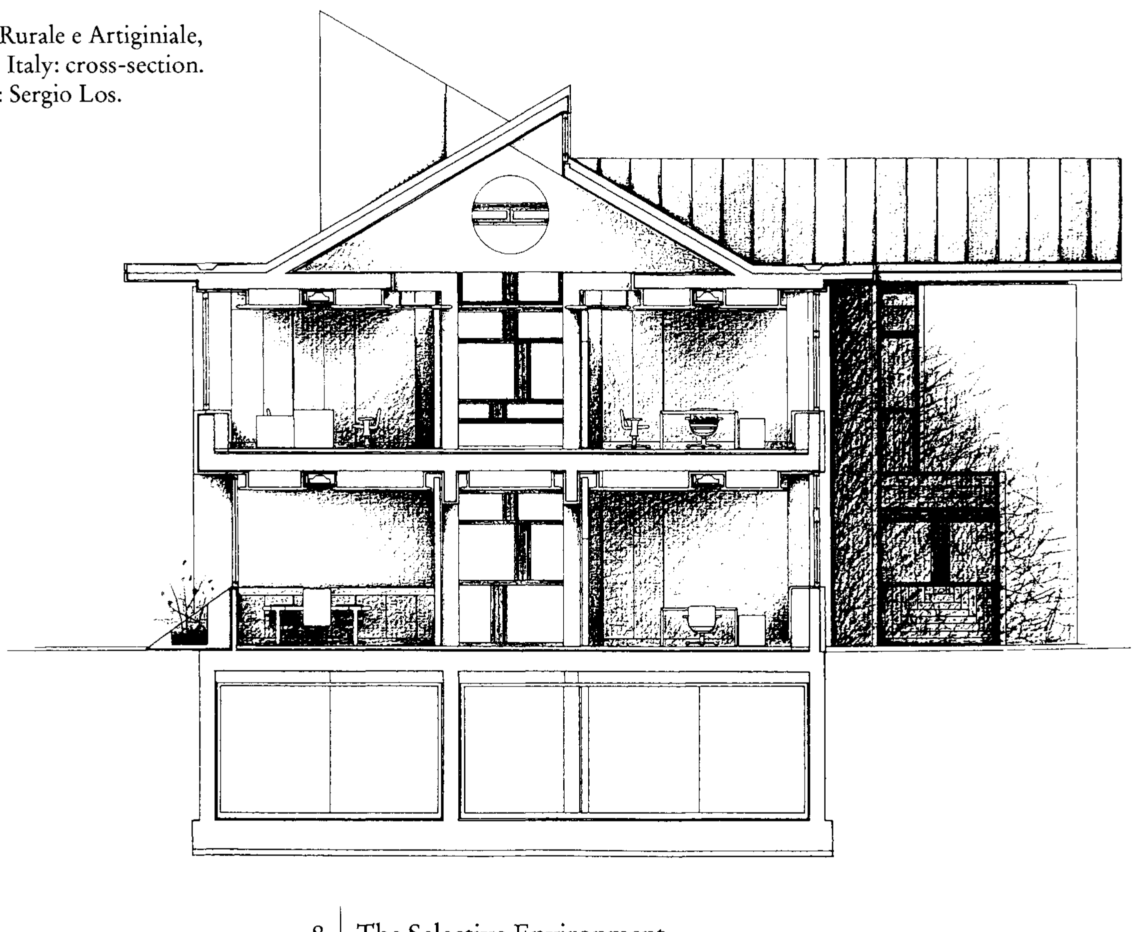
- To maximise the use of ambient, renewable sources of energy in place of generated energy.
- To minimise the use of energy-consuming mechanical plant in the processes of environmental control.
- To provide the users of buildings with the maximum opportunity to exercise control over their environment.

Table 1.1
General characteristics of exclusive and selective mode buildings.

Exclusive mode	*Selective mode*
Environment is automatically controlled and is predominantly artificial	Environment is controlled by a combination of automatic and manual means and is a variable mixture of natural and artificial elements
Shape is compact and aims to minimise the interaction between the internal and external environments	Shape is dispersed and aims to maximise the collection of ambient energy
Orientation is relatively unimportant	Orientation is a crucial consideration
Windows are restricted in size and are fixed	Windows are of variable size depending on orientation, room size and function. Solar controls are incorporated on exposed façades
Energy is primarily from generated sources and is used constantly throughout the seasons	Energy is primarily ambient supplemented by generated sources when essential. Use varies from season to season

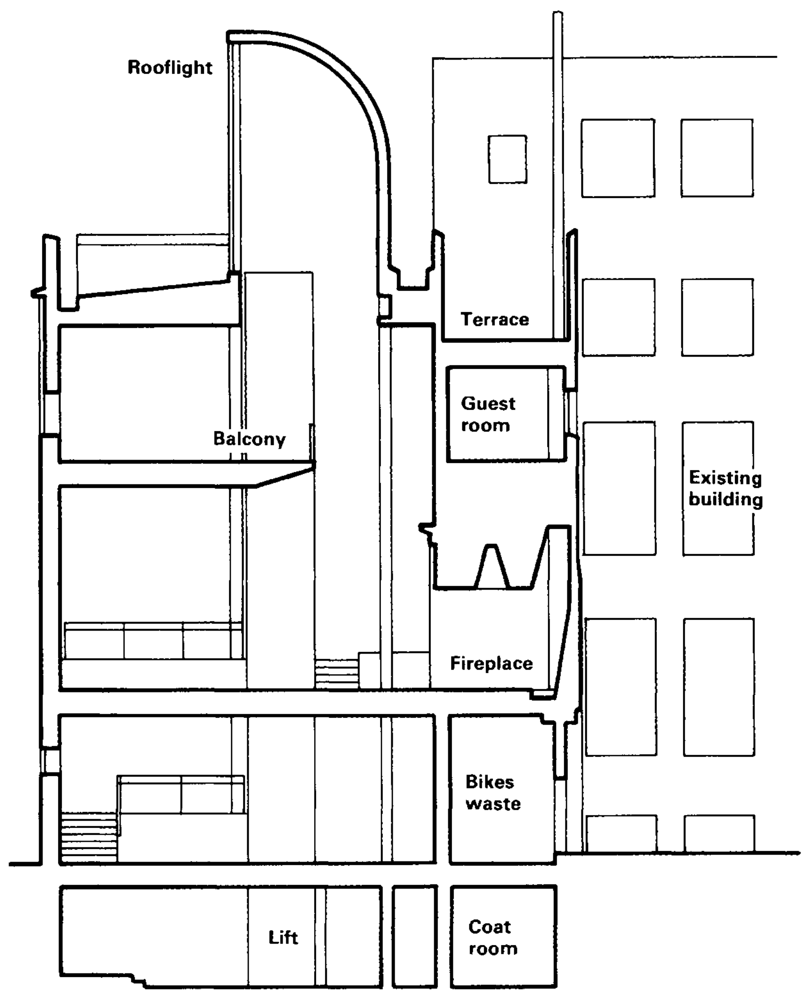
Climate response

As originally defined, 'selective design' was conceived with reference to the temperate climate of Northern Europe. This, with its relative absence of extremes, but with clear-cut seasonal variations, leads to a 'selective' architecture which expresses, in its form and detail, the environmental differences between northerly and southerly aspects, with plan, form and cross-section being relatively elaborate to maximise the interface between internal and external environments, and with glazing concentrated to the south to exploit useful solar gains to supply space heating in the winter months. From these factors, a distinctive architectural language emerges which is, in some respects, a formal analogue of the conditions of climate in which it is located. This is exemplified in the design of buildings such as the Casa Rurale e Artigianale in Brendola, Northern Italy, by Sergio Los (Figure 1.7) and the Danish architect Erik Sorenson's building for the Cambridge Crystallographic Data Centre in the UK (Figure 1.8). Both buildings demonstrate the importance of the cross-section in environmental architecture. Los's manipulation of the pitched roof form balances the admission of daylight with the control of unwanted solar heat gains in a manner which is in direct lineage from Andrea Palladio's sixteenth-century formulation of exactly the same problem of environmental response to the climate of the Veneto in the *I quattro libri d'architettura* (1570).[8] Sorenson also controls the cross-section of the Cambridge building to limit direct solar gains through the minimally glazed south façade and also to flood the interior with daylight captured by the soaring rooflight. Here, the section also promotes natural ventilation exploiting the stack-effect.[9]



1.7 Casa Rurale e Artiginiale, Brendola, Italy: cross-section. Architect: Sergio Los.

In extending these original principles to the global context, this specific relationship between form and environment must be reconsidered. At the higher latitudes where seasonal variations are marked and the major environmental goal is that of winter heating, the model remains valid, but as latitude reduces and summer temperatures increase, so the environmental priority shifts to address the need for summer cooling. Here account must be taken of the change in solar geometry, with all its consequences for the design and protection of window openings. This is precisely the range and variation of environmental response which Vitruvius described when he set out principles for design in the late Roman Republic, which at that time extended from Egypt to Northern France.



1.8 Cambridge Crystallographic Data Centre, Cambridge, UK: cross-section. Architect: Erik Sorensen.