

A STRUCTURALIST APPROACH  
TO THE  
CLIMATIC DESIGN  
OF THE  
BUILT ENVIRONMENT

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STATEMENT

I declare that this thesis is my own original work.

T. Maravelias  
April 1978



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## ABSTRACT

This thesis, as its title suggests, is primarily concerned with the potentials and the limitations of applying, from a design point of view, a structuralist paradigm to the study of climate and built environment interaction. It begins by examining a number of theoretical and methodological questions which pertain to architecture in general and to architectural climatology in particular and proposes a strategy organized within the epistemological context of structuralism as an alternative way of dealing with architectural climatological problems within the general process of production of the built environment. The work is presented in four interrelated parts:

Part I explains the need for approaching the climate-built environment interaction through the dialectics between its physical and its semantic dimensions; an approach which has been called here "ecoclimatic".

Part II examines systematically the conceptual structure underlying ecoclimatic phenomena and develops a taxonomic framework for these phenomena within the broader context of architectural empirical research.

Part III presents a brief review of the main research trends of architectural climatology and attempts to evaluate them with reference to the conceptual framework of the "ecoclimatic approach" developed in the previous parts. The discussion is also extended to certain areas of ecoclimatic research which suggest both the necessity and the possibility of establishing more comprehensive conceptual bases for

architectural climatological research and design.

Part IV is concerned with the development of a structuralist methodological framework for the study of ecoclimatic phenomena. It examines the applicability of different structuralist strategies to climatological problems of the built environment and, in a general sense, to broader architectural problems in terms of both research and design. The discussion is supplemented by two papers produced collectively by the author and his colleagues A. Awadalla and Dr T. Kotsiopoulos. These papers, published in 1976 and 1977, are included here in their original form as Appendix I and Appendix II respectively.

Finally, Part IV is followed by a chapter in which the general conclusions of the thesis are summarized and certain orientations for further research are proposed. These results suggest that the present microclimatic approach to climatic research and to the design of the built environment, though useful at certain levels, is on the whole inadequate to provide a comprehensive conceptual and methodological base for architectural climatology. It is suggested that this inadequacy cannot be effectively overcome simply by an increase of research activity within the present microclimatic framework of research, but only through careful considerations of the semantic dimension of the climatic problems of the built environment. The ecoclimatic approach has been developed on the basis of these considerations and it is proposed here as a comprehensive conceptual and methodological framework for architectural climatological research and design. The conclusions reached in this thesis are theoretical in nature and they are intended to provide additional research and design tools for the study of the climatic problems of the built environment rather than to give answers to these problems in the form of final statements.

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## GENERAL INTRODUCTION

### THE EPISTEMOLOGICAL PROBLEM

This work deals with some basic methodological problems concerning the interaction of climate with the built environment and, in a more general sense, the integration of physical environmental factors in architectural and environmental design.

The emphasis on methodology has been the outcome of a number of theoretical observations made during the development of the thesis which will be presented and discussed in detail in due course. Most of them are referred predominantly to the absence of methodological frameworks in architectural climatological research. At present these are insufficiently developed to provide adequate possibilities for studying architecturally significant climatic problems in an effective architectural design language.

The above statement does not mean to suggest that the literature of architectural and building climatology lacks the theoretical formulation of climatic problems of the built environment which are of significance in architectural practice. Such an interpretation could have been easily refuted in the light of works carried out by E.J. Aronin (1953), V. Olgyay (1963), B. Givoni (1969, 1976), J.M. Fitch (1972) and others. What is meant is that, in spite of the overwhelming number of theories *in* architectural climatology there is no comprehensive methodological framework on the basis of

which theories *of* architectural climatology could emerge.

The distinction between theories *in* architectural climatology and theories *of* architectural climatology is an important and, at the present juncture, a crucial one; and a major part of this thesis is orientated towards a close examination of its epistemological and methodological implications in the study of climate and built environment interaction.

Theories in architectural climatology refer to those theoretical formulations and solutions of architectural climatological problems which are principally organized within conceptual frameworks originated outside the domain of architectural empirical research and "imported" to architectural climatology as convenient theoretical instruments of research. On the other hand, theories of architectural climatology are those theoretical formulations and solutions of architectural climatological problems which are organized on conceptual bases originated either within or in close reference to the total framework of architectural empirical research.

I will show, in due course, that the proposed methodological shift from "theories *in*" to "theories *of*" architectural climatology is both significant - in terms of providing an alternative which could effectively bridge established research or applicability gaps in the field - and possible - within the epistemological conjunction which surrounds architecture, as a social science, today. Consider, for instance, some of the reasons for which this methodological shift is of importance. A theory in architectural climatology related, for instance, to 'thermal performance of buildings', or to 'health and comfort standards in buildings' may provide solutions which, though correct in terms of the theory, may, at the same time, be

unsatisfactory or inapplicable at the higher synthetic levels of design action. An explanation might be that validation of a given solution to a particular climatic problem cannot be achieved on the basis of theoretical postulates which are "imported" to architecture from other scientific areas, but only within a comprehensive domain of "architecturally significant" empirical data. Nevertheless, even if a theory in architectural climatology succeeds in providing theoretically a comprehensive solution to a particular range of climatic problems, this solution might lose its comprehensive character (and usually does so) at the level of design action, since imported theories in architecture, due to their origin, do not take fully into account the potentials and the limitations of practical design action. Finally, theories of architectural climatology should be in a position to provide much more comprehensive approaches to climatic problems since they would provide synthesizing instruments of research operating simultaneously at two required levels of integration: integration in climatological terms - by considering the interaction of different climatic fields and by weighting their relevant significance for the architectural environment - and integration in architectural terms - since validation depends on a much wider spectrum of architectural empirical phenomena than the purely climatological ones.

The methodological distinction introduced above becomes more urgent if it is considered within the broader context of architectural theory in general. The history of architectural theorizing since Vitruvius and the more recent ones of architectural research, are characterized by a plethora of (imported) theories in architecture, while recent attempts to develop theories of architecture are very

limited and may be identified with attempts at establishing disciplinary frameworks for architectural research.

The argument introduced so far has indicated the orientation and the nature of the research described in this thesis. However, the development of a complete theory of architectural climatology undoubtedly falls outside the time framework of a PhD thesis and what is intended is to provide a "conceptual framework" within which attempts to develop theories of architectural climatology could be fertilized and be resolved through long-term theoretico-practical research.

To summarize the basic arguments in this thesis: (i) there are enough signs of maturity in architectural research, in general, and in architectural climatological research, in particular, to indicate both the necessity and the possibility for a methodological framework for theories of architectural climatology to be developed; and (ii) due to the complexity resulting from the high degree of generality and integration required for the development of such a framework, a methodological shift from the commonly adopted analytical approaches to more comprehensive structural ones becomes imperative. In the following paragraphs I will try to present a preliminary account of the structure of the thesis and, in addition, to explain further my second basic argument of the necessity to develop a structural approach to the problems emerging from the climate-built environment interaction. First, however, it will be useful to summarize briefly some additional points which influenced the aim and the orientation of the work.

## THE STRUCTURALIST APPROACH

In the course of developing this study on the climatic problems of the built environment, it became clear that a satisfactory understanding of the architectural significance of these problems and the evaluation of those processes by which climate and weather influence human habitation and contribute to the general organization of the built environment, cannot be adequately and comprehensively achieved without first understanding those processes by which people attach meaning to climatic phenomena within a broader architectural context.

Unfortunately, the relevant literature of architectural and building climatology suggests that, apart from certain partial studies, no serious attempt has been made, so far, to study the semantics of the climatic fields in an integrated and architecturally comprehensive manner. Furthermore, architectural research, dealing especially with phenomena of the physical environment, presents a serious drawback in its inability to realize either the significance of transforming "imported" knowledge from other scientific fields within its own disciplinary domain or the significance of the semantics of physical phenomena to generate architecturally meaningful explanations for the organization of the artificial environment. It has been, therefore, a fundamental aim of this study to examine the possibility of developing a comprehensive and integrated approach to climatic phenomena of the built environment, by which the architectural relevance and importance of these phenomena can be thoroughly identified and evaluated.

It will become gradually apparent that the majority of the methodological problems which are discussed and analysed in this work, for instance, terminological, taxonomic, descriptive and so forth,

although specifically related to climatic phenomena of the built environment, are also significant and central in examining, at a more general level, problems concerned with a wider spectrum of the physical environment. Thus, it follows that the general methodological framework developed here is in many respects applicable to a wider range of physical phenomena than the title of the thesis suggests. Nevertheless, beyond the fact that, due to their general formulation, certain major arguments are referred to a wider range of physical phenomena rather than strictly climatic ones, no particular effort has been given here to expand the applicability of the work to phenomena other than those which are, in one way or another, climatically relevant.

Architecturally relevant climatic phenomena are considered here to be all these phenomena which are produced by the mutual interaction between climate and buildings and which affect people in different ways and on various levels. Therefore, a major assumption which provides the core theme in most of the arguments in this work is that the study of climate - architecture interactions can only be studied adequately in a general methodological framework within which integrated "anthropocentric" approaches to the various climatic problems of the built environment can be organized. Accordingly, what the work ultimately suggests and hopes to prove is that, in contradistinction to the line followed by almost all modern architectural and building climatological research, it is both necessary and possible to develop an anthropocentric methodological framework in order to study effectively problems of architectural climatology. It is "necessary", in order to achieve the degree of integration and comprehensiveness required to make the formulation of climatic

problems of the built environment architecturally significant, and it is "possible" within the philosophical and methodological context of structuralism.

Within this context, the conventional approaches established in the literature of architectural and building climatology, by which it is possible to study a physical mapping of the climatic environment into the microclimatic conditions created or modified by the built development in various scales - by simply using climatological, meteorological and physical languages - are not considered here to be anthropocentric and to fulfil the requirements of architectural practice. An approach (called, in this work, the "microclimatic approach") essentially developed within a mode of relational logic, can only, at best, be developed at some stage to become "man-related", through systems of evaluation applied to that mapping in an *a posteriori* way; but it is not anthropocentric. What is necessary is the development of approaches on the bases of both the human perception and understanding of the "microclimatic mapping" and the architectural processes by which such a mapping is produced by the *a priori* involvement of systems of human evaluation. I have called this approach the "ecoclimatic approach" to the built environment. Through it, the semantics of the physical fields of climate and microclimate, which dominate human reaction and behaviour towards them, become central to the identification and description of the ecoclimatic mapping of the built environment. Consequently, such a mapping cannot be defined by its microclimatic characteristics alone, but only within a much broader conceptual framework where the general processes of producing the architectural environment are taken into account.



The existing literature on architectural and building climatology and its main research orientations considers the interaction of man with the ecoclimatic environment at many different levels. These can be categorized roughly in two sets: (a) levels at which man is considered as a biological being of a mechanistic type, and (b) levels at which man is considered as a person, that is, as a psychological, sociological, cultural and ecological entity. These categories are not exclusive and, consequently, isolation within any or some of the levels can only be justified by strict methodological requirements organized by the assumptions and the specific objectives of each particular study. However, it is important to point out that the shift from the most simplistic and isolated levels to the more generalized and comprehensive ones is accompanied by an increasing capacity of research to formulate more appropriate contexts within which meaning and value can be attached to climatic and other physical phenomena of the built environment.

The absence of any systematic building climatological research programme conducted at the higher socio-cultural levels and within an architectural disciplinary framework, makes any attempt to study the meaning or the pragmatic value of climate a difficult task. At the same time there is an obvious awareness among architects and building climatologists of the inadequacy of the present conceptual framework for providing grounds for further development and understanding of the climatic organization of the built environment. The recognition of these points has orientated the thesis towards a "proper" methodological framework in which the description and evaluation of climatic phenomena can be achieved within the broader framework of architecture. It is very important to recognize that only in relation

to the general nature of architectural phenomena and, particularly, to those complex processes which account for the organization of the built environment as a whole, can climatological information be transformed into "effective knowledge" for the designer of the built environment. As a result of this, building climatology has to extend the spectrum of its research considerably in order to be able to incorporate the kind of interdisciplinary conceptual frameworks which are inevitable if this transformation is to take place.

Although interdisciplinary considerations of this nature and complexity have become popular in recent developments of architectural theory, they are inclined to lose their descriptive value (and become "puzzle-solving" rather than "problem-solving" activities) if they do not consider seriously the increasing conceptual complexity in which they result and the methodological requirements that they imply. Such levels of complexity demand, for instance, "proper levels of abstraction" in order to be resolved and to acquire an explanatory and a problem-solving capacity, both of which are necessary for effective action upon the architectural environment.

In a more general sense, the context within which methodological requirements can be derived is concerned with the manifested conflicts between design theory and design practice; that is, between the normative prescriptions of how design "should be done" and the actual way in which design "is commonly done". Explanatory theories concerned with the organization of the physical elements of the built environment do not pay much attention to the synthetic levels at which design action occurs in practice. The general methodology dealing with the physical organization of the built environment (including the climatic one) generally assumes a rationalization of design action which in many respects conflicts with the prestructuring of the design solution

and the intuitive use of prototypes by the architects. It appears that this conflict, which is part of the so-called "applicability gap", reaches its maximum at the higher synthetic levels appropriate for design action. Accordingly, the materialization of the design solution has to follow its own practical procedure which usually deviates considerably from the described norms of the theory.

Architecture is commonly acknowledged today to be a social science, and so it has the responsibility not only of explaining the products of its practice, but also the processes by which they are produced. Nevertheless, "rationalized methodologies" have repeatedly failed to comply with this requirement. The present work argues that, within the broader methodological framework of "structuralism", architectural theoretical methods can be equipped with the necessary links to practice, not in attempting to scientificise practice (as the present epistemology of architecture seems to assume) but in shifting the theoretical method closer to the empirical processes of practice. This general method of "theoretical-practice" has already proved useful in other fields of social sciences where their general epistemology is dominated by social rather than scientific paradigms.

From the argument above it will have become apparent that the orientation of the research described in this thesis is twofold. In the first place, the investigation has been orientated towards a comprehensive description of the phenomena of the built environment which might be of direct interest to architectural climatologists. In the second place, the investigation is further orientated towards a methodological framework for studying environmental structures of the built environment within the multidisciplinary domain in which architectural actions operate, in order to create or to modify these

structures. The whole investigation, however, has developed in a dialectic manner between the study of physical phenomena - mainly, but not exclusively, related to the climatic aspects of the built environment - and the broader methodological requirements of architectural research as a whole.

Accordingly, many of the arguments in this thesis and especially those of Part IV can be viewed in two different ways. The first way is from the point of view of the architectural climatologist. In these terms the arguments are particularly concerned with the question of whether empirical studies on building climatology could benefit by adopting the kind of the methodology developed in this work, and in what sense. The second, and much more general way (and this refers especially to Part II and Part IV) is from the point of view of the architectural theoretician; and in these terms the arguments are concerned with questions of whether structural methodology as applied to architecture can benefit from the study of climatic and other physical problems of the built environment. It should be stressed, however, that it is important for the work as a whole to consider these two ways of viewing the arguments, not as two conceptually different lines of thought, but as interrelated aspects of a bipolarity, the development of which depends on the development of their mutual interaction. For instance, an expression of this bipolarity may be the mutual interaction between: (a) the introduction of the dialectics between physical climate and its dynamic meaning, and (b) the search for an appropriate methodological framework, in which these dialectics can be developed into a particular language which can be operationally useful at the higher synthetic levels of design action (which undoubtedly deals simultaneously with a much more complex set-up than that of the climatic one).

It is obvious, therefore, that the search for a methodological framework has to proceed simultaneously with the study of the specific object: the climate of the built environment. In turn, this means that no structural methodology can be assumed in an "ad-hoc" manner, and that such a methodology cannot be induced from other spheres of application alone, but only in relation to the empirical domain of facts related to the specific object of the study. Thus, the methodology of structuralism developed here is evolved in "contextual" terms rather than on an "inductive" basis, as has happened with previous applications of structuralist methods in architecture. The linguistic model, for instance, either in its Saussurian (semiological) or in its Chomskian (generative) modes is not directly applicable to architectural systems, or to other systems of human culture outside the linguistic ones. This work, therefore, takes a critical look at both "semiological" (socially meaningful) and "genetic" (general and abstract) structuralism so far as their application to architectural phenomena, in general, and to ecoclimatic ones in particular, are concerned.

The linguistic structural paradigms are strong and their impact on any methodological discussion involving structuralism is very influential. However, the present work stresses the point that it is only in relation to a "contextual" approach to architectural methodology that both the limitations and the potentials of established structural paradigms can be evaluated and above all acquire their operational character by means of their fusion into a "contextually defined structural framework".

## THE STRUCTURE OF THE THESIS

The fifteen main chapters of the thesis are organized in four Parts.

Part I, comprising Chapters 1 and 2, examines the "ecoclimatic" nature of architectural climatological problems. The concept of "ecoclimate" is the key one in most of the arguments developed here. A first definition of this concept is attempted on p.<sup>28</sup> and its methodological implications for architectural climatological studies are the major object of investigation throughout the thesis. In short, the concept of ecoclimate - and, subsequently, its terminological derivatives, "ecoclimatic phenomena", "ecoclimatic prototypes", etc. - is evolved from an attempt to describe comprehensively and in a unified manner the significance of the dialectics between the physical and the semantic nature of the climatological problems of the built environment.

The discussion in Chapter 1 deals with the basic climatological terminology and taxonomic modes to be found in architectural climatological studies and raises a number of questions about their relevance to the nature of architectural climatological problems. The outcome of this discussion can be briefly summarized in the following three points:

- (i) The imported terminology and taxonomy currently used in the study of architectural climatological problems are, in many respects, irrelevant to the nature and character of these problems, as well as to the needs of designers of the built environment.
- (ii) Current research on building climatology and in other fields



of applied climatology, such as bio-climatology, econo-climatology, socio-climatology, provide enough evidence to support the argument that social values are becoming inherent in applied scientific research, a fact which suggests a more critical look at the knowledge "imported" into architecture, which is directly derived from a purely physical climatological context.

(iii) As a result of (i) and (ii) a new conceptual approach to the climatic phenomena of the built environment is introduced under the term "ecoclimatic approach".

Chapter 2 gives a historical explanation of the ecoclimatic approach. The examination of a number of factors that mediate the interaction of man and his buildings with the climatic environment of his habitat, has resulted in the formulation of the core argument of this chapter. This argument suggests that man in history has always conceived and described the influences of the climate and of the physical environment in ecoclimatic terms, that is, by internalizing complex ecoclimatic prototypes in the structure of which social, economic, religious and physical (together with climatic) aspects have been integrated. In addition, the discussion in Chapter 2 develops the hypothesis that the existing distinction between socio-cultural and physical phenomena, as far as the conceptualization of the built environment is concerned, is not always valid. In many respects this distinction prevents a comprehensive description of the processes that are involved in the production and transformation of complex architectural phenomena, such as ecoclimatic ones. In turn the above hypothesis offers another objective for the present work, that is an examination of the possibility of formulating conceptual and methodo-

logical frameworks within which it could become testable.

Part II, made up of Chapters 3, 4 and 5, sets out to develop a taxonomy of ecoclimatic studies within the broader framework of architectural research. It was argued earlier in this Introduction that a methodological framework intended to provide theories of architectural climatology can only be developed in close relationship to the broader spectrum of architectural empirical research and data.

In particular, Chapter 3 provides some further epistemological arguments, mostly of psychological origin, which point to the significance of studying the climatological problems of the built environment both within an ecoclimatic conceptual framework and in a broader architectural one.

Chapter 4 gives a systematic analysis of ecoclimatic phenomena by proposing an abstract but commonly shared basis for considering architectural climatological problems, called here "ecoclimatic conceptual schema". The ecoclimatic conceptual schema is investigated in terms of its systemic organization and in terms of the different relationships generated by the interaction of its three conceptual domains: climate, buildings and man. The chapter also defines the basic complexity levels in which the ecoclimatic conceptual schema is generated and examines the methodological implications at each of the defined complexity levels. Finally, the overall examination of the ecoclimatic conceptual schema results in a more precise formulation of the two major methodological assumptions adopted in the thesis for further elaboration. First, that at the higher levels of ecoclimatic complexity - where the climatological problems of the built environment are more adequately represented - the logical shift to structural methodologies becomes an inevitable requirement. Secondly, the



investigation of ecoclimatic phenomena, at the higher level of logical complexity, requires the formulation of specific ecoclimatic descriptors within the broader framework of architectural empirical research.

Chapter 5 proposes a method of organizing ecoclimatic studies within a general taxonomic framework of architectural research. It does so by first examining the concept and the general nature of architectural complexity. I have argued that problems of complexity when referred to the organization of ecoclimatic phenomena within the context of architectural research belong, in their greatest part, to the higher form of logical complexity. Secondly, in developing the taxonomic framework it became apparent that significant areas of ecoclimatic research - some of which are almost entirely neglected in the present literature - could be identified, described and evaluated in relation to both the logic implied by the ecoclimatic conceptual schema and the paradigm offered by the framework of architectural research as a whole.

Part III (Chapters 6, 7, 8 and 9) reviews a number of architectural climatological studies in an effort to stress the necessity of integrating them within the broader areas of established architectural empirical research. In this context, it became important to study some newly developing areas of research and particularly those of psycho-climatology and socio-climatology, and to evaluate their starting premises and orientations in relation to the taxonomic model of architectural research presented earlier. Emphasis has been given to the methodological aspects of these research programmes and certain arguments have been raised which are concerned with their efficiency in dealing comprehensively with the major ecoclimatic problems,

particularly at the level of design.

Chapter 6 looks at the notions of "modification" and "transformation" of ecoclimatic phenomena, and provides a general reference base for the next three chapters.

Chapter 7 reviews and evaluates a number of theoretical and empirical studies concerned with problem-situations resulting from the climate-building interaction.

Chapter 8 reviews and evaluates the major postulates of research related to the "climate-man" interaction in both physiological and psychological terms.

Chapter 9 considers some very recent orientations of building climatological, socioclimatological and ecological research which clearly suggest both the necessity and the possibility of establishing more comprehensive conceptual bases for architectural climatological research.

In Part IV, I have attempted to develop a comprehensive framework for architectural climatological research. Following the methodological conclusions reached in the previous parts of the thesis, Part IV reflects an effort to develop a structural approach to architecture in general, and to architectural climatology in particular, sufficient to explain not only the products of architectural activity, but also the processes by which these products are produced.

Chapter 10 discusses the epistemological origins of the "social paradigm" - the significance of which for architectural research has been examined earlier in Chapter 9 - and its descriptive methodological beyonds which are assumed in this thesis.

It is, however, in Chapter 11 that the methodological implications of the social paradigm are incorporated within a broader strategy where the complementarity between comprehensive frameworks of research and structural methodology becomes apparent. In this chapter the discussion is developed further to examine and evaluate - on the basis of the multidisciplinary nature of architectural phenomena - the two major structuralist approaches; genetic structuralism, and semiological structuralism.

Chapters 12, 13 and 14 elaborate on the applicability of different structuralist methodologies to architecture and particularly to ecoclimate and, in addition, explain the terminology of these approaches through particular microclimatic and ecoclimatic examples.

Chapter 12 examines and evaluates the application of a purely semiological approach to ecoclimate and points out the mechanisms by which appropriate levels of meaning can be identified, and further, it stresses the limitations of analytical semiology at the complex levels in which the ecoclimatic structure is generated.

Chapter 13 supplements the discussion of Chapter 11 and deals further with a syntactic (general and abstract) approach to the microclimatic and ecoclimatic structures of the built environment. Also, it examines the limitations of purely abstract descriptive bases in generating architecturally meaningful explanations of these phenomena.

Chapter 14, which is based on the methodological conclusions reached in the previous two chapters, develops an appropriate structural framework for ecoclimatic studies - and in a more general sense, for architectural research - which in this work has been called a "syntagmatic structural framework".

The discussion in Part IV is supplemented by two more papers which have been produced collectively by the author and his colleagues, A. Awadalla and Dr T. Kotsiopoulos. These papers were published in two separate articles: (i) "Description and Descriptors in Architecture", Edinburgh Architectural Research, Vol.3, 1976; and (ii) "Description and Descriptive Theories in Architecture", Edinburgh Architectural Research", Vol.4, 1977. These papers are included in this thesis as Appendix I and Appendix II respectively. In particular, Appendix I presents the core arguments and the methodological philosophy on the basis of which this part of the thesis has been either modified or further developed. The paper which appears here as Appendix II originated during the later stage in the development of this thesis, supplements Appendix I and, to a lesser degree, the methodological framework developed in Chapter 14 of the thesis, for the study of ecoclimatic phenomena.

Finally, Part IV is supplemented by Chapter 15, in which the general conclusions of the thesis are summarized, followed by criticism of the work and suggestions for future research on the ecoclimatic approach and on the methodology of architectural research as a whole.

## PART I

### THE ECOCLIMATIC NATURE OF ARCHITECTURAL CLIMATOLOGICAL PROBLEMS

#### CHAPTER 1

NOTES ON THE TERMINOLOGY AND THE INFORMATION CONCERNED  
WITH THE STUDY OF THE CLIMATIC PROBLEMS OF THE BUILT  
ENVIRONMENT

#### CHAPTER 2

THE ECOCLIMATIC CONCEPTUALIZATION OF THE BUILT  
ENVIRONMENT IN A HISTORICAL PERSPECTIVE

## CHAPTER 1

### NOTES ON THE TERMINOLOGY AND THE INFORMATION CONCERNED WITH THE STUDY OF THE CLIMATIC DESIGN OF THE BUILT ENVIRONMENT

#### 1.1 INTRODUCTION

In the Introduction to the thesis I have attempted to give a rather lengthy account of the nature and structure of the present work and the type of phenomena with which it mainly deals. It might have already become apparent that a primary difficulty in this study is related to the identification and description of the various phenomena, whose architectural relevance I shall try to examine in the course of its development. It may also have become apparent that the multi-disciplinary nature of the background information directly or indirectly related to these phenomena presents a number of terminological and taxonomic problems.

These problems and difficulties necessitate an attempt to clarify some basic climatic concepts and to evaluate their relevance in the context of this work. Information about these concepts, which could be of interest to people professionally involved in the production of the built environment, may be found on a number of bases ranging from the purely physical descriptions of climatic phenomena to the more integrated socio-economic considerations of the interaction between climatic phenomena and man or his activities and functions. Thus, approaches to the definition and taxonomization

of climatic related concepts may differ in terms of the scale (in space or time) of the climatic phenomena considered, the number and type of climatic elements involved and the overall methodology employed.

This chapter presents a terminological discussion concerned with the basic climatological and meteorological concepts. These are, mainly, 'climate', 'weather', 'microclimate' and 'ecoclimate'. The discussion develops in three sections. The first gives a brief account of these concepts within a strict climatological and meteorological context. The second section discusses some of the established scientific areas of applied climatology which are more contiguous to building climatology. The third section presents some existing taxonomic frameworks related to human climatic classification systems and examines their relevance to architecture. Finally, a definition of the concepts of "microclimate" and "ecoclimate" is reached in the conclusions, for use as conceptual bases for further elaboration and development.

## 1.2 MICROCLIMATE AND ECOCLIMATE

The concept of "climate" may be defined as the characteristic weather conditions of a locality, or region, averaged over an extended period of time (usually over 30 years). In respect to this definition meteorologists represent climate by the mean values of its physical parameters. More recent approaches within the context of a "dynamic climatology" have produced more sophisticated methods of looking at climate by defining it as "a summation of weather types each of which having a characteristic frequency distribution

over the averaging period"<sup>1</sup>. The advantages of the second definition are that it permits judgements to be made about how the climatic variables interact with each other and thus a more integrated and dynamic view of climate can be achieved.

"Weather", on the other hand, is defined as the general atmospheric conditions (temperature, humidity, precipitation, winds, radiation, etc.) at a given place at a given time. In the everyday language weather is described more meaningfully by terms like "wet", "fine", "warm", "cold", "chilly", "rainy", and so on, but since certain activities were recognized as weather sensitive economically (e.g. industry, transport, agriculture) a specific symbolic language was developed in meteorology. However, the distinction between "climate" and "weather" is not always clear. Since climate is a time average of weather the distinction fades when we are concerned with short intervals of time where averages are not always meaningful.

Generally, the word "climate" has meaning when incorporated in an expression of the form "the climate of ...". Thus, terminologically, climatological concepts are strongly influenced by the size and characteristics of the area the climatic conditions of which they intend to describe and, also, by the time reference of this description. The directly "imported" climatological terms in environmental studies which are referred to climate are macroclimate, mesoclimate and microclimate, while a number of transformations of these have been made, in the various areas of applied climatology, to produce terms like city-climate, urban climate, ecoclimate, teleo-climate and so on.

1. See M.I.T.'s report of the Study of Man's Impact on Climate (S.M.I.C.), published under the title Inadvertant Climate Modification, M.I.T. Press, 1971, p.28.



"Macroclimate" referred to also as "regional climate" or "geographical climate" reflects directly the standard meteorological measures and methods, and it is more or less equivalent to the term climate. "Mesoclimate" refers to a local climatic effect due to terrain, extending in influence over several kilometres and vertically one or two hundred metres, contrasting with the macroclimate. "Microclimate" was first introduced as a concept in 1927 by R. Geiger who defined it as "the climate near the ground" or "climate in a small space"<sup>2</sup>. More recent attempts define "microclimate" as "the climate, no matter how small, in the immediate vicinity of an object or an organism"<sup>3</sup>. Other definitions define "microclimate" as "a local climatic effect on a small scale from a metre to a kilometre horizontally and up to tree or house height"<sup>4</sup>.

In the fields of applied climatology, however, there is no commonly accepted definition of microclimate and even more the term has acquired a number of homonymic and synonymic associations. For instance, microclimate is used to describe "the climate underneath clothing"<sup>5</sup>, "the habitat climate"<sup>6</sup>, "the climate of a building site in a scale of 10 to 100 metres"<sup>7</sup>, the "climatological sheath"<sup>8</sup>,

2. GEIGER, R., (1965), p.2.

3. GATES, D., (1972), p.3.

4. See, for instance, GILPIN's Dictionary of Environmental Terms, GILPIN, A., (1976) p.103.

5. BATES, M., (1966), p.393.

6. GEIGER, R., (1965), p.2, and in an appropriate architectural context see FITCH, J.M., (1972), p.243.

7. PAGE, J.K., *Weather as a Factor in Building Design and Construction*, in BURGESS, R.A., HORROBIN, P.J., and SIMPSON, J.W., (eds.), *Progress in Construction Science and Technology*, Medical and Technical Publishing Co. Ltd., 1971, pp.74-75.

8. See M.I.T.'s report (S.M.I.C.), *op.cit.*, reference to RYD, H. (1970), p.152, and RYD, H., (1972), p.71.

the "climatological dome", the urban "thermal and pollution plume"<sup>9</sup> and also, "the milieu of the yard, the street or the neighbourhood ... the only true measure of this level of human (climatic) experience"<sup>10</sup>, etc. On the other hand, other terms have been used to describe similar situations like "teleoclimate" (the microclimate at the boundary between living organisms and the environment)<sup>11</sup>, "ecoclimate" (the climate of the habitat affected by building, shelter and habitat)<sup>12</sup>, "indoor climate" (confined within the building envelope), "cryptoclimate" (the climate within distances of a metre from the building envelope)<sup>13</sup>, etc.<sup>14</sup>.

Within a pure climatological framework the term "ecoclimate" was first referred to by Geiger as synonymous with "local climate", "topoclimate" or "climate near the ground", that is, with "microclimate"<sup>15</sup>. The term does not appear frequently in texts of climatology or even of applied climatology and when it does so its use remains quite ambiguous. The origin of the term has been influenced by the Greek terminology "οἰκο-κλίμα", but its usage has failed most of the time to transfer the meaning of the first component "οἰκο-". "Οἰκο-" comes from the verb "οἰκίζω" which means 'I create a living space'; a habitat which might range from a house (οἶκος) to

9. M.I.T.'s report (S.M.I.C.), *op.cit.*, p.152.

10. FITCH, J.M., (1972), p.244.

11. GILPIN, A., *op.cit.*, p.159.

12. BATES, M., (1966), p.393.

13. PAGE, J.K., *op.cit.*, The term "cryptoclimate" was first used by GEIGER, (1965), p.484, to describe the climate of completely or partially enclosed spaces and in this way becomes synonymous with the term "indoor climate", while Page's concept of "cryptoclimate" describes the climate in the immediate vicinity of a building, that is the climate of its "climatological sheath".

14. Obviously, much of what has been included above in the concept of "microclimate" should properly be called "micro-weather". However, for reasons of simplicity I prefer here the generality of the term microclimate as being more appropriate in distinguishing between climatic and ecoclimatic phenomena in architecture. Nevertheless, whenever a distinction should be drawn between microclimate and micro-weather the difference is clearly indicated.

15. GEIGER, R., (1965), see his Index p.603, and pp.2,455,456.

a town (οικισμός). Thus, 'βικόκλιμα' becomes a dynamic term describing both the different scales of climatic conditions to which it refers and the creation of the climatic environment of the human habitat. Although there is some connection, the term should not be taken to denote the "ecological climate" as Bates<sup>16</sup> suggests, but it might be used as a comprehensive term for "indoor climate", "building climate" and "urban or city climate", that is, climates that have been created intentionally or otherwise by the conscious act of "building". These also constitute the spatial scales proposed and adopted here for the term "ecoclimate".

It becomes obvious from the above discussion that both terms "microclimate" and "ecoclimate" have not generally acquired a commonly acceptable meaning in the literature of climatology, meteorology and their applied sciences. Accordingly, the terms have to be redefined in the context of each particular field of applied climatology, in close relationship with the type of phenomena with which this field is dealing. In the case of architectural climatology this has been done - but still unclearly - only for "microclimate", thus it becomes one of the aims of this thesis to describe and define ecoclimate in relation to architectural phenomena.

The reasons for which I introduce the concept of ecoclimate as a supplementary and more comprehensive than those of "microclimate", "indoor climate", "urban climate", etc., currently used in building climatology, are discussed in many respects throughout this thesis. However, it might be advantageous to summarize some of these reasons - even partially - in the following argument.

16. BATES, M., (1966), p.393.

First, let me distinguish conceptually between two types of environments, the physical and the artificial, both of which constitute the "architectural environment" in the broader sense. The physical environment - which includes the natural environment - is definable and describable within the conceptual framework of physics. On the other hand, the artificial environment refers to that component of the architectural environment which is produced or largely modified by a variety of human actions upon the physical environment. In this way, the artificial environment - part of which is the built environment - as a product of either organized or unorganized sequences of human actions, requires a much broader conceptual framework.

The problem of organizing those elements of the built environment which directly interact with our perception of it, belongs to the core of every architectural activity either practical or theoretical. Whether or not we accept architecture as a "learning mechanism" a kind of "environmental grammar", it becomes very important to study the perceptual organization of the built environment within the broader framework defined by the processes by which this environment is produced. To study the perceptual organization of the built environment means to study those elements of it which interact with our "visual", "thermal", "spatio-gravitational", "auditory", etc., perceptual systems. Most of these systems interact with the climatic elements of the built environment and it is a major task of architectural and building climatology to study this interaction carefully.

Within this context, the process of studying the "physical mapping" of the transformations of the macroclimatic environment to the climatic conditions which are created or modified by the built

environment (in different scales), by using the language of physics and specifically of climatology and meteorology, is the process of studying the microclimate of the built environment<sup>17</sup>. On the other hand, the process of studying the human perception and understanding of both the "microclimatic mapping" and the architectural processes by which it has been produced is the process of studying the eco-climate of the built environment. Thus, ecoclimate reflects the semantics of the physical fields of climate and microclimate which dominate human reaction and behaviour towards them and, therefore, cannot be defined by its microclimatic characteristics alone, but only within a much broader conceptual system where the general processes of producing the architectural environment are taken into account<sup>18</sup>. Examples from the history of architecture and the contemporary architectural practice can be used to support the argument that ecoclimatic rather than microclimatic conceptualization of the built environment accounts for a successful climatic organization of the habitat from the scale of the house to that of the settlement<sup>19</sup>.

### 1.3 FIELDS OF APPLIED CLIMATOLOGY RELATED TO ECOCLIMATIC STUDIES

I intend to examine some of the fields of applied climatology, including building climatology, which, in my view, strongly suggest (though without explicitly stating so) the need to consider the man-

17. *Microclimate is used here in its broadest sense to describe comprehensively different climatic arrangements, for instance, indoor climate, climatological sheath, urban climate, etc.*
18. *The concepts of "microclimate" and "ecoclimate" are further explained through particular examples during the development of the thesis in the next chapters, but they are redefined, within a rather rigorous methodological framework, in Part IV where appropriate levels for describing these concepts are formulated.*
19. *Historical examples are given in Ch.2, Part I, while examples of successful contemporary architectural practice - microclimatically and ecoclimatically speaking - are discussed in Part III.*

climate interaction within the ecoclimatic context suggested above. These are the well established fields of Bioclimatology, Econo-climatology and Building Climatology and the newly developing field of Socio-climatology.

### 1.3.1 Bioclimatology

Bioclimatology investigates the dependence of plants, animals and particularly of man on climatic and weather processes. Human Bioclimatology may be divided into three areas - though such a distinction is not always clear: Biosynoptics, Biometeorology and Bioclimatology. Biosynoptics is the study of large-scale weather effects on biological processes such as the increase of clinical illnesses influenced by an influx of sub-tropical warm air at high levels. Biometeorology investigates the effects of individual weather phenomena on living processes, such as the influence of "fohn" winds<sup>20</sup> on people's suicidal tendencies. Finally, Bioclimatology investigates connections between climate and human physiology, such as associations of infantile paralysis with certain periods of summer weather.

S.W. Tromp, who in 1956 formed in Holland the International Society of Biometeorology and Bioclimatology, defined these fields on physiological grounds and emphasized the interaction of weather and climatic elements (e.g. sunlight, heat, wind, cold) with the physiological processes of man. He suggested five principal ways in which this interaction takes places: (a) stimulates the skin due to thermal stresses; (b) stimulates the eyes and head, mainly as a result of solar radiation; (c) stimulates the internal mucous

20. *Fohn wind: extremely hot, dry and violent wind in the Swiss Alps and particularly the northern valleys. It affects the nervous system so that many people feel ill. It also electrifies people's hair, the furniture, walls and woodwork in the house crack and the danger of fires is maximized considerably. See AUBERT de la RUE, E., (1955) pp.37-41.*



membranes of the nose by changes in the humidity of the air and by air pollutants; and (e) stimulates the peripheral nerves possibly by electrostatic and electromagnetic fields<sup>21</sup>. (See also Figure 1).

Bioclimatology has made clear, so far, that regulatory mechanisms for physiological adjustments to climatic changes are effective only within limited ranges which have been more or less well-defined. Also, that climatic factors can have an indirect effect upon health through their influence on susceptibility or other psychological processes<sup>22</sup>.

However, what it is more interesting to notice here is that since 1968 Bioclimatology has considerably expanded its scope of enquiry. According to D.H.K. Lee, president of the International Society of Biometeorology, the field has taken the view that:

"Within this zone (of climatic tolerance) the degree of imposed stress can be controlled by various technical devices and cultural shifts and the resultant strain on the bodily economy or psychological acceptance varies enormously with a multitude of genetic, cultural, experiential and physiological factors. It is in this regulation of imposed stress within this zone, and its effect upon resultant strain, that human bioclimatology gets its greatest opportunity. Various other aspects of bioclimatology, agricultural, animal, engineering, ecological, etc., find equal opportunity in those aspects of the environment that stand between man and climatic elements - food, water, housing and environmental pollution".<sup>23</sup>

It is very characteristic that bioclimatology, an applied science with a vigorous scientific background, has recognized the need for the social evaluation of bioclimatic issues to become an essential part of its empirical and theoretical research. Again, in a paper

21. See MAUNDER, W.J., (1970), p.205.

22. DUBOS, R., (1965), p.61.

23. LEE, D.H.K., (1968), p.317. See also Part III, Ch.8, pp. 218,219 of the present work.

FIGURE 1: REPORTED EFFECTS OF THE INFLUENCE OF WEATHER AND CLIMATE ON DISEASES\*

Short periodical effects	Long periodical effects (seasonal or pseudo-seasonal)
<p style="text-align: center;">Lung diseases</p> <p>Tuberculosis: Haemoptysis suddenly increased in clinics after oppressive warm weather before thunderstorms, after fohn, humid cold foggy weather or sudden heat waves</p>	<p>Increased sensitivity to tuberculin test in March and April; low during autumn</p>
<p>Asthma (bronchial): Increases with sudden cooling (particularly if accompanied by falling barometric pressure and rising wind speed); during high barometric pressure and fog (in W. Europe) very low asthma frequency</p>	<p>Low in winter, suddenly increasing after June, max. in late autumn (W. Europe)</p>
<p>Bronchitis: Increasing complaints during fog (particularly in air-polluted areas) and specially if accompanied by atmospheric cooling</p>	<p>High in winter, low in summer (in W. Europe)</p>
<p>Hay fever (and various forms of rhinitis): Allergic reactions often increase during atmospheric cooling</p>	<p>Hay fever is related to flowering of certain plants or grasses different for different countries. In W. Europe usually max. complaints in May-June</p>
<p style="text-align: center;">Cancer</p> <p>Skin cancer: More common with increasing number of sun-hours and increased exposure of the skin to the sun</p>	<p style="text-align: center;">----</p>
<p style="text-align: center;">Rheumatic Diseases</p> <p>Most forms of arthritis react to strong cooling (falling temp; strong wind). Humidity seems to have no direct effect, only indirect through cooling</p>	<p>Arthritic complaints particularly common in autumn and early winter (W. Europe)</p>

continued

\* For authors and references see Tromp (1963a), pp. 374-8, 575-84.



continued

<p style="text-align: center;">Heart Diseases</p> <p>Coronary thrombosis, Myocardial infarction and Angina pectoris: Occur most frequently shortly after a period of strong cooling</p>	<p>Highest mortality in Jan-Feb (in W. Europe and northern USA), lowest July-Aug. In hot countries (e.g. southern USA) highest mortality in summer, lowest in winter</p>
<p>Common cold: Weather changes affecting thermoregulation mechanism, membrane permeability and growth and transmission of common cold virus seem to initiate the diseases (e.g. very cold period followed by sudden warming up).</p>	<p>Max. in Feb-March; increasing from Sept-March (in W.Europe)</p>
<p>Influenza: Rel. humidity below 50% and low wind speeds seem to favour the development and transmission of influenza virus</p>	<p>Max. in Dec-Feb; increasing from Sept-March.</p>
<p>According to MAUNDER, W.J., (1970), p.207 (abridged from Tromp,1964b)</p>	

significantly titled "Culture and Society", Lee has stated:

"A reassessment of bioclimatologic interests is certainly needed, but in terms of what? Change is at the heart of the contemporary scene. It affects not only our concept of environment, but our scale of values. Just as precise thought about well-defined entities displaced an earlier romanticism, *social values have now become inherent in applied sciences and threaten a virus-like transformation of pure science itself.*"<sup>24</sup> (my emphasis)

### 1.3.2 Econoclimatology

The study of the economic influences of weather and climate on certain human activities - the so-called weather sensitive activities - is a growing field, especially due to the remarkable developments of "weather forecasting" which provided the necessary data for these

24. *Ibid.*, p.318.

studies. Econoclimatic studies have been undertaken in fields related to agriculture, forestry, fishing, the manufacturing and construction industries, transportation, utilities and commerce. So far, these studies have been more or less localized without reference to a regional or a national economic level<sup>25</sup>.

Econoclimatic studies related to building climatology have been largely related to the study of the effects of weather and climate on the construction industry. The most important climatic elements affecting economically both production and the speed of construction are considered to be temperature fluctuations, wind force, humidity changes, and mostly, rainfall and snow (see Figure 2).

By considering "building" as a weather sensitive economic activity and by using suitable design weather information in decision making, the economic gain has been estimated to be of the order 0.5% of the total production of the construction industry and, obviously, if heating and air-conditioning are considered, the benefits are several times higher, depending, of course, on how successfully these services are designed. The type of models used generally in econoclimatology is shown in Figure 3.

Econoclimatic studies which influence architectural design beyond the stage of construction and at a much broader socio-economic level are related to the provision of comfort, the minimization of energy consumption, the utilization of solar and wind energy, etc. Experimental architectural movements, for instance, "solar house", "autonomous house", "climatic dome", etc. have usually been described within an econoclimatic framework, though they also extend into a broader ecological and socio-political one<sup>26</sup>.

25. For a comprehensive study on the economics of climate and weather refer to MAUNDER, W.J., (1970).

26. Refer to VALER, et. al., (1975).

FIGURE 2: CRITICAL LIMITS OF WEATHER ELEMENTS HAVING SIGNIFICANT INFLUENCE ON CONSTRUCTION OPERATIONS

Operation	Rain	Snow and Sleet	Low temperatures (°F)	High wind (mph)	Dense fog	Ground freeze	Drying conditions
Surveying	L	L	0 to -10	25	X	-	-
Demolition and clearing	M	M	0 to -10	15-35	X	X	-
Temporary site work	M	M	0 to -10	20	X	X	-
Delivery of material	M	M	0 to -10	25	X	-	-
Material stockpiling	L	L	0 to -10	15	X	-	-
Site grading	M	M	20 to 32	15-25	X	X	X
Excavation	M	M	20 to 32	35	X	X	X
Pile driving	M	M	0 to -10	20	X	X	-
Dredging	M	M	0 to -10	20	X	X	-
Erection of coffer dams	M	L	32	25	X	X	X
Forming	M	M	0 to -10	25	-	X	-
Emplacing reinforcing steel	M	M	0 to -10	20	-	X	-
Delivery of pre-mixed concrete	M	L	32	35	X	X	-
Pouring concrete	M	L	32	35	-	X	X
Stripping and curing concrete	M	M	32	25	-	X	X
Installing underground plumbing	M	M	32	25	-	X	X
Waterproofing	M	M	32	25	-	X	-
Backfilling	M	M	20 to 32	35	X	X	X
Erecting structural steel	L	L	10	10-15	X	-	-

continued

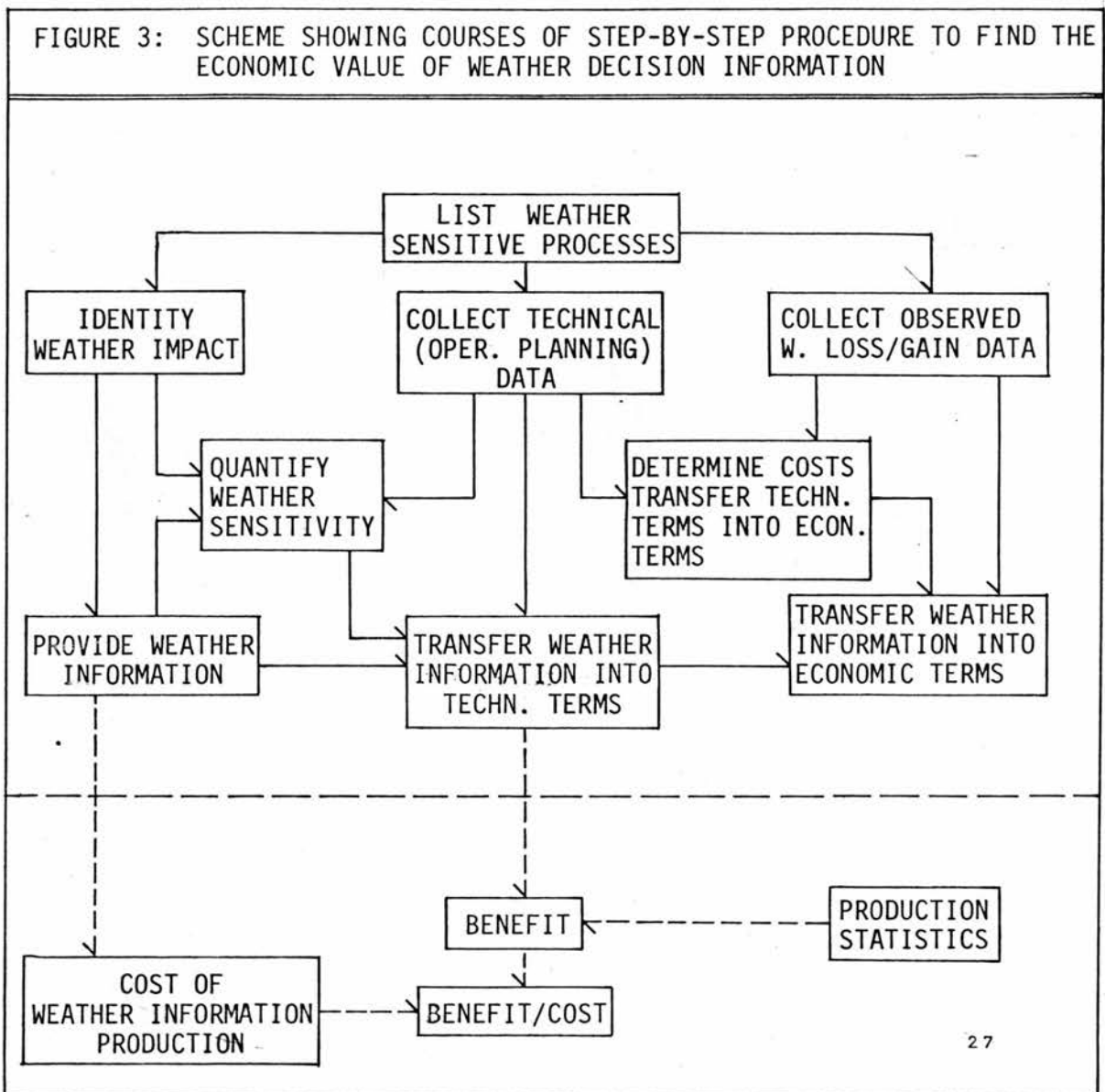
continued

Exterior carpentry	L	L	0 to -10	15	-	-	-
Exterior masonry	L	L	32	20	-	X	Z
External cladding	L	L	0 to -10	15	-	-	-
Installing metal siding	L	L	0 to -10	15	-	-	-
Fireproofing	L	L	0 to -10	35	-	-	-
Roofing	L	L	35	10-20	-	-	X
Cutting concrete pavement	M	M	0 to -10	35	-	X	-
Trenching, installing pipe	M	M	20 to 32	25	-	X	X
Bituminous concrete pouring	L	L	45	35	X	X	X
Installing windows & doors, glazing	L	L	45	35	X	X	X
Exterior painting	L	L	45 to 50	15	X	-	X
Installation of culverts and incidental drain drainage	M	L	32	25	-	X	X
Landscaping	M	L	32	25	-	X	X
Traffic protections	M	M	0 to -10	15-20	X	X	-
Paving	L	L	32 to 45	35	X	X	X
Fencing, installing lights, signs etc.	M	M	0 to -10	20	X	X	-

Note: L indicates light; M indicates moderate  
\* indicates water freeze

See MAUNDER, W.J. (1970), p.104, (abridged from U.S. Department of Commerce (1966) publication, *Weather and the Construction Industry*).

FIGURE 3: SCHEME SHOWING COURSES OF STEP-BY-STEP PROCEDURE TO FIND THE ECONOMIC VALUE OF WEATHER DECISION INFORMATION



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### 1.3.3 Socioclimatology

Studies on human climatology have been almost wholly carried out on physiological, psychological and strict economical bases while socioclimatic considerations have been largely neglected, though it is generally agreed that certain social reactions and behaviours are

27. ..according to VALCO, P., see his paper, "Use of Climatological Data in Building Design with Respect to Economy", in Teaching the Teachers in Building Climatology, (1972), p.137.

associated with the state of the atmospheric environment<sup>28</sup>. Socio-climatology, defined as the field which studies the interaction of weather and climate on human social behaviour, is in many respects closely related to architecture, planning, and generally to environmental sciences, since environmental design, to a certain extent, shapes the atmospheric surroundings of man. In this way it becomes imperative to study the relationship between environmental design - including architectural and planning - and human reaction to the produced microclimates and ecoclimates. Parr<sup>29</sup>, for instance, has suggested that sociologists should work in conjunction with architects and planners in order to establish goals for environmental design by examining the above relationships.

It is important to note that such social bases for environmental design have been well-established in human ecology. The well-known human ecologist, Pierre Samuel<sup>30</sup>, discussing the general ecological problems related to modern cities, considers problems associated with the socio-spatial order of the built environment to be of equal, if not of greater, importance than those which are strictly related to the physical deterioration of the atmospheric environment, like air pollution. Samuel successfully relates the biological and socio-economic aspects of the environmental problems in a process of describing and defining the ecological problems of cities, and it is mainly this "socialization" of the ecological phenomena which permits him to explain comprehensively the real causes of deterioration of the human environment. But even in Samuel's context, although environmental phenomena acquire the necessary dimensions to formulate

28. *This area of investigation is extensively, though not comprehensively, discussed and defined in SEWELL, D.R.R., (1966), and (1968). For a summarized view of this topic see MAUNDER, W.J., (1970), pp.185-216.*

29. PARR, A.E., (1968).

30. See SAMUEL, P. (1973), especially Chapter 4.

an integrated explanatory basis for the ecological deterioration of the environment, there is no established methodological framework by which meaningful action upon the environment may be implemented<sup>31</sup>.

Today, although there is some tendency on the part of sociologists and environmentalists to establish a rather more open attitude towards the socioclimatic problems of the environment, the field of socioclimatology has remained virtually unexplored<sup>32</sup>. Furthermore, the limited research conducted so far fails to consider the importance of developing a broad theoretical framework within which statistical information from studies like those proposed, for instance, by Haas<sup>33</sup> and Maunder<sup>34</sup> could become meaningful in organizing and implementing action upon the environment. In organizing such a framework for those socioclimatic problems which are related to the broader architectural environment it becomes significant to describe the processes by which certain microclimatic and ecoclimatic phenomena

31. *Further discussed in Part III, Ch.9. See also, CLAIBORNE, R., (1970).*
32. *Refer, for instance, to the "Discussion on Human Sciences as Basis for Performance Requirements" in Teaching the Teachers in Building Climatology, (1972), pp.170-181, and also to the conclusions of this colloquium, summarized by WALLEN, C.C., pp.289-291.*
33. *HAAS, E., (1968) has suggested among others possible topics for socio-climatic research concerned, for instance, with incidence of illness or crime and organization of the relevant social institutions, disruption and use of basic community services - nature and use of recreational and leisure-time activities, etc. See pp.53-57.*
34. *MAUNDER, W.J., (1970), proposed topics of socio-climatic research concerned with the discernible consequences of weather modification, the kinds of individual and group readjustments that may be anticipated due to weather variations; whether significant differences of individual or community responses exist between planned weather modifications and inadvertant modifications such as air pollution; relationships between weather and riots, etc.*



are produced, experienced and transformed into human reactions and modes of behaviour. This process also includes the role played by buildings as physical objects, and by the processes of production of the built-environment as a whole. Meaningful explanations of the ways in which climate interacts with human social behaviour cannot be given only through statistical correlations. The complexity caused by both the diversity of microclimatic and ecoclimatic phenomena and the dynamics of human responses to climate is far too high to be grasped through analytical methods. Instead, it is imperative to go beyond the level of surface reality, towards their unobservable deep structure.

Socioclimatology examines both the influences of weather and climate on human social behaviour and also, in an ecological mode, the modifications of these elements due to particular forms of social organizations and activities. In this way it becomes interested in man's ability to modify and forecast the weather with some precision; in the pollution of the atmosphere by means of certain socio-economic modes of production; in the environmental control man exerts on urban areas, etc. Since man-made modifications of the "natural" climate involve planning and decision making, they initiate political and legal problems. Political and legal climatology, therefore, are included in the sphere of socio-climatological investigation<sup>35</sup>.

#### 1.3.4 Building Climatology

Many of the problems which are identified today with the field of building climatology - such as "pollution", concern for "clean air",

35. *For a more detailed discussion concerned with the political and legal aspects of weather and climate, and more generally with socially based climatic research, see Part III, Ch.9.*



"comfort", etc. - were extensively studied during the nineteenth century by the fields of "public health", "planning" and "ventilating design". These fields were not identified as "Building Climatology". As such, building climatology grew out of attempts to design buildings rationally in relation to a whole set of influences and got its identification out of the move to a rationalist architecture.

The established areas of research in building climatology are usually taxonomized in the following five categories:

1. Studies of weather and macroclimate in the overall surroundings of a city or a building and application of this information to the decision making: in planning processes about the location and orientation of buildings; and in the construction process. Ordinary meteorological statistics may be used for these applications.
2. Studies of the mesoclimate within a city and the surroundings of buildings and application of this information to the design of buildings or the landscaping process. Ordinary meteorological records do not provide enough data and special meteorological observations might be necessary.
3. Studies of the microclimate surrounding the vicinity of a building or a neighbourhood and application of this information to building details such as selection of materials, fenestration, vegetation around the building and provision of environmental control devices or structures. Measurements to map the climatological sheath of the building are necessary.
4. Studies on the transport of moisture and heat through the building envelope and application of this information to

architectural and constructional details of a building, and the provision of appropriate installations for the maintenance of a desired indoor climate.

5. Studies on the relationship between outdoor and indoor climates with application of information received from studies under 1 to 4<sup>36</sup>.

However, it has recently become commonly accepted among building climatologists that human sciences should form the basis for performance requirements, and that research should be oriented towards a careful treatment of the human component and particularly the "human need" as the basic unit for evaluating research on the above topics.

John Langdon, for instance, has stated that:

"I then see that most of our research is directed to clearing up the mess; to deal with problems of nuisance, noise, wind around buildings, over-heating and so on. Critical situations which we have tried to put right and we hoped that in the course of doing so we would also establish some functional norms. What is wrong about this process is that we are not taking a general look at 'la condition humaine'; we are not taking a general over-view of human needs and of how building and planning can meet them."<sup>37</sup>

The human needs for shelter and its particular climatic performance cannot be derived only by considering the man-climate interaction in isolation from the general socio-economic system within which such human needs are to be fulfilled. Obviously, the need for shelter varies with the severity of the climatic forces to be overcome and may range from the need for no shelter at all (on climatic grounds), to

36. *This categorization of research in Building Climatology was proposed by C.C. Wallen, representative of the World Meteorological Organization at the "Teaching the Teachers on Building Climatology" colloquium - held in Stockholm on 4-6 September, 1972, under the auspices of the International Council for Building Research (CIB) and the World Meteorological Organization (WMO) - in his introductory speech. See pp.9-12 of the above colloquium.*

37. *Ibid, p.30.*

the need for maximum protection<sup>38</sup>. But, in any case, building performance requirements are to be based on the broader system of social-evaluation within which cultural values, local technological resources, socio-economic conditions and climate should be brought together and balanced in a process of defining the social need. There is no doubt that the more severe the climatic constraints the less variation will be permitted from performance requirement defined on climatic grounds alone.

It is characteristic that in primitive and vernacular architecture successful solutions to climatic problems were undoubtedly based on some system of social evaluation. In Rapoport's study of these problems, it becomes evident that such successful solutions were always "group solutions" and not individual: a fact representing a cultural response to building performance requirements and the methods by which they can be achieved<sup>39</sup>.

Another way of establishing a social base for the evaluation of building performance climatic requirements is by shifting the scope of investigation from the concept of "human" or "social need" to the more specific one of "human activity"<sup>40</sup>. Harriet Ryd summarizes this view in the following statements:

38. *A. Rapoport's concept of "climatic scale" is a useful tool to examine the dynamic relationship between human need and design approaches determined by pure climatic functionalism. See RAPOPORT, Amos (1969), p.85.*

39. *Ibid., p.86.*

40. *This is, of course, a more backward thinking to the man/nature rationalist duality.*

"It is, therefore, sensible both from the economic and ecological point of view to define the comfort climate as a climate which facilitates activity"....." Research is, therefore, needed to supply development planning procedures with knowledge of the opportunities which there are at every planning level for checking the climatic effect of building development, in order that the climate of the region, urban area and outdoor spaces may be as favourable as possible, with regard to both people's outdoor activities and the climatic stresses imposed on buildings and landscape".<sup>41</sup>

The possibilities, in terms of both the advantages and the difficulties, of establishing a comprehensive framework within which a "climate-activity design oriented system" could be developed have been discussed by the author in a preliminary paper<sup>42</sup> and they are further considered in this thesis.

#### 1.4 HUMAN CLIMATIC CLASSIFICATION SYSTEMS: THEIR RELEVANCE TO ARCHITECTURAL CLIMATOLOGY

During the last century more than seventy different classifications of climate have been attempted, the overwhelming majority of which are concerned with the relationships between climate and vegetation or soils. Surprising as it might be, only few attempts have been made to classify climate from a human point of view, and most of them were originally prepared for military planners interested in extreme climates<sup>43</sup>. Here, we are going to discuss three of these human classification systems; Maunder's, Terjung's (1966b) and Gates',

41. RYD, H., (1972), pp.56, 78-79.

42. MARAVELIAS, Th., (1975), pp.22-32.

43. *Attempts to classify climate from a human point of view - apart from MAUNDER (1962), TERJUNG (1966b) and GATES (1972) discussed in the text - are, among others, BRAZOL (1954) who proposes a system of "comfort months" to be used in assessing military clothing needs; TERJUNG (1966a) on the physiological climates of California; GREGORCZUK (1968) who introduced mappings of the world bioclimates related to air enthalpy. PROHASKA (1967), also provides a discussion of the problems associated with the terminology in bioclimatic classifications.*

in order to examine their relevance to architectural and planning climatic phenomena.

Maunder formulated his human classification index of the climate of New Zealand<sup>44</sup> from thirteen climatic elements as follows:

$$X = (3R_1 + 3R_2 + 2R_3) + (4S_1 + 3S_2) + \\ (2T_1 + T_2 + T_3 + T_4 + T_5) + (5H_1) + (2W_1 + 2W_2)$$

where: (see Figure 4).

In assessing his index Maunder pointed out the following difficulties which generally characterize any attempt towards human classification of climate:

"First, the climatic elements which portray the human climate must be selected...; second, not all the desired climatic elements are available for classification...; and, third, once a selection of the climatic elements is made, they must then be weighted'. That is, it must be decided how important a particular climatic element is in relation to the total human climate".<sup>45</sup>

Maunder's human classification system provides a useful technique of mapping climatic information at a level defined by the network of existing meteorological stations but it lacks the possibility of converting this information to the urban scape where it would have more relevance to architectural climatology. Furthermore, it attempts to classify climates from a strictly comfort index standpoint without taking into account cultural and regional connotations and historically produced customs which might be of primary importance for a comprehensive human classification system.

44. See, MAUNDER, W.J., (1970), p.201, and his paper on *A Human Classification of Climate*, *Weather*, 17, No. 1, Jan, 1962, pp.3-12.

45. MAUNDER, W.J., (1970), p.202.

FIGURE 4: RATING SCHEME FOR EVALUATION OF HUMAN CLIMATE INDEX

Factor	Rating	1	2	3	4	5
R <sub>1</sub> = Mean annual rainfall (in)		10.0- 17.7	17.8- 31.6	31.7- 56.2	56.3- 99.9	100.0-177.8
R <sub>2</sub> = Mean annual duration of rainfall (h)		355-446	447-562	563-707	708-891	892-1122
R <sub>3</sub> = Percentage of rainfall occurring at night (9 pm - 9 am)		53.0- 54.9	51.0- 52.9	49.0- 50.9	47.0- 48.9	45.0- 46.9
S <sub>1</sub> = Mean annual duration of bright sunshine (h)		2400-2599	2200-2399	2000-2199	1800-1999	1600-1799
S <sub>2</sub> = Mean winter duration of bright sunshine (h)		450-499	400-449	350-399	300-349	250-299
T <sub>1</sub> = Mean annual degree-days (base 60°F)		1000-1349	1350-1905	1906-2630	2631-3630	3631-5011
T <sub>2</sub> = Mean number of days with screen frost per year		0- 7.9	8.0- 23.9	24.0- 47.9	48.0- 79.9	80.0-119.9
T <sub>3</sub> = Mean daily maximum temperature of coldest month (°F)		56.0- 59.9	52.0- 55.9	48.0- 51.9	44.0- 47.9	40.0- 43.9
T <sub>4</sub> = Mean annual maximum temperature (°F)		74.0- 77.9	78.0- 81.9	82.0- 85.9	86.0- 89.9	90.0- 93.9
T <sub>5</sub> = Mean number of days with ground frost per year		0- 14.9	15.0- 44.9	45.0- 89.9	90.0-149.9	150.0-224.9
H <sub>1</sub> = Humidity index expressed as dew point(°F)		50.0-51.9	52.0- 53.9	54.0- 55.9	56.0- 57.9	58.0- 59.9
W <sub>1</sub> = Mean number of days with wind gusts 40 mph per year		0- 14.9	15.0- 44.9	45.0- 89.9	90.0-149.9	150.0-224.9
W <sub>2</sub> = Mean number of days with wind gusts 60 mph per year		0- 2.4	2.5- 4.9	5.0- 12.4	12.5- 22.4	22.5- 35.0

Source: MAUNDER, W.J., *Weather* 17, No. 1, Jan. (1962), p.9.



FIGURE 5: HUMAN CLIMATE INDEX FOR NEW ZEALAND

Station	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	S <sub>1</sub>	S <sub>2</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	H <sub>1</sub>	W <sub>1</sub>	W <sub>2</sub>	X
Nelson	3	3	2	1	1	3	3	2	3	4	2	2	1	60 Best
Auckland	3	1	4	3	2	1	1	1	2	1	5	3	1	78
Christ- church	2	2	2	4	3	4	3	3	4	4	2	3	2	83
Wellington	3	3	2	3	4	3	1	3	2	2	2	5	5	90
Inver- cargill	2	3	1	5	5	5	3	3	3	3	2	4	3	101 Worst

Source: MAUNDER, W.J., *Weather* 17, No. 1, Jan. (1962), p.9.

Another interesting human classification of climate is the one proposed by Terjung (1966b). The unique characteristics of this system are:

- (i) It considers "human comfort" in its historical evolution with cultural and regional connotations attached to it. As a result of this Terjung tried to define the concept of human comfort in a broader physio-cultural context of climatic sensations which include customs, preconceived ideas and even irrational notions which differ historically and geographically.
- (ii) It considers the social significance of climate by taking into account the fact that the climates of certain regions have influenced population movements, occupancy, military strategy and cultural achievements.

Such a classification system may serve, according to Terjung, a number of different purposes:

- (i) To map human climate for the benefit of the "retired" and "the victims of certain diseases intensified by climatic conditions".

- (ii) In the field of education by developing a better appreciation of the atmospheric environment.
- (iii) In mappings which may help to determine clothing requirements, nutritional needs and physiological and psychological repercussions of an area.
- (iv) The bioclimatic maps which are provided by this classification system would simplify housing needs, building materials and heating or cooling requirements<sup>46</sup>.

There is a major problem inherent in human classification systems, based on comfort indices, which is concerned with the concept of comfort itself. Comfort states do not provide satisfactory description of permissible climatic ranges for certain kinds of endeavour and activity even when they are based on a much broader definition of comfort than the psycho-physiological one. The concept "comfort climate" should be replaced by "climate which facilitates activity", if such classification systems are to provide useful information for architects and planners who mainly, and primarily, deal with activities. This, of course, is possible only for activities for which their climate-activity function is not very complex<sup>47</sup>. Nevertheless, classification systems like those of Terjung, though general in scope - particularly when applied to the scales of architectural climatology - represent encouraging attempts towards some sort of socially evaluated classification system.

In a more recent attempt, Gates<sup>48</sup> has suggested a human classification system at a microclimatic level and in a dynamic sense.

46. *Ibid.*, p.203.

47. See ARENS, E.A., (1972).

48. GATES, D., (1972), pp. 69-74.



Particularly, he tried to describe the microclimate which surrounds an organism and which is significant for its comfort, its behaviour and its viability. At the same time, he tried to describe microclimate as it may occur moment by moment throughout day and night. The climatic elements which Gates considered significant for his classification system are: (i) the amount of radiation absorbed by an organism's surface, (ii) the air temperature, (iii) the wind speed, and (iv) the relative humidity. His system gives approximate quantitative conditions for different spaces in different hours during the day or night (see Figure 6).

Such a classification system may be used, in certain cases, to describe approximately the changes of microclimate brought about by the activities of an organism. Take one of Gates' examples which illustrates this point:

"Consider the climate of a skier in the sun standing still on a snow field at a high altitude in the mountains. The sky is clear, the air is still and cold,  $-10^{\circ}\text{C}$  ( $14^{\circ}\text{F}$ ). The relative humidity may be fairly low. The skier's microclimate is SCSD. He is receiving a great deal of radiation, since he gets direct sunlight and skylight, much reflected sunlight from the snow and, in addition, thermal radiation from the snow surface and nearby pine trees. He becomes so warm because of the energy flowing into his body through his clothing that he takes off his coat. He begins to ski, moving rapidly down the slope. His microclimate is now SCWD, and the convective cooling of the cold air rushing across his surface becomes great; he is chilled and stops to put on his jacket. Soon, however, the sky clouds over, and a storm moves in with an increased humidity. Standing still on the slope his microclimate is CCSH, but as he skis it is CCWH. His energy budget has changed dramatically, and now the convective cooling is not compensated by high radiation input but by a very low radiation field, since he is sandwiched between a very cold snow surface and a cold cloud surface overhead. Even his snug down-filled jacket may not keep him warm enough. The humidity has increased, and the conductivity of his clothing has increased with the additional moisture. The skier must exercise vigorously, thereby increasing the body heat or metabolic heat, in order to stay warm."<sup>49</sup>

49. *Ibid*, pp.73,74.

FIGURE 6: CLASSIFICATION OF MICROCLIMATES

Radiation ( $\text{cal cm}^{-2} \text{ min}^{-1}$ )	Air Temperature ( $^{\circ}\text{C}$ )	Wind ( $\text{cm sec}^{-1}$ )	Humidity (%)	Classification
Sunny	Hot	Still	Dry	SHSD
Cloudy	Warm	Breezy	Humid	SHSD
Dark	Temperate	Windy	Humid	SHBD
	Cold	200 or more		SCWH
		20		CCBW
				CHWD
				DCBD
<b>Examples</b>				
Sunny	Hot	Still	Dry	SHSD
Sunny	Hot	Still	Humid	SHSD
Sunny	Hot	Breezy	Dry	SHBD
Sunny	Cold	Windy	Humid	SCWH
Cloudy	Cold	Breezy	Humid	CCBW
Cloudy	Hot	Windy	Dry	CHWD
Dark	Cold	Breezy	Dry	DCBD
<b>Situations</b>				
Field at noon, clear, summer				SHSH
Field at night, cloudy, summer				DWSH
Desert at noon, clear, summer				SHSD
Tree top noon, clear, summer				SHBH
Tree top noon, clear, spring				SWBH
Tree top night, clear, spring				DTSH
Tree top night, cloudy, winter				DCSH
Tree top night, clear, winter				DCWD
Inside forest at noon, summer				CHSH
Inside forest at noon, spring				CWSH
Alpine tundra noon, clear, summer				STWD
Alpine tundra night, cloudy, summer				DCBH
Lake shore noon, cloudy, summer				CWBH
Room in house				CWSD

According to GATES, D., (1972), p.72.

However, the microclimatic complexity of the built environment appears to be so high that Gates' classification can describe it only at a very simplistic level. This complexity is multiplied to a considerable extent by building and planning features as Figure 7, introduced by Ryd, indicates. Obviously, if one succeeds in formulating a satisfactory classification system by introducing Ryd's microclimatic complexity into a Gates' type classification system a number of basic problems, related to the microclimatic mapping of the built environment could be solved. But, in my view, though a microclimatic mapping, like the above, would be a valuable achievement in building climatology, the problems of how this mapping could be evaluated and used in design and planning decisions still remains. Such problems could probably be answered through an "ecoclimatic mapping" of the build environment, based on some system of social evaluation applied to the microclimatic mapping, thus establishing design criteria on a much broader and more comprehensive base. I will return to this concept of "ecoclimatic mapping" of the built environment in Part IV after establishing a proper methodological and descriptive framework within which the basic concept of ecoclimate can be adequately defined.

## 1.5 CONCLUSIONS

The imported terminology and taxonomy which are currently used for the study of meteorological and climatic phenomena in architecture and planning introduce a number of difficulties.

Climatological concepts are strongly influenced, terminologically, by the size and morphological characteristics of the area which they describe. This characteristic is also observed in all the fields of

BUILDING PLANNING MEASURES AFFECTING THE CLIMATE IN												METHODS FOR CHECKING THE RESULTING CLIMATE																		
CLIMATIC CRITERIA	METEOROLOGICAL DATA	REGIONS			TOWN AREAS			CLIMATOLOGICAL SHEATH			INDOORS																			
		Location of pollution works	Green areas	Prevention	Orientation of open space w. prevailing wind	Distance between buildings	Building height	Heat absorbing and light reflecting material	Moisture absorbing material incl. green areas	Topography	Trees	Orientation	v. wind	Form	CONSTRUCTION	Orientation	v. sun	Form	Material	WALLS	Orientation	v. sun	Form	Material	WINDOWS	Orientation	v. sun	Form	Material	Shading devices
<b>LIGHT QUALITY</b> Light intensity & wavelength Light directions & luminance distribution	Solar constant Sun height Angular zenith position Cloudiness Atmospheric radiations conditions																													SUN DIAL
<b>HEAT QUALITY</b> Air temperature Air velocity Air humidity Radiation intensity	Temp. of the air Wind velocity profile Prevailing wind direction Air moisture content Sun height Angular zenith distance Cloudiness Atmospheric radiations conditions																													WIND TUNNEL SUN LOAD CALCULATION
<b>AIR QUALITY</b> Pollution dispersion Air humidity Air temperature	Inversions Prevailing wind direction Wind velocity profile Wind turbulence Air moisture content Temp. of the air																													DISPERSION CALCULATIONS WIND TUNNEL
<b>SOUND QUALITY</b> Air pollution propagation	Wind velocity Wind turbulence Prevailing wind direction Moisture content of the air																													
<b>OTHER CLIMATIC CRITERIA</b> Sunshine distribution Snow formation	Sun height Angular zenith position Amount of snow Snow quality Wind velocity Wind direction during snowfall																													WIND TUNNEL

FIGURE 7: According to RYD, H., (1972) p.77.



applied climatology where the "imported" climatological terminology is usually left intact, although enriched with different connotations. These connotations account for the homonymity and the synonymity which are associated with most climatological terms. This state of affairs characterizes the terminology used in the fields of architectural and building climatology and, eventually, results in the disassociation of the terminology used with the nature and character of the particular phenomena which it intends to describe.

Thus, I have tried in this chapter to introduce a new terminology which, although imported from climatology, has been redefined in relation to the multidisciplinary nature of the architectural phenomena and specifically those with which the present work primarily deals. In this context the concepts of "microclimate" and "ecoclimate" have been redefined and distinguished in the following manner:

"Microclimatic" phenomena are considered to be those concerned with (i) the transformation of the macroclimatic environment to the climatic conditions created or modified by the built environment and (ii) with the physical mapping of these transformations which is describable in the language of physics and specifically of climatology and meteorology.

"Ecoclimatic" phenomena, on the other hand, are considered to be those concerned with the semantics of the physical fields of climate and microclimate, that is, with the human perception, understanding and evaluation of the climatic conditions of the built environment. These phenomena, therefore, cannot be defined by their microclimatic characteristics alone and they are not describable in a purely climatological and meteorological language, but only *within a much*

*broader conceptual framework* where the processes of producing the architectural environment together with the semantic dimensions of the climate of the built environment are taken into account.

Furthermore, the brief examination of certain fields of applied climatology - bioclimatology, econoclimatology, socioclimatology and even building climatology - has shown that some interesting concepts, developed lately in these fields, provide enough evidence to support the argument that social values are becoming recognized as inherent in applied science, a fact which suggests a more critical look at the "imported" knowledge directly derived from a purely physical climatological context.

Finally, a brief review of the existing human classification systems of climate and microclimate showed that, although they are undoubtedly useful in certain cases, they are not directly applicable to a study of the climatic problems of architecture. A taxonomy relevant to the study of the climate of the built environment has to consider primarily the ecoclimatic phenomena and structures organized in it and for this reason it should be formulated on an appropriate dynamic basis.

The next chapter undertakes, among other things, the objective of showing, through examples taken from the history of the built environment, that man and society have always conceptualized their habitat and their cities in ecoclimatic rather than in microclimatic terms. Additionally, a general framework within which an appropriate taxonomic system for ecoclimate can be developed is provided in Part II of this work. However, it should be stressed that a lot more experimental and, in certain aspects, theoretical work is needed before such a general framework can be developed into an integrated and practically useful ecoclimatic classification system.



## CHAPTER 2

### THE ECOCLIMATIC CONCEPTUALIZATION OF THE BUILT ENVIRONMENT IN A HISTORICAL PERSPECTIVE

#### 2.1 INTRODUCTION

It has been a methodological assumption in this project that architectural descriptors in general and ecoclimatic descriptors in particular, have been influenced to a great extent by historically emergent problems. Although the History of Architecture constitutes a quite different volume of knowledge from the one which might be suggested by the above assumption, it is possible in certain areas of investigation to derive an appropriate body of information necessary to explain diachronically the evolution of environmental concepts.

The historical investigations of climatic and ecoclimatic concepts, though generally neglected in the literature of the subject, constitute a useful base upon which the evolution of these concepts and the major dimensions involved in the process of ecoclimatic conceptualization of the built environment may be examined. Such a broad scope presupposes the adoption of the view that the built-environment should be regarded as a result of the interaction between man-and-nature. Here, man is considered with his social organization; his way of life; his nature and aspirations; his social, psychological, individual and group needs, his world view and his attitudes towards nature; and his knowledge and techniques. Nature, on the other hand, is considered as a

given set of structural laws; as availability of resources; as climate, material and landscape characteristics. In such a framework we have also to assume that, with respect to the built environment, the climatic influences on man should be understood in two ways. First, climate and other physical aspects influence directly certain behaviour and activity patterns of the individual or the social group and through these influences the total organization of the built-environment. Second, climate influences indirectly the behaviour and activities of man through modifications which affect the organization of the built-environment and which become habituated and internalized by the individual or the social group at many different levels.

In dealing with the history of the built environment, we are obviously concerned with evidence of the past. Historical studies concerned with certain aspects of the built environment which are related to the materials, construction techniques and styles do not present serious difficulties since evidence can be drawn from the remains of buildings or other archaeological remains. But, historical studies concerned with the conceptualization of certain features of the built environment (e.g. climate or ecoclimate) deal with man's attitudes and values towards his environment and, therefore, the scope of their investigation must be extended beyond mere archaeological evidence. Apart from written records, information concerned with ecoclimatic concepts can be drawn from studies investigating the types and organization of buildings in close relation to the socio-cultural and physical character of the milieu that have produced them. The emphasis should be primarily on the type of socio-cultural knowledge needed for an understanding of the paradigms, norms and set of values that people employed and manifested in their buildings during their struggle with



their environment as a whole.

Historical studies of this kind are of an explanatory character in terms of providing an appropriate framework in which a number of points may be clarified: for instance, which aspects of the ecoclimatic conceptualization remain constant, which are changeable and what are the reasons for change. In other words, they provide a framework within which all the advantages of studying diachronically the built environment can be exploited.

An additional but also important reason for studying the conceptualization and organization of the ecoclimatic environment of the past is that the physical constraints were very strong and people's response to them much more immediate and clear than in contemporary situations where not only the response to the problem but also the recognition of it has become much more difficult for the architect due to the involvement of self-conscious design processes and the overall complexity of the modern environment. By comparing the ecoclimatic organization in earlier cultures with that resulting from the impact of the Industrial Revolution upon the economic, technological and environmental components of the built environment, the magnitude of change in the systems of evaluation of the ecoclimatic environment may be studied. Furthermore, the various static or dynamic factors involved in the general process by which the ecoclimatic environment is produced, organized and evaluated may be defined.

However, historical studies of this type which take into consideration cultural factors may not be necessarily of a chronological nature. There are societies which in terms of culture are closely related to each other, although their chronological distance might be more than two thousand years. Anthropologists, for instance, have

described a great number of primitive cultures of the present day which in terms of technology, way of life and social organization are closely related to those existing in the neolithic period of our civilization. Therefore, a study on the evolution of ecoclimatic concepts should employ its own particular methodology. One method is to examine types of buildings and their spatial organization in different places and within different cultures in an attempt to identify constancies or differences in the way in which ecoclimatic needs are conceptualized and compensated. Another method is to study the diversity of building types and organizations within the same physical and cultural context, in terms of their materials, construction, social and symbolic aspects, in order to identify the predominance of certain factors in the process of production of the ecoclimatic environment.

That ecoclimatic conceptualization and organization of the built environment can only be understood within a much broader framework extended beyond the limits of physical determinism does not constitute the only assumption in this chapter. Beyond this, there is the intention to identify and describe certain aspects of those processes by which more abstract factors become predominant in the production and transformation of the ecoclimate. Thus, I am interested in the inhibited background system which constitutes the framework in which the relevant to the built-environment climatic concepts are formulated and operate.

The aim of this chapter is not to present an extensive account of the various types of ecoclimates which can be found in the history of man's habitation, but is oriented towards examining some of the principles which govern the process by which ecoclimatic prototypes are internalized and used in the production and organization of the

built environment. Examples for investigation have, therefore, been chosen on the basis of the availability of information on the physical and socio-cultural environment.

Such information can be found, for instance, in Biology, Anthropology, Geography, and sometimes in the History of Architecture. Pre-Socratic philosophers; the writings of Vitruvius which reflect the Greco-Roman culture; the sociological writings of Montesquieu; Howard's concept of the "Garden City"; the climatic determinism of Huntington and Mills; recent proposals like those of Buckminster Fuller and other diversified literature, provide useful sources for diachronic considerations of ecoclimatic conceptualization and organization. Furthermore, certain historical periods in which obvious relevant reorientations took place provide additional information. An example of this is the mid-Victorian which reflects the ideal "city of Hegeia". The Industrial Revolution, connected especially with problems of pollution, industrial slums, high density habitation, may also provide additional information. On a more general level, the study of the transformation of the concept of "suburb" from the medieval period to modern times, or the evolution of open spaces within the city also constitute interesting themes.

## 2.2 ECOCLIMATIC PROTOTYPES IN PRIMITIVE AND VERNACULAR CULTURES

The formal History of Architecture, exclusively concerned with the monumental architecture of an "elite" architectural community, does not provide a proper text for the study of the ecoclimatic conceptualization of the built environment. Furthermore, architectural climatology has made no systematic effort to study climate in its relation to the organization of the built environment at a cross-

cultural level and in a historical perspective. A few studies which can be found in this literature have followed a totally deterministic approach to the influences of climate on the overall organization of the environment and they have paid no particular attention to these processes by which ecoclimate is conceptualized<sup>1</sup>. Rapoport's<sup>2</sup> study "*House, Form and Culture*", may be the only exception, particularly because it takes the view that the built environment and especially buildings manifest the interaction among socio-cultural, climatic, and technological forces, together with the availability of materials and other resources of the physical environment. Although Rapoport's intention is quite different from that of this thesis, since he is interested in describing the climatic influences on built environment at a "climatic" level rather than at an "ecoclimatic" one, his work provides valuable insight in any study concerned with the organization of the ecoclimatic environment and the processes by which this environment is conceptualized<sup>3</sup>.

1. HUNTINGTON, E., (1924) *relates climate to civilization considering that the three main factors determining the conditions of civilization are climate, racial inheritance, and cultural development.* MARKHAM, S.E., (1947) *relates climate with the energy of nations supporting his ideas with ancient and contemporary examples. Although any deterministic view of climate in relation to civilization and energy of nations can be questioned, one cannot deny its important influences in their historical evolution, considering that during the early days of mankind the first civilizations were developed in those regions in which man was not in a continual fight against the climatic conditions for his survival.*
2. RAPOPORT, A., (1969)
3. *Ibid., see especially Ch.2 and Ch.4. However, I should point out that the major weakness in Rapoport's approach is that he does not take into account the possibility of culture being climatically influenced, nor does he take into consideration the cultural formation of ecoclimatic prototypes. Nevertheless, his concept of the "climatic scale" clearly suggests a type of overall environmental balance achieved by semantic rather than physical considerations and which may be used in identifying the criticality of climatic forces, RAPOPORT, op.cit., pp 85-87.*

Rapoport distinguishes buildings in two categories: those of the "grand design" tradition and those of the "folk" tradition. He specifies that buildings of the folk tradition are those which more totally reflect the needs and values, the desires, dreams and passion of the people and they represent the bulk of the built environment, while buildings of the grand design tradition reflect simply the culture of the elite. It is, therefore, justifiable to look primarily at built-environments organized in folk tradition, in order to examine the ways in which people have responded to the climatic stresses according to the accepted ecoclimatic prototypes.

The folk tradition is comprised by both primitive and vernacular buildings. The major difference between the two is that vernacular buildings involve a sort of "design process" practiced by the building tradesman with more specialized knowledge than the owner<sup>4</sup>, while in the primitive building every owner possesses the necessary knowledge to build his own house.

In the case of the primitive building the ecoclimatic conceptualization is included in the prototype which is inherited from one generation to another in an unselfconscious process in the manner described by Christopher Alexander<sup>5</sup>. This is probably due to the internalized environmental needs and values of these societies and their members which come as a result of their closely connected lives and activities with the physical environment. In this way ecoclimatic arrangements are taken for granted for long periods and become integrated

4. ... *though that the owner participates in this "design process"*.

5. *see ALEXANDER, C., (1964), Ch.4.*

parts of the whole culture of these societies. Consider the following example. What may be called "the second Human Revolution" (the first being the utilization of fire) was the establishment and organization of life outside the existing physical shelters offered by caves which opened the road to the artificial environments. Among the hypotheses constructed to explain such an undoubtedly dramatic step of human evolution, the one given on an ecoclimatic basis might be difficult to refute. Gardiner argues on this point:

"The mystery that has always puzzled archaeologists and historians is: what, in particular, prompted man to leave the cave, to come out of the womb of nature and, so to speak, to stretch and to begin the long business of making progress. There is no conclusive evidence, although a number of theories have been put forward; primarily we have to use our imagination. Climate may have been a reason; as the glaciers retreated north, weather became warmer and wetter and plants grew; the sunshine draws people out of doors just as it makes flowers open. At the same time, the glaciers took the lid off other fertile lands, and vast herds of animals followed, emptying the plains; this meant that hunting became unreliable as a source of food."<sup>6</sup>

However, the move from the cave to the hut does not seem to have happened at once. Archaeological evidence of temporary settlements established near rivers 10,000 years ago shows signs of frequency rebuilding which means that the inhabitants were still partly cave dwellers. Settlements such as those of Zawi Chenui, in Shanidar (near the Zagros mountains on the Turkish-Iranian borders) were occupied only for half the year, since the nearby caves of Shanidar offered greater protection during the winter. The transformation of the caves ecoclimatic prototypes to those of the settlements was a long-term process in which other than climatic factors such as the development of

6. GARDINER, S., (1976), p.1.



farming and other skills were also involved<sup>7</sup>.

On the other hand, vernacular building even in its pre-industrial form and organization involves some sort of specialised knowledge brought about by urbanization. This sort of specialized knowledge, reflected also in the existence of some kind of design process, divides knowledge about buildings into two parts: the first shared by the owner and the tradesman and second concerned with the specialised knowledge of the tradesman alone. In their common prototype ecoclimatic values are, of course, shared but there are additional considerations to be made by the tradesman alone, especially in relation to specific family requirements, to the site and to the microclimate. Rapoport, quoting a Yugoslavian study describing the "design" of a house in Sarajevo during the Islamic period, illustrates the point above:

"One day the owner of the neighbouring garden brought a carpenter to the site and told him to build up a house. They stopped on a spot where the ground sloped gently downwards. The carpenter had a look at the trees, the ground, the environments, and the town in the valley. Then he proceeded to extract from his cummerbund some pegs, paced off the distances, and marked them with pegs. (Note that there is no question of *what type* of house is to be built - there is a self-evident accepted model). Thus he came to his *main* task. (Italics added). He asked the owner which trees might be sacrificed, moved his pegs for a few feet, nodded and seemed satisfied. He found that the new house would not obstruct the view from the neighbouring structures ... (and then he goes on to examine light, sun, water and so on)".<sup>8</sup>

In connection with the above quotation, Rapoport notes:

7. For a discussion concerned with this transformation refer to GARDINER, *op.cit.*, p.1-4.
8. Quoted by RAPOPORT, A., (1969), p.5, from GRABTIJAN, D. and NEIDHARDT, J., *Architecture of Bosnia, Ljubljana: Drzvena Zalozba Slovenije, 1957, p.313.*



"The Bosnian description sums up the characteristics of vernacular building as I see them; lack of theoretical or aesthetic pretension; working *with* the site and micro-climate; respect for other people and *their* houses and hence for the total environment, man-made as well as natural, and working within an idiom with variations within a given order".<sup>9</sup>(his emphasis)

In reference to both the Bosnian description and Rapoport's remarks, it is worth noting that: the lack of "theoretical or aesthetic pretensions" is compensated by the shared prototypes; the carpenter is "working *with* the site and micro-climate" that is, with additional ecoclimatic knowledge; the carpenter is "working within an idiom with variations within a given order", that is, with generalized prototypes exhibiting strong prescriptive capacity.

In terms of the ecoclimatic prototypes which enter the production of the vernacular building, one could suggest that they belong to both categories of the "shared" prototypes and the "specialized" ones of the carpenter. The shared ecoclimatic prototype is manifested in the owner's confidence that the carpenter *knows* how *he* is expecting the building to behave microclimatically. The shared prototype is referred to gross modifications of the built-form brought about by climatic and socio-cultural factors, over a period of many years and sometimes centuries. On the other hand, the carpenter's specialized ecoclimatic prototypes are concerned with the particular procedure by which the owner's shared prototypes are to be constructed in relation to the particular characteristics of the site and the microclimate.

An understanding of the processes by which a "shared" or a "specialized" ecoclimatic prototype is structured and transformed

9. RAPOPORT, A., (1969), p.5.

demands a much higher level of analysis from that of the individual building. At a general level, philosophies dominating man's relation to nature or man's relation to health may be seen as generative factors affecting the overall organization of the ecoclimatic environment and the prototypes that man structures within it.

### 2.3 BIOMEDICAL PHILOSOPHIES AND PARADIGMS INFLUENCING THE ECOCLIMATIC CONCEPTUALIZATION OF THE BUILT ENVIRONMENT

The concept of "health" has played an important part in the historical evolution of the ecoclimatic environment of cities without this meaning that it ever became its major generator force for their organization as a whole. Nevertheless, the various bio-medical philosophies have contributed to the spatial organization of cities by establishing systems of evaluation for the ecoclimatic environment. It is not accidental that the advocates of the Hippocratic doctrine, as Hippocrates himself, had repeatedly made planning and design propositions. Their writings reflect that propositions of this kind were not the by-products but the "core" of their medical philosophy.

Health, from very ancient times, has been related to environmental factors and particularly those of climate. Chinese philosophers, several thousand years ago, advocated that health requires a way of life compatible with the laws of the seasons<sup>10</sup>. Bio-medical philosophies as they have been transformed from ancient to modern times may be used to illustrate, very generally, ecoclimatic attitudes which influence the organization of the built environment.

10. DUBOS, R., (1970), p.77.

The discussion in the following sections makes clear that the history of the ecoclimatic organization of the built environment has been determined not only by the state of the environmental technology, but also by the prevailing attitudes towards health, disease and, more generally, towards nature.

### 2.3.1 Deification of the man-climate interaction

Climatic conceptualization in ancient Greece was undoubtedly characterized by the deification of climatic elements such as wind, sun and rain, and of health. The symbol of the perfect physician for the ancient Greeks was Asclepius with his daughters Hygieia and Panacea. As Dubos observes, it was this Asclepiad tradition which gave rise to Hippocratic medicine and, indirectly, to the basic structure of modern medicine<sup>11</sup>. Hygieia and Panacea symbolize two radically different and yet complementary approaches to the control of disease widely used in modern medicine.

"Hygieia was one of the manifestations of Athena, the goddess of reason. She was concerned not so much with the treatment of disease as with its prevention and with the maintenance of health. She symbolized the belief that men would remain healthy if they lived within the golden rule and according to the laws of reason."<sup>12</sup>

It is precisely this concept of Hygieia that for many centuries has formed the basis for describing and evaluating the ecoclimatic environment. Even today, schools of hygiene emphasize the prevention of disease in the community as a whole through healthy social practices and descriptors like "unhealthy site" or "unhealthy weather" are still preserved in everyday language.

11. *Ibid.*, p.79.

12. *Ibid.*

### 2.3.2 From deification to rationality: Hippocrates' doctrine

Hippocrates had a dominating influence on the development of western medicine. He lived, practised and taught on the Greek island of Cos around 400 B.C. His doctrine gave the Asclepiad philosophy a more rational basis. The fundamental characteristic of his philosophy was that diseases are not caused by capricious gods or irrational forces, but that they constitute natural phenomena which behave according to specific natural laws.

The effect of the Hippocratic doctrine on the overall conceptualization of the physical and the ecoclimatic environment should not be underestimated. His primary principle, that medicine should be based on the natural sciences and not on religion and that the physician should be able to recognize the logical relations between cause and effect in natural phenomena, still lies at the heart of western philosophy. Furthermore, Hippocrates made a number of points related to the ecoclimatic conceptualization of the environment which are briefly summarized by Dubos:

- "1. The well-being of man is influenced by all environmental factors: the quality of air, water and food; the winds and the topography of the land; and the general living habits ...
2. Health is the expression of harmony among the environment, the ways of life, and the various components of man's nature ...
3. Whatever happens in the mind influences the body and the body has a like influence on the mind. Mind and body cannot be considered independently of each other. Health means, therefore, a healthy mind in a healthy body. It can be achieved only by governing all activities of life in accordance with natural laws so as to create an equilibrium between the forces of the organism and those of the environment ..."<sup>13</sup>

13. *Ibid.*, pp.82-83. For a general discussion on the influences of Hippocrates' doctrine on the development of western medical thought see LLOYD, G.E.R., (ed.), Hippocratic Writings, Penguin, (1978); especially his Introduction.

### 2.3.3 The body-machine paradigm: Descartes' dualism

During the 17th century René Descartes and his followers introduced the model of body-mind dualism based on the assumption that man consists of two separate entities, body and mind which, though linked during life, are of profoundly different kinds. Descartes himself claimed that since the mind is a direct expression of God, its nature cannot be understood by science<sup>14</sup>. Later, during the 19th and 20th centuries, the analogy between bodily operations and those in a machine make a remarkable impression on physiologists who began to study man in terms of energy requirements, working efficiency, metabolism and other physiochemical processes. Descartes' simplistic model has been proved operationally useful, although its philosophical validity has been questioned in many scientific circles.

The body-mind dualism in its Cartesian or Kantian version represents the general paradigm of science during the 17th century onwards. As Dubos points out, "Since Descartes' time, the study of the body machine, its structure and its functions, has reflected directly the state of knowledge in physics, chemistry and other natural sciences."<sup>15</sup> The social sciences have been influenced also by Descartes' philosophy just as the paradigm itself was influenced by the social philosophy and the scientific epistemology of Descartes' times.

As we shall see later, the body-machine paradigm had serious influences in town planning and particularly in the description of the relationships between man and his physical environment. Studies

14. See DESCARTES, R., "*Meditations on First Philosophy*" (1641) in VESEY, G.N.A., (ed.), (1970), pp.22-36.

15. DUBOS, R., (1970), p.85.

on man-climate interaction based on an overall ecoclimatic conception expressed in terms of the body-machine analogy still continue to be developed along the channels opened by Descartes and his followers, though in practice they have proved inadequate for a comprehensive understanding of the complexity of both man's nature and his products.

J.R. Ravetz has bitterly observed that:

"... the wreckage of so many of the great schemes for human betterment is, sadly, only the natural state of affairs, at least so long as our conception of 'science' is that inherited from Galileo and Descartes."<sup>16</sup>

#### 2.3.4 The whole-man paradigm

This holistic approach started to appear a hundred and fifty years ago when humanitarianism emerged as a dominant social philosophy. The fundamental principle behind this philosophical movement was that man's nature and thereby his individual or social behaviour is the result of complex inter-relationships between body, mind and environment. Within this context, Pavlof's experiments on conditional reflexes and later the Freudian psychosomatic medicine established a sufficient conceptual basis to question Descartes' dualism.

Although this new paradigm has since dominated social sciences and especially psychology and philosophy, in the fields of human practices, like architecture, it has not so far established a strong paradigmatic stage. An explanation for this might be that the approach rarely lends itself to the acquisition of precise knowledge, though it is philosophically correct to think of man in his total environment. This accounts for the slow progress in scientific fields, like architectural climatology, in this direction and also for the general influence of the mechanistic paradigm on these fields.

16. RAVETZ, J.R., (1973), p.320.



Nevertheless, the whole-man philosophy is gradually gaining ground as the establishment of areas of investigation like environmental psychology, psycho-climatology, socio-climatology indicates.

## 2.4 HIPPOCRATES' INFLUENCE ON THE ECOCLIMATIC CONCEPTUALIZATION OF SPACE IN THE GREEK AND ROMAN CULTURES

### 2.4.1 "Airs, Waters and Places"

The oldest known systematic account of the effect of environment on people is to be found in Hippocrates writings on *"Airs, Waters and Places."*<sup>17</sup> This text was probably intended to provide the Greek physician arriving in a new city or locality with some knowledge of the consequences of people's ecoclimatic environment upon their general state of health. *"Airs, Waters and Places"* ceased to be reprinted as a practical guide to physicians just after 1874, and dominated western medical philosophy for more than two thousand years.

The pre-Hippocratic tradition of the pre-Socratic philosophers had already turned its philosophical scope towards rational explanations of man's nature and his state of health. Alcmaeon of Croton, for instance, had before Hippocrates advocated that:

"Disease occurs sometimes from an internal cause such as excess of heat or cold, sometimes from an external cause such as excess or deficiency of food. It may occur in a certain part, such as blood, marrow, or brain; but these parts also are sometimes affected by external causes, such as certain waters, or a particular site, or fatigue, or constraint, or similar reasons."<sup>18</sup>

That both supernatural and natural forces determine human life to a great extent have been considered as a reasonable explanation

17. *For a comprehensive discussion of the general influences of these writings, especially in the evolution of western medicine, see MILLER, G. (1962) and EDELSTEIN, L., (1939).*

18. *See MILLER, G., op.cit.*



throughout man's historical evolution. Even in modern times, all cultures have in their language and traditions references to the biological effects of winds, the turn of the season, the phases of the moon and even the influence of sunspots and stars<sup>19</sup>. But, the real shift from the religious to rational explanations of human nature and its manifestations started with Hippocrates.

Hippocrates tried to relate public hygiene to the choice of sites, the ecoclimatic planning of cities and the way in which such planning was conceptualized and understood by the layman and the physician of these times. For him, the orientation of buildings and streets to minimize the summer sun and maximize cooling breezes, the avoidance of marshy unhealthy lands and generally unsanitary surroundings, the overall climatic performance of cities, were the primary measures to be taken in order to achieve a sanitary ecoclimatic environment. It is characteristically relevant to our times that Hippocrates' proposals did not apply to the existing cities, mainly because they were in conflict with the overall political and economic elite, as well as with the planning tradition of using every bit of land available through a "cluster" building design. Lewis Mumford, for instance, points out that:

"These prescriptions (of Hippocrates) did not make headway quickly. It was easier for the wealthy and the leisured to visit a distant sanatorium when they were ill than for a municipality to provide the capital needed for great works of engineering that would bring pure water down from the hills, provide ample open spaces for recreation within the city, open up the crowded dwelling quarters and secure circulation of air, if not by lessening residential crowding, then by intersecting each building block, at frequent intervals, by streets and alleys."<sup>20</sup>

19. See, for instance, the epistemological discussion concerned with the philosophical differences between "astronomy" and "astrology" in KUHN, T., "Logic of Discovery or Psychology of Research?" in LAKATOS, I., MUSGRAVE, A., (eds.), (1970), pp.7-10.
20. MUMFORD, L., (1966), p.167.

The first practical application of Hippocrates' theory was introduced to the new Hellenistic cities in Greece and Roman colonial towns. As we shall see later, Vitruvius' writings which reflect the influence of this theory on the town-planning and architecture of the 1st century A.D. show that, in terms of the ecoclimatic conceptualization of the built-environment, Hippocrates' paradigm remained alive without any drastic transformations.

A brief description of the urban climate and microclimate of the Greek cities during the 5th and 4th centuries B.C. may help to display some of the problems which generated Hippocrates' proposals. Greek cities were characterized by primitive housing accommodation and lack of sanitary facilities, although building technology had already been developing since Minoan times. They were characterized by overgrowth and high densities and by lack of open spaces. The streets were little more than alleys; just a few feet wide. Refuse and ordure were widely spread all over the city, inviting disease and multiplying the severity of plagues. It is not surprising that Aristotle also had prescribed in his "politics" the need for official sanitary inspectors to exercise supervision over the town's refuse. It is reasonable, therefore, that a good physician of that time should have been also a town-planner and an architect and a climatologist. According to Hippocrates, a physician who cares about his profession is the one who understands the seasons of the year and the diseases they may produce; who marks carefully the location of the town and its orientation in terms of sun and wind, and who knows the effect of hot or cold, of wet or dry climates on human health, and so on.

#### 2.4.2 Theophrastus: "On Winds and Weather Signs"

Theophrastus, a pupil of both Plato and Aristotle, in his works "*On Winds*" and "*On the Signs ...*" clearly expresses the climatic and ecoclimatic concepts held by the Greeks during the peak of their intellectual development (4th century B.C.). The biomedical philosophy of Hippocrates had a remarkable influence on the writings of both Aristotle and Theophrastus. For instance, in the Aristotelian philosophy "Nature" was reduced to four fundamental properties: "the hot", "the cold", "the dry" and "the moist". These elementary principles compounded two-by-two produce fire (hot + dry), air (hot + moist), earth (cold + dry) and water (cold + moist)<sup>21</sup>.

In his first treatise "*On Winds*" Theophrastus describes extensively the characteristics and the "properties" of winds<sup>22</sup>. His analytical description is extended to wind modification of small spaces and in the vicinity of the building, to wind turbulence, to the draughts of enclosures, etc. But most interestingly, from para 56 onwards, Theophrastus attempted to describe, in his own conceptual framework based, primarily, on the Aristotelian model of nature, the physiological and psychological interactions between winds and people. It is interesting to see the following large quotation:

"...with Southerly winds men find themselves more weary and incapable; and the reason is that, instead of a little, a great deal of moisture is produced, being melted out by the heat; and so instead of a light air, there is a heavy damp ... Northerly winds will produce a certain balance, so that we are stronger and can exert ourselves more.

Again, Southerly winds, when dry and not rainy, produce fevers; for being naturally warm and moist they induce in our bodies a warm moisture that is foreign to them; and such a condition is feverish; for fever is due to the excess of

21. THEOPHRASTUS, (1894), p.12.

22. *Ibid.*, para 1 - 56 of the first treatise "*On Winds*".

both these two conditions. But, when these winds are accompanied by rain, the rain cools the system.

In the same way, whatever else affects the habits of our bodies depends on one or other of these conditions; and such things are very numerous, and are observed in numerous persons; but the causes of all are the same, or very nearly so ...

So, too, in the case of inanimate things; such as the breaking of lyre strings, the cracking open of glued articles, and other occurrences which happen as things become moist and slack. For instance, in the manufacture of iron they say that they can beat it out further with a Southerly wind than with a Northerly; and the reason is that Northerly winds dry up and make hard, but Southerly winds moisten and soften; and everything is easier to work when it is softened, than when it has become somewhat hardened. At the same time, however, (the smiths) are stronger and more active in Northerly winds."<sup>23</sup>

Apart from its deterministic character, the above description of the relationships between man and wind within the framework of the Aristotelian concept of Nature clarifies a great deal of the conceptual and methodological bases through which the ecoclimatic environment during the 4th period was approached. It specifies, for instance, that man-environment interaction should be understood at all physiological, psychological and behavioural levels. That climatic influences on man should be understood in their totality which is extended to "numerous" aspects of the way of life and mostly in the activities of people. More interestingly, it suggests a methodology by which description of climatic elements stems from the observation of the transformations that these elements influence on the way of life and the activities of people.

Theophrastus' second treatise *"On the Signs of Rain, Winds, Storms and fair Weather"* may be thought of as the first written text on forecasting climatology. Climatic data were taken by astronomical observations, the behaviour of domestic animals and day-to-day or seasonal weather information as far as rain and wind were concerned.

23. *Ibid.*, p.49-50.

But much of his information derives from Aristotle as, for instance, in the case of the diagram which defines the directions of winds:

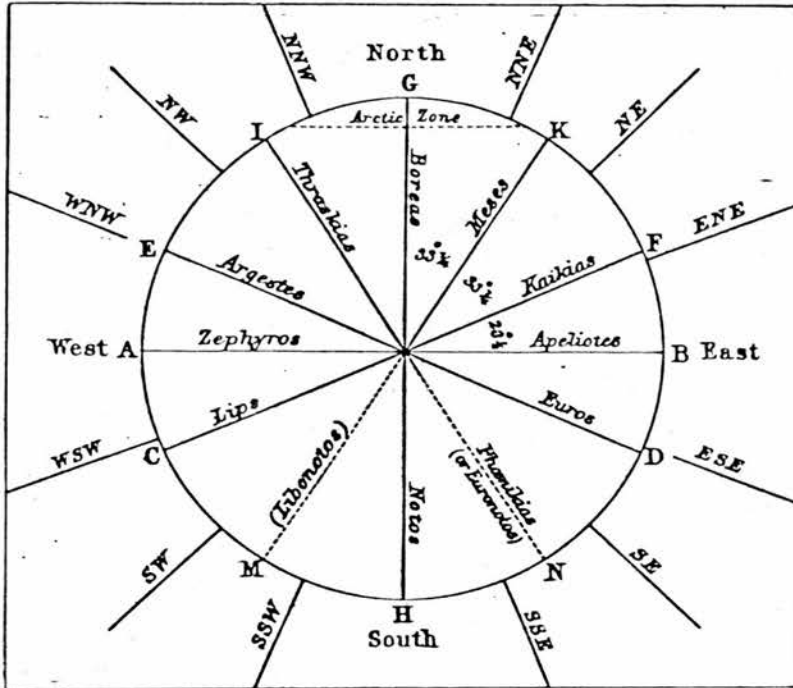


FIGURE 8: DIAGRAM OF THE DIRECTIONS AND ORIENTATIONS OF WINDS BY ARISTOTLE, ADOPTED BY BOTH THEOPHRASTUS AND VITRUVIUS.

#### 2.4.3 Vitruvius' Building Climatology

Marcus Vitruvius Pollio, a Roman architect of the 1st century B.C., presents the most interesting example of architectural internalization and comprehension of the Hippocratic and Aristotelian philosophy, especially in terms of the ecoclimatic organization of the built environment. His precepts were accepted for almost twenty centuries by western architecture and his written work is the oldest and most influential work on architecture in existence<sup>24</sup>.

24. See MORGAN, M.H., 1914 translation of VITRUVIUS, "The Ten Books of Architecture", published by Dover Publications in 1960. (Bibliographical reference under VITRUVIUS (1960)).



In the first chapter of his first book, Vitruvius explains his attitude towards his concept of climate and its interaction with the built environment, in a way that shows his loyalty to the Hippocratic conceptualization of ecoclimate.

"The architect should also have a knowledge of the study of medicine on account of the questions of climates (in Greek κλίματα), air, the healthiness and unhealthiness of sites, and the use of different waters. For without these considerations, the healthiness of a dwelling cannot be assured."<sup>25</sup> (his parenthesis)

It is characteristic that Vitruvius was working on interdisciplinary grounds not only in his concept of architecture but also in the environmental aspects of it, as for instance in its relation to climate. In the choice of a proper site for a new town he gives priority to the general environmental and climatic factors, even from the needs of fortification. His choice of site was dependent on both regional and local climatic and landscape conditions. He states:

"First comes the choice of a very healthy site. Such a site will be high, neither misty nor frosty and in climate neither hot nor cold, but temperature (regional considerations); further, without marshes in the neighbourhood (landscape considerations) ... Again, if the town is on the coast with a southern or western exposure, it will not be healthy ... (local climatic considerations)."<sup>26</sup> (my parentheses)

And elsewhere:

"After ensuring on these principles the healthfulness of the future city, and selecting a neighbourhood that can supply plenty of foodstuffs..., the next thing is to lay the foundations for the towers and walls (environmental considerations come prior to the needs of fortification).... The town being fortified, the next step is the apportionment of house, lots within the wall and the laying out of streets and alleys with regard to climatic conditions... (urban climatic considerations)."<sup>27</sup> (my parentheses)

25. *Ibid.*, Book I, Ch.1, p.10.

26. *Ibid.*, Ch.4, p.17.

27. *Ibid.*, Ch.5, pp.21,24.

Wind modification by means of particular urban organizations becomes very important in Vitruvius' writings. He produced a geometrical method for assessing the town streets in such a way that favourable wind modification could result and by which "... the disagreeable force of the winds will be shut out from dwellings and lines of houses."<sup>28</sup> The turbulence of wind is also taken into consideration:

"For if the streets run full in the face of the winds, their constant blasts rushing in from open country, and then confined by narrow alleys, will sweep through them with great violence."<sup>29</sup>

Vitruvius' deterministic concept of climate in respect of the location of cities and the major characteristics of the urban form such as streets layouts, was extended also to the level of individual houses. In Ch. 1 of his Book VI, which is devoted to climate as determining the particular structure and style of the house, he specifies:

"If our designs for private houses are to be correct, we must at the outset take note of the countries and climates in which they are built. One style of house seems appropriate to be built in Egypt, another in Spain, a different kind in Pontus, one still different in Rome, and so on, with lands and countries of other characteristics..."<sup>30</sup>

The physiological level in the interaction of man and climate is well established in Vitruvius' conceptual and descriptive framework. But, most importantly, there is a continuous effort in Vitruvius' writings to relate man's psychological, behavioural and even sociological and ethnological characteristics to climate factors. For instance, he attempted to relate phonology and human intelligence to the climatic elements of heat and moisture. However,

28. *Ibid.*, Ch. VI, p.27.

29. *Ibid.*,

30. *Ibid.*, Book VI, p.170.



he indicates quite clearly what we may call a cultural approach to the ecoclimatic environments.

"Now if it is a fact that countries differ from one another, and are of various classes according to climate, so that the very nations born therein naturally differ in mental and physical confirmation and qualities, we cannot hesitate to make our houses suitable in plan to the peculiarities of nations and races since we have the expert guidance of nature herself ready to our hand."<sup>31</sup>

It is especially in the fourth chapter of Book VI that the main characteristics of Vitruvius' conceptualization of the ecoclimate at the microclimatic level becomes apparent. There he examines the layout of the house in respect of the relationships between indoor and outdoor environment; between climatic qualities and certain indoor activities; and between plan and orientation. His description is comprehensive enough to grasp the total structure of the ecoclimatic environment in terms of climatic elements, built form characteristics and behavioural patterns and activities:

"Winter dining room and bathrooms should have a south-western exposure, for the reason that they need the evening light and also because the setting sun facing them in all its splendour but with abated heat, lends a gentler warmth to that quarter in the evening. Bedrooms and libraries ought to have an eastern exposure, because their purposes require the morning light, and also because books in such libraries will not decay ... Dining rooms for Spring and Autumn to the east; for when windows face that quarter, the sun, as he goes on his career from over against them to the west, leaves such rooms at the proper temperature at the time when it is customary to use them..."<sup>32</sup>

## 2.5 ECOCLIMATIC ASPECTS IN THE HISTORY OF TOWN PLANNING

In examining the relationship between ecoclimatic conceptualization of the built environment and organization and evolution of open spaces the interaction of certain environmental, economic and social

31. *Ibid.*, Ch.1, p.174.

32. *Ibid.*, Ch.5, pp.180-1.

factors appears to be the generator behind both the spatial formations and the schematization of ecoclimatic prototypes. Although these factors are linked and structured together and at a deeper level are always dominated by the economic hardware of society, it appears that each one of them may become predominant in the process of transforming the above relationship at surface levels and in the process of explaining the reasons behind particular organizations of open spaces at different historical periods.

#### 2.5.1 The ecoclimatic significance of open spaces in Ancient Greek, Hellenistic and Medieval towns

The reason that Hippocrates' philosophy emphasized some kind of environmental control over the built-environment was not only on account of health. Certain open spaces had strong social significance for the ancient Greeks in maintaining their political system, the norms and values of their culture. The "agora", for instance, the core of social and political life in the ancient Greek town, was nothing else but an open space usually in the centre of the city incorporating its political, social, economic and cultural functions, and its performance was strongly regulated by climatic and weather conditions. The agora's political and economic functions diminished later in the Latin countries in favour of the social and cultural ones. Open spaces like "plaza", "campo", "piazza" and "platia" became the informal clubs which even today constitute in these countries the heart of social and cultural life.

The Hellenistic open spaces as distinct from the ancient Greek ones were characterized by a very different organization. The widening of streets which came as a by-product of the multiplicity of carriages and wheeled chariots, as well as from the necessity to allow

the performance of military and religious parades, took place in these cities from the 3rd century onwards. An additional explanation of the openness of the street networks might be that these cities, in the course of their overall development, provided the possibilities of some kind of planning procedures of the type described by Vitruvius. It is especially the desire for light and air that resulted after the 4th century in the building of "stoas", in an attempt to provide more favourable ecoclimatic conditions and, especially, shadow from the mediterranean summer sun for the shops and the pedestrians. Thus, Mumford points out that stoa "became common in Hellenistic cities, with their general effort to improve urban comfort."<sup>33</sup>

Later, during the development of the medieval town the main urban characteristic was its extension in the vertical direction. This lift upwards created, in fact, possibilities for open spaces beyond that of the streets. Here, the predominance of economic and religious factors become the generator force behind the organization and character of open spaces, since they acquired their social significance primarily because they became marketplaces and places for religious ceremonies. Usually, the open space in front of the cathedral contains the market-place and gradually becomes some kind of community centre performing almost all the functions of the "agora" apart, of course, from the political one. Such places were connected with other streets or with narrow covered passages to form a sufficiently integrated circulation network.

Considering the total circulation network, as well as the developments of medieval cities mostly in cold climates, the environmental factor becomes significant for certain particular characteristics

33. MUMFORD, L., (1966), p.226.

and features of the structure and organization of open spaces within the city. A successful ecoclimatic organization of open spaces had strongly appeared. Mumford, for instance, describing the medieval street, emphasises this point:

"But in general, the street was a line of communication for pedestrians, and their utility for wheeled transport was secondary. Not merely were the streets narrow and often irregular, but sharp turns and closures were frequent. When the street was narrow and twisting, or when it came to a dead end, the plan broke the force of the wind and reduced the area of mud. Not by accident did the medieval townsman, seeking protection against winter wind, avoid creating such cruel wind-tunnels, as the broad, straight street. The very narrowness of medieval streets made the outdoor activities more comfortable in winter. But, likewise, in the south, the narrow street with broad overhangs protected the pedestrians against both rain and the sun's direct glare."<sup>34</sup>

What is significant to be considered in relation to the above ecoclimatic organization of medieval open spaces is the recognition and even more the internalization of certain ecoclimatic prototypes of the layman by the architectural and planning profession of that time. For instance, a typical medieval urbanist of the late 15th century, Leone Battista Alberti, gives a lot of insight into the question of the ecoclimatic organization of the medieval built-environment, in his description of the street pattern and its adaptation to environmental conditions which he undoubtedly considers as the major factor contributing to their aesthetic features<sup>35</sup>. Alberti argues:

"Within the heart of the town it will be *handsomer* not to have them (the streets) straight but winding about several ways, backwards and forwards, like the course of a river. For thus, besides by appearing so much longer, they will add to the idea of the greatness of the town, they will likewise be a great *security* against all accidents and emergencies. Moreover, this winding of the streets will make the passenger at every step to discover a new structure, and the front door of

34. *Ibid.*, pp.354-55.

35. For a further discussion on the argument that aesthetic processes are generally dependent on some kind of homeostatic equilibrium, see FITCH, J.M., (1972), Ch.1, pp.1-19.

every house will directly face the middle of the street; and whereas in larger towns even too much breath is *unhandsome* and *unhealthy* in a smaller town it will be both *healthy* and *pleasant* to have such an open space view from every house by means of the turn of the street."<sup>36</sup> (my emphasis)

To get into the real meaning behind Alberti's description of the medieval street, we should not forget how important physical protection against the weather was for the medieval townsman. Glass was not introduced to the stalls and the booths of handicraftsmen and merchants until the seventeenth century, thus business life and even cooking was conducted more or less out of doors. Such organization of commerce and household activities provided strict ecoclimatic requirements for the pattern of the streets and the characteristics of open spaces. In ecoclimatic terms the closed narrow street, the arcaded front and the exposed shop were in fact complementary until, at last, selective environmental filters - such as cheap glass - became commonly accepted.

On the whole, despite the common belief, medieval sanitation was much better than the later towns of the 16th century. This is probably due to the fact that ecoclimatic requirements were much more respected, people were used to the outdoor living and due to the existence of sufficient open spaces at hand, they were engaged in some kind of natural life. Mumford points out characteristically that:

"the medieval town had at its foundation and throughout most of its existence a far higher standard for the mass of the population than any later form of town, down to the first romantic suburbs of the nineteenth century."<sup>37</sup>

36. Quoted by MUMFORD, *op.cit.*, p.355.

37. *Ibid.*, p.333. *It is characteristic that the paving of streets though appeared in the early Roman times, it started to be applied regularly as an urban feature during the early medieval period.*

### 2.5.2 Ecoclimate and suburbanism

The most characteristic and important by-product of the increasing ecoclimatic conceptualization of the city environment on a popular scale is probably "suburbanism". Suburbanism as a phenomenon cannot be described only by environmental dimensions; its origin was influenced by economic and social factors together with environmental ones. At the same time, the factors behind the origin of the suburb at different historical periods cannot be explained by the same model as far as the predominance of their economic, social or environmental feature is concerned.

Suburban movements appeared quite early in history, probably during the Roman times. But the organized expansion of cities started growing during the medieval period as the need for better ecoclimatic environment was increased due to over-population, density and air pollution. From the 13th century onwards the fear of plague prompted periodic exodus from the cities and in this sense, as Mumford comments, the suburb began as a sort of "rural isolation ward"<sup>38</sup>. The superiority of the suburb in contrast to that of the city, in terms of hygiene, was professionally advocated as early as Alberti's time (late 15th century), and the evaluation system used was explicitly an ecoclimatic one:

"The great beauties of such a retreat are being near the city, upon an open *airy* road, and on a pleasant spot of ground. The greatest commendation of itself is its making a cheerful appearance to those that go a little way out of the town *to take the air*; as if it seemed to invite every beholder... Nor should there be any want of pleasant landscapes, flowery mead, open champains, shady groves, or limpid brooks, or streams and lakes for swimming, with all other delights of the same sort. Lastly... I would have the front and whole body of the house *perfectly well lighted, and that it be open to receive a great deal of light and sun, and a sufficient quantity of wholesome air.*"<sup>39</sup> (my emphasis)

38. *Ibid.*, p. 554.

39. Quoted by MUMFORD, *op.cit.*, p. 552.



The suburb brought about significant changes not only to the spatial order of the city, but also in terms of its social context<sup>40</sup>. A general consequence of the enlargement of open areas both in the suburb and in the city resulting from the exodus of a great part of the population to the suburbs, was the opportunity given to every inhabitant of enjoying environmental qualities which in previous times were privileges of the aristocracy. An example of this transformation of open spaces is the well-known "residential square" which appears during the 17th century both in France and in Britain. These "baroque" open spaces, till the end of the 17th century, were used only as parking lots for coaches with a largely minimal social significance apart from their existence as "residential" places. Nevertheless, later in the 18th century when these spaces were planted and transformed into favourable ecoclimatic spots within the city, they invited greater participation by residents, especially during the spring and summer.

### 2.5.3 The ecoclimatic problems of over-urbanization and of industrialization and their impact on the social organization of the industrial city

The increasingly deteriorating ecoclimatic environment of industrial towns, together with overcrowding during the end of the 18th century, constituted imperative reasons for someone to move out to the suburbs. But, paradoxically as it might seem, suburbanism in industrial towns was developing at a low pace. The working class, composing the majority of the urban population and mostly needing an improved sanitary environment, was the least economically capable to

40. *From the early 19th century onwards the impact of suburban planning, well-developed in planning procedures, was transferred to architectural form as well. The basic form constituents of modern dwellings have in their majority firstly achieved in the suburban house.*



respond to the capital needed for a suburban house. Suburbanism was, at this period, confined to the upper classes and this class-character survives in most of the under-developed world.

Urbanization increased in almost direct proportion to industrialization. Both these factors brought the most sharp changes, in the physical and especially the climatic characteristics of the urban environment, while at the same time they created and maximized problems which in turn formed the basis for a new appreciation and conceptualization of the ecoclimatic environment. It is not surprising that these environmental problems appeared together and in parallel intensity with the increasing class differentiation and the struggle brought about by the institutionalization of profit-making economic enterprises. Thus, social and environmental conceptual revolutions during the period of late 18th and 19th centuries present a remarkable chronological connection to the extent that one is tempted to examine them in more detail.

The major contribution of the industrial towns in the development of the social character of town-planning and of architecture was, perhaps, the reaction it produced against its own ecoclimatic standards. The necessity of controlling the increasingly deteriorating ecoclimatic environment by bringing back pure air, greenery and sunlight into the city constitutes the major problem of town-planning attempts of that period, breaking once and for all the traditional theme for urban beauty. Beyond the every-day experience of a miserable microclimatic and ecoclimatic environment, two other factors had primarily influenced the formulation of a new descriptive basis for the ecoclimatic phenomena. The first concerns the pressure of scientific knowledge at that time and particularly the advances in biological sciences which formed a new conception of hygiene and

sharpened the need for pure air and sunlight. The second and even more important factor concerns the general ideological and political movement towards socialism.

At a first level of consideration these factors can be explained by the argument that the newly formed concept of hygiene demanded space, municipal equipment and natural resources, and these demands, in turn, enforced municipal socialization as the only means to fulfil these demands and to improve services. No doubt that such municipal organizations had an important influence on developing the social consciousness of the people. But the major ecoclimatic problems of the industrial town like air pollution, water and land pollution, pollution of buildings and clothes, noise pollution, colourless environments and absence of greenery, high urban density with problems of sunlight and so on, were soon proved capable of surviving in the most developed and organized municipalities. These problems reinforced by poverty had deleterious effects on the people in terms of organic modifications and malformations of the bone structure and organs, plagues and occupational diseases<sup>41</sup>.

Municipal responsibility for control over the ecoclimatic problems of the industrial environment did not help the realization of their strong economic basis. Nor did the developing socialism offer sufficient conceptual platforms on which the strong economic character of environmental problems could be recognized and internalized by people. Science, and especially philosophy and social sciences, still held similar views with Vitruvius, as far as climatic and ecoclimatic influences on the social organization of the city were

41. *Industrial pollution together with poverty had deleterious effects upon the health of the inhabitants. Mumford states briefly: "... organic modifications: rickets in children, due to the absence of sunlight, malformations of the bone structure and organs, defective functioning of the endocrines, through a vile diet; skin diseases for lack of the elementary hygiene of water; smallpox, typhoid, scarlet fever, septic sore throat, through dirt and excrement; tuberculosis, encouraged by a combination of bad diet, lack of sunshine, and room overcrowding, to say nothing of the occupational diseases, also partly environmental."* MUMFORD, *op.cit.*, p.531.

concerned.

I intend to explain the above argument by looking at Montesquieu, probably one of the most important "ideologists" of the 18th century, who prepared the way for the French Revolution. His writings established him as a political philosopher, but also as a legal historian and much more as one of the leading sociologists of his era. The major reason that Montesquieu's work and, in particular, "*The Spirit of the Laws*"<sup>42</sup> becomes relevant to this discussion, is that some of his philosophical and sociological ideas have been illustrated by examples drawn from the physical environment and especially from climate.

Montesquieu devoted a large part of the above work (Book XIV through Book XVIII) to material or physical causes, that is to the influence of soil and climate on human beings, their manners and their institutions<sup>43</sup>. His writings on the influences of climate and land on the ways of life and on the organization of institutions preceded those of social causes. Specifically, his conceptualization of climate follows the pattern that certain physical and climatic environments are directly responsible for certain physiological, nervous and psychological traits of man and, therefore, directly affect man's social organization and culture as a whole. The climatological considerations in his writings have not been really extended beyond a taxonomy of climate in terms of hot, cold, temperate and extreme, but his assumptions about climate - man interaction are in some ways a sociological version of Hippocrates' doctrine. He writes, for

42. *For an extensive summary and critical discussion of Montesquieu's philosophical views in this work, see ARON, R., (1965), Vol.1., pp.17-62.*

43. *In his theory of "causes" Montesquieu studied the influences of two different categories; physical causes and social causes. Examining the "physical causes" he was particularly interested in climate and its influences on the way of life and the social institutions.*

instance, that the "temperaments" and "sensitivity" of people can be attributed directly to climate:

"In cold countries we have very little sensitivity for the pleasures of life; in temperate countries they have more; in warm countries their sensitivity is exquisite."<sup>44</sup>

But, even more questionable is Montesquieu's attempt to relate the physical characteristics of the environment to certain social institutions and certain social behaviour like slavery. Thus, he states that:

"There are countries where the excess of heat enervates the body, and renders men so slothful and dispirited that nothing but the fear of chastisement can oblige them to perform any laborious duty: slavery is therefore less offensive to reason..."<sup>45</sup>

Here we clearly observe not an attempt to indicate climatic influences on certain social institutions but a "*justification*" of slavery in terms of climatic influences.

Montesquieu's views of the relationships between physical realities and social institutions reflect on the whole the sociological framework - dominated by the paradigms of the physical sciences and especially of physics - within which new town-planning proposals later in the 19th century were formulated. The major characteristic of these proposals was the assumption that capitalism is the proper economic basis for the production of the built environment. In the absence of a unifying framework between environmental and institutional manifestations and phenomena arbitrary conclusions were drawn as far as the influences of the physical environment on man were concerned and, beyond that, such conclusions were carefully fitted into the overall economic organization of capitalism. Although capitalism

44. Quoted by ARON, R., *op.cit.*, p.40.

45. *Ibid.*, p.41.

appeared as an economic phenomenon as early as the 13th century, it became clearly a money-making economy only around the 17th century, and developed a spiritual climate which can be understood in its concept of "freedom". Capitalistic freedom means freedom from municipal restrictions and regulations, private investment and profit, in short freedom from any social obligation, and without reference to the welfare of the community as a whole.

The overall impact of the capitalistic economic system upon the production and organization of the built environment is very complex and difficult to evaluate here, but one thing is clear: money interests progressively dominated planning and ecoclimatic interests in laying out and building activities. To quote Mumford:

"... as soon as the principles of capitalist conversion, divorced from any sense of social responsibility were accepted, slum accommodation and slum housing received authorization."<sup>46</sup>

#### 2.5.4 Revival of Hippocrates' doctrine: Sanitary Revolution and Garden Cities

During the late 18th and early 19th centuries there was a strong revival of the Hippocratic doctrine - due to the general impact of Industrial Revolution - which, together with the socio-economic framework presented above, led towards the "Sanitary Revolution" developed particularly in Germany and Britain. The sanitarians were advocating that the environmental problems of health could be solved only by transforming them from an individual to a social level. Thus, in Germany, pioneers in sanitation were projecting the view that the clean city is the surest approach to health. In Britain the reaction towards a healthier city was much stronger, involving many social groups. But, of course, the campaign was carried out by members of the

46. See MUMFORD, *op.cit.*, p.475.

aristocracy who created the "Health and Town Association", a movement which constitutes the prototype of the present-day voluntary health associations throughout the world. The outcome of the sanitary movement in Britain was the Public Health Act of 1875.

At the same time, Benjamin Ward Richardson published his "*Hygeia: A City of Health*" which reflected the sanitary ideal at a planning level. The following quotation gives some idea about his proposals:

"Richardson limited his city to 100,000 persons. He provided, moreover, a limit of 25 persons per acre and houses which should not exceed four stories in height. For maximum ventilation and sunlight, every house had its own ample garden in the back. Even public buildings were invariably surrounded by lawn and garden space.

The paved streets, of course, were spaciouly wide and were kept spotlessly clean. They were washed daily, and debris was carried away beneath the surface. To eliminate noise and accidents, surface streetcars were eliminated in favor of an underground railway system."<sup>47</sup>

It can be argued that Richardson's utopian conception of environmental and social control over the cities, though in conflict with the extreme individualism advocated by Herbert Spencer and well accepted by the Victorian era, served as a counter-movement against more comprehensive social control over the problems created by the Industrial Revolution, because on the whole it suggests that a few prescriptions in terms of environmental management are able to solve medical problems, instead of proposing social, economic and environmental reforms.

In 1898, Ebenezer Howard published his book "*Tomorrow: A Peaceful Path to Real Reform*" which was reissued in 1902 under the title "*Garden Cities of Tomorrow*"<sup>48</sup> Howard's ideas brought a

47. CASSEDY, J.H., (1962).

48. HOWARD, E., "*Garden Cities of Tomorrow*", edited by OSBORN, F.J., Faber Paper Covered Editions, 1965. Listed in the bibliography as HOWARD, E., (1965).



revolution in town planning which might be comparable only to the Vitruvian one in architecture. Mumford, for instance, stressing the importance of Howard's thoughts, considers the aeroplane and the Garden City as the two greatest inventions of the beginning of the twentieth century. Howard, as opposed to the sanitarians, recognized the limitations of municipal administration in giving adequate solutions to city problems and in grasping their political, social and economic dimensions. Thus, his Garden City proposals were very little concerned with the outward form of the new city and in their majority were referred to the processes that would produce such communities.

Howard's intention was to establish an integrated ecological balance through control of the functions and the growth of the city as a whole. He was concerned primarily with the limitations of cities, the organization of business, industry, administration and education, the outdoor ecoclimatic environment, but mostly with the reunion of the city with the surrounding countryside by means of his famous "green-belt".

We should generally admit that Howard's proposals seem to be less utopian than many of his contemporary thinkers believed. Nevertheless, his overall conception characterized, as Mumford notes, by "simple pieties of Victorian rationalism, coloured by Christian benevolence" led him in many respects to fail to consider the major socio-economic forces as the starting point of the processes which account for the organization of the built environment as a whole, and which largely determine the growth as well as the limitations of the city. By saying this, I do not deny some of his thoughts which even today might be of real value. It is remarkable that he called attention to a representative public authority which could have the power to assemble



and hold the land, to plan the city and to provide necessary services; that he refused speculative individual investors, or even owners dealing with individual building lots, individual houses, individual business sites and so on. Mumford suggests that it is probably this part of Howard's proposals that has made him so anti-pathetic to the dominant ideology and practice of our time. However, I must admit his failure to incorporate such proposals into an integrated economic base and within a well-established ideological framework. And, unfortunately, precisely this failure has turned away even those who would have probably agreed to certain social aspects of his theory.

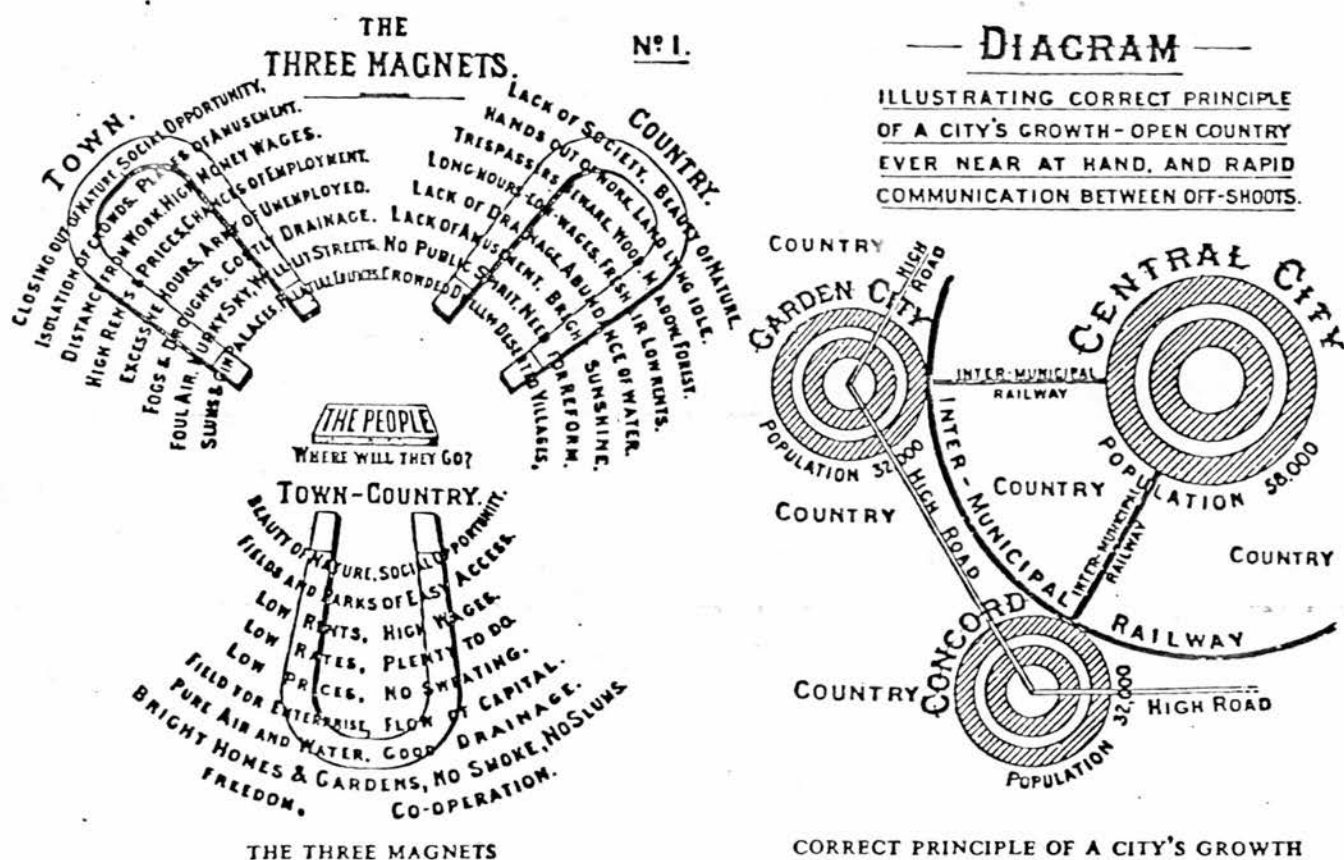


FIGURE 9: HOWARD'S THEORY AND PROPOSALS OF GARDEN CITY, in HOWARD, E., (1965), pp.46,143.

However, much of the responsibility for many of the twentieth century city features, like city park systems, satellite towns, recreation areas, national parks and so on, lies with the organic analogy introduced by Howard and further developed into a social ecology by the inter-war Chicago School of Sociology, and mainly by Geddes. Geddes' pioneering thinking, especially in emphasising the relationship between the physical and the biological on the one hand, and the social on the other, has done much to foster the organic analogy in general and the acceptance of an ecological variation of conservative character in British town planning.

## 2.6 CONCLUSIONS

Man in history has always conceived and described the influences of the climate and of the physical environment on him and his settlements in ecoclimatic terms, that is, by internalizing complex prototypes in the structure of which social, economic, religious and physical (together with climatic) aspects have been integrated. Furthermore, this internalization of ecoclimatic prototypes has been reflected clearly in both the descriptors and the processes by which he organized his habitat. For instance, two and a half thousand years ago, climatic elements like heat, winds, humidity and so forth, were conceptualized and described by means of comprehensive and integrated descriptors like "health" or "disease". And since health was understood to be a required balance of all physiological, psychological and sociological aspects of life, so was climate.

These ecoclimatic prototypes have been generated and transformed, not only in respect of the particular climatic or microclimatic conditions and the changes produced by them in the development and

evolution of human settlements, but also in respect of the general socio-economic problem-situations which have affected man's attitudes towards nature and towards his fellow man. In this respect their structure resembles general paradigms like those of biomedical philosophies. Since, therefore, these prototypes reflect the complex processes by which urban climatic and microclimatic conditions are internalized by the individual or the social group they are obviously structured not only in terms of direct climatic influences on man, but also in terms of all these climatic modifications by means of environmental, behavioural and socio-economic modifiers. The environmental and behavioural components of the prototype are those more easily understood because they manifest themselves in recognizable images, such as natural or artificial environmental objects or behaviour patterns and activity organizations compensating favourable or unfavourable climatic conditions. The socio-economic modifiers, though the most important, since they largely dominate the structure of the previous two, are much more difficult to internalize and, therefore, consciously manipulate during the process of ecoclimatic organization of the built-environment.

The general influences of these prototypes on building development and organization, because of their highly complex structure, are far more difficult to be estimated. At an analytical level, such an attempt would probably require the identification of the particular character of the structure of these prototypes at a given historical period; the degree to which they have been internalized not only by the layman, but also by those responsible for the mechanisms of production of the built environment; and the particular predominancies of different images (e.g. environmental, socio-economic, cultural) structured within the prototype itself. Two factors may primarily

account for the construction of these predominancies: firstly, the magnitude of direct climatic influences on man and his products and secondly, the system of social evaluation within which these influences are to be understood.

However, what became apparent in this historical study was that the socio-economic images of ecoclimatic prototypes were understood only when their predominance in influencing the urban and micro-climatic environment was considerably increased (e.g. during the Industrial Revolution). And most importantly, that it was exactly this socio-economic conceptualization of the physical and climatic environment that provided bases for understanding the general processes which shape and transform the organization of the ecoclimatic environment as a whole.

Unfortunately, the general character of the History of Architecture suggests that self-conscious design or planning processes have largely failed to consider ecoclimatic prototypes within their broader structure. Architectural theories concerned with ecoclimatic concepts - if at all - were usually confined to the environmental image of the prototype, thus forming purely physical deterministic conceptual bases. Physical determinism as a general conceptual base has accommodated different prisms (for instance, climatic, constructional, technological, etc.) through which the building or the settlement is viewed as a result of taking one factor to be prior to the others. There is no need to deny the importance of these factors in influencing directly certain aspects of the organization of the built environment in order to stress that such influences can only be understood and evaluated within a wider system which includes also socio-economic and cultural factors. Rapoport in his book, "House,

Form and Culture", argued about this point very specifically and, in my view, successfully<sup>49</sup>.

Consider, for instance, the concept of "shelter" frequently used in architecture to describe a favourable space for habitation as it is the house. Shelter as a descriptor has played an important role in the conceptual formulation and organization of microclimatic and ecoclimatic problems of the built environment. The problem behind those theories concerned with the concept of house as a "shelter" is that considerations of this kind have inclined towards single causes of form-determinants and they have been especially physically or climatically deterministic in nature. And, although today physical and climatic determinism have lost their popularity in architectural empirical research and, indeed, in practice, it seems that they have left behind a strong conceptual background, particularly dominating the field of architectural climatology. A result of that is the orientation of these studies in examining the climate-man interaction purely in physiological and psycho-physical levels, greatly neglecting the more important socio-economic component of the ecoclimatic prototype.

To reject physical determinism as a possible base on which the ecoclimatic environment could be effectively studied, does not mean rejecting the idea of studying the built environment from a climatic point of view. Climate constitutes a very important factor<sup>50</sup> in the

49. *"The great variety of forms strongly suggests that it is not site, climate, or materials, that determine either the way of life or the habitat. Many examples from almost all areas of the world could be adduced to show that dwellings and settlements are not the result of physical forces, particularly since the form often changes in areas where physical aspects have not changed."*  
 RAPOPORT, A., (1969), p.42.

50. *One could argue from an ecological point of view that climate is the dominating factor since it governs the food chain as well as the physical environment and, thereby, generates socio-cultural activities which compensate favourable or unfavourable conditions.*

habitat of every animal, but it is only through the study of its social, economic, cultural, as well as its physical aspects that its implications on human life could be identified. Beyond that an understanding of the social, economic, cultural and physical dimensions of climate, though necessary, is not enough for comprehensive planning and design of the ecoclimatic environment even in theoretical terms. We need to know how all these influences come together and interact and finally are grouped in the structures which we have called ecoclimatic prototypes.

The counter-movement to physical determinism has already been formulated in disciplines like those of Cultural Geography, Social Anthropology, Cultural Ecology and, to a lesser extent, in Architecture. We might say that these are disciplines which have not yet reached the other pole, that of social determinism. Social determinism would probably isolate man's products at an institutional level, neglecting the physical or environmental image. However, I do not think that such an approach, though useful in certain areas of investigation, could explain sufficiently architectural phenomena which undoubtedly present a strong environmental image. But the recognition of the institutional dimension of the artificial environment, even in its ecoclimatic aspects, is inevitable for understanding these structures.

My hypothesis, therefore, is that the existing distinction between socio-cultural and physical phenomena, as far as conceptualization of the built-environment is concerned, is an artificial one and fails to describe comprehensively the nature of the processes either physical or socio-cultural that are involved in the production and transformation of these phenomena. Furthermore, that climatic phenomena in architecture can be studied also at a cultural level, especially

because they are capable of being transformed - and always are - from an environmental to an institutional and even to a symbolic level. In doing so, they interact directly with all the different images in which built environment is organized.

The objective of the present work is, among other things, to examine the possibilities of formulating a sufficient conceptual and methodological framework within which the above hypothesis can be tested and further developed.



## PART II

### TOWARDS A TAXONOMY OF ECOCLIMATIC STUDIES WITHIN THE BROADER FRAMEWORK OF ARCHITECTURAL RESEARCH

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## CHAPTER 3

PSYCHOLOGICAL AND CULTURAL DIMENSIONS OF THE CONCEPT OF  
ECOCLIMATE

The general aim of this Part has been to organize an "integrated conceptual basis of taxonomic character" in which microclimatic and ecoclimatic studies may be viewed within a "proposed broader framework of architectural empirical research". The reasons for this have been given briefly in the Introduction of the thesis and they are further developed here.

In organizing such a framework it is essential that the investigation should follow two different, though in many respects interconnected, approaches. On the one hand, efforts have been made to present a review of the basic concepts, the major research concerns in architectural climatology, and the problems which are directly or indirectly concerned with different levels of relationships between man and his climatic environment. Whilst doing so, gaps in research were indicated towards which further research should be oriented in order to establish more integrated and comprehensive approaches to the microclimatic and ecoclimatic problems of the built environment. On the other hand, attempts have been made to show that the ecoclimatic phenomena of the built environment can be treated not merely as "physical" but more significantly as socio-cultural and institutional and, moreover, that it is only in this broader context that these phenomena become meaningful and amenable to social evaluation. Further discussion of these two

points is given below.

The variety of studies which are directly concerned with climatic aspects of the built environment are scattered not only in the literature of architectural and building climatology but also in the fields of environmental and ecological psychology, psycho-biology, cultural anthropology, human ecology and in other fields of environmental or cultural concern. Several reasons might be given to explain why no serious attempts have been made so far to review and present in an integrated and comprehensive manner the diversified information provided by these fields. Some of these will be given in the following paragraphs.

A first and major reason is of an historical character. During the period 1930-50 when most fields of applied climatology were rapidly developing, there was a strong negative reaction to the suggestion that man's social behaviour and institutions may be determined significantly by his physical environment. As a result of that, architectural climatology, a field which may offer common grounds for interdisciplinary considerations on micro- and eco-climate, found itself restricted to purely physical aspects and the physiological functions manifested in the man-climate relations.

A second reason is methodological. It is concerned with both conceptual and descriptive difficulties which stem from the high degree of complexity generated by the very nature of microclimatic and eco-climatic phenomena when they are considered especially from an integrated socio-economic and cultural point of view. To this we might add the problem of data which manifests itself in the failure of architectural and building climatological methods and techniques to deal "simultaneously" with design and scientific climatic analysis.

A final difficulty is connected with the disorientations of certain environmental problems which are directed to different spheres of investigation. These occur for two reasons. The first is concerned with the failure of scientific methods of observation to recognize the exact nature of the general environmental implications on the built environment of the continuous and mostly unconscious familiarity which characterizes the interaction of man with these phenomena. The same problem is faced in all those disciplines where the object of investigation is part of a continuing experience (for example in psychology and linguistics). The second reason for disorientation is the "displacement" of environmental problems by methodologies which are considered "rational" within the socio-economic system of the most technologically advanced western cultures. This is undoubtedly due to the influence of western ideology upon the system of production of scientific knowledge. The emphasis on technological support to solve certain ecoclimatic problems and the increase of artificially extended needs for comfort, manipulated by the market forces, could be given as examples of this.

A second target towards which the investigation in this Part is orientated, is to show that microclimatic and ecoclimatic phenomena of the built environment are heavily charged with cultural input. This effort has been based on the general assumption that climate, together with other physical aspects of the built environment, influences man's behaviour and culture to the extent that knowledge of this kind is necessary at various levels in order to enable a meaningful organization and evaluation of this environment.

Without ignoring certain arguments which maintain that the amount of variation in human behaviour produced by the physical environment is

minimal, compared with that produced by the social, institutional or cultural environment. I intend to argue that the internalization of the microclimatic and ecoclimatic phenomena at both the individual and societal levels unavoidably attaches to them cultural dimensions. Thus, without assuming any physical or social determinism, I maintain the argument - which I will try to illustrate in the following paragraphs - that certain aspects of the quality of human life are in many respects related to the ecoclimatic and the overall physical organization of the environment in both psycho-physiological and cultural terms.

Architecture has been ambitiously, but repeatedly, defined as "the organization of the elements of any type of environment" including the perceptual environment and that of social structure and economy<sup>1</sup>. Thus, one of its problems is, and always was, the organization of the perceptual environment, that is, of those elements which come under our visual haptic, auditory and olfactory perceptual systems. Today, there exists a vast variety of architectural studies which have tried to import and absorb the information provided in both theoretical and empirical terms, in psychology, sociology, physiology, social anthropology, human ecology, and so on. Behind all these studies there is the assumption that architectural elements, physical or organizational, determine to a certain extent human behaviour, not only in terms of providing (or not) possibilities for communication, for gathering, for work or for other specific activities, but also because environmental sense-images are internalized and structured by man to form a kind of environmental language, just as human sound-images form a language for verbal communication.

1. See, for instance, FATOUROS, D.A., (1972), p.17.

Psychological studies of the perceptual organization of the environment have reached certain proposals, the significance of which cannot be underestimated if the architectural environment is considered as part of a wider environmental language. G.L. Gregory<sup>2</sup>, for instance, speaks about a "grammar of vision" - a sort of structure which precedes the grammar of language. Piaget, also speaking about the pre-operational stage of a child's intellectual development, stresses the point that spatial manipulation forms a prerequisite for language acquisition. In fact, there is some sort of agreement that the learning of environmental structures goes much deeper than does the Chomskian notion of deep structure in language.

The majority of studies concerned with the physical environment and especially with the ecoclimatic one, have been based on the assumption that it is "something" which exists outside man. In these terms, the most significant contribution of psychology to the general epistemology of the sciences of man can be found in its success to prove that, as far as human perception and knowledge are concerned, the only physical environment which exist is that which facilitates or restricts man in his biological and cultural evolution. Accordingly, experimental studies have made a number of points which cannot be ignored when we deal with the perceptual organization of the micro-climatic and especially the broader ecoclimatic environment. The qualities and the characteristics of the ecoclimatic sensations of man (thermal, pressure, noise, comfort, etc.) are directly related with the source of stimulation from which these sensations are generated. Although it is true that without physical stimulation no sensation arises it is also true, and far more important, that these sensations depend

2. GREGORY, G.L., (1970).



largely upon previous experiences and that they are explained only through the particular past of the individual or of the society.

The argument that the major significance of ecoclimatic environment, as far as architecture and planning are concerned, can be found in its capacity to influence man's perceptual ability and consequently other aspects of his material life immediately dependent on it, has also been presented by cultural ecologists dealing with those ecological factors which determine to a degree man's perceptual ability<sup>3</sup>. However, some hypotheses have gone even further in suggesting that the perceptual organization of the environment influences man not only perceptually, but also "conceptually" with much greater effects on his patterns of behaviour. Psychological studies like those of Fiske et al.<sup>4</sup> and Gibson<sup>5</sup>, have shown that the total interaction of man with his physical environment depends not so much on the quantity of stimulation as on the way in which stimulation is organized. Piaget, for instance, referring to the human need for stimulation, suggests that this need should be understood not simply as a "hunger for stimulus" but as a "functional food" since stimulation is functionally connected with the conceptual schemata which are responsible for the reaction of man to these stimuli<sup>6</sup>. This is of great importance and should be remembered when dealing with the perceptual organization of the built environment, since architecture organizes a large part of

3. *For brief discussion on this argument see LEE, S.A., (1973) and RAPOPORT, Amos and WATSON, N., (1968).*
4. *Fiske and Maddi have developed a group of proposal-hypotheses which are referred, within a proper psychological context, to relationships like stimulus-impact; impact-activation level; activation level - arousal or performance, etc. They support these proposals-hypotheses through a number of experimental or theoretical works of different authors which provide useful material for explaining psychologically the influences of environment stimulation on different aspects of human behaviour. See FISKE, W.D. and MADDI, R.S., (1961).*
5. *GIBSON, J.J., (1966).*
6. *PIAGET, J., et al., (1963).*



the sources of stimulation which act upon man.

However, psychology itself does not provide an appropriate context to understand the concept of ecoclimate and its significance to architecture. Ecoclimate should be discussed within a general approach organized in such a way as to produce an integrated taxonomic basis for ecoclimatic phenomena within the context of architectural empirical research. In particular, a general ecoclimatic approach to architecture necessitates first the development of ecoclimatic conceptual bases, and the investigation of the general ecoclimatic descriptors which derive from them. It necessitates, also, the search for a general framework of architectural research within which ecoclimatic research may be organized and discussed in reference to the overall complexity of the built environment. Whilst doing so, it is possible to indicate a way towards integration and comprehensiveness of ecoclimatic descriptors and towards coordination with other descriptors common to architectural practice. This task becomes the subject of discussion in the next two chapters.

## CHAPTER 4

### COMPLEXITY LEVELS, CONCEPTUAL BASES AND DESCRIPTORS COMMON TO ECOCLIMATIC RESEARCH

#### 4.1 INTRODUCTION

The study now develops in two interacting, though conceptually distinct modes. In the first place, we are interested in understanding and defining the nature of the ecoclimate itself at a level of systemic analysis and, thus, the object of investigation consists of studying the sets of relationships formed among climate, buildings or urban spaces, and man. Here, the aim is to describe the different levels at which these sets or systems of relationships are organized and structured in forms useful to architectural practice. An additional aim is to define the limits within which "relational" analyses of ecoclimatic phenomena may acquire the necessary applicability to the "real-life" situations of the built environment.

In the second place, ecoclimate is considered as an organized and structured totality: that is, as a particular "schema"<sup>1</sup> by which certain aspects of the built environment can be viewed in a more integrated manner. The concept of schema is used in its broader sense of conceptual model through which the environment is analysed and interpreted on the basis of terminological and methodological assumptions implied by the schematic nature of ecoclimate. Since "schema" refers to a structured

1. *For an extensive discussion of the epistemological context of the concept of "schema", within an architectural framework, see LEE, T., "Psychology and Living Space" in DOWNS, R.M., STEA, D., (1973), pp.87-108.*

totality of a defined range of phenomena, it can be used in a more specific manner than the concept of "paradigm". On the other hand, "schema" refers to a more abstract organization of reality than does the concept of general model since it is concerned more with explanation than with prescription.

There are two reasons for attempting a study of ecoclimate on a "schematic" basis. First, it provides bases on which generalized processes for assessing environmental needs at different levels can be produced within a defined mode of thought which permits alternatives without losing the common domain of facts by which these alternatives or the processes that produced them may be evaluated. Secondly, it provides the necessary conceptual framework to view the built environment and the processes of its production from an integrated point of view. These two attributes of ecoclimatic schema interact and so no attempt has been made to distinguish them in the course of the study. Whenever such a distinction is forced on us for methodological or conceptual reasons, it is clearly specified.

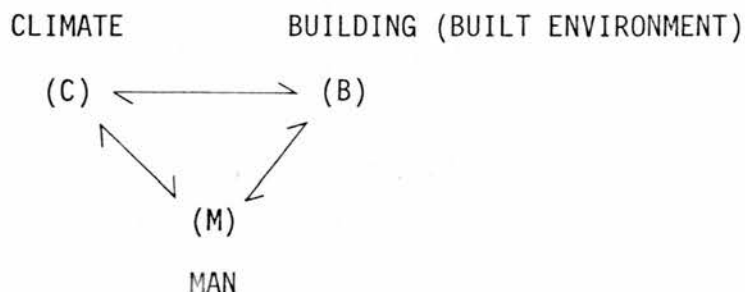
This chapter is concerned with two major aspects of the ecoclimatic schema: first, the conceptual domains upon which microclimatic and ecoclimatic research has been heavily based for the production of the most basic general models which generate different interpretations, descriptions and, therefore, practices of the ecoclimatic problems<sup>2</sup>; and second, the general descriptors which are so produced and the particular meaning that they acquire at different levels and scales in the built environment.

2. *The "conceptual domain", as it is understood here, consists of the commonly recognized conceptual bases which produce the general microclimatic and ecoclimatic descriptors in the fields of architectural and building climatology.*

It is through a careful investigation of these conceptual bases and the descriptors produced by them that the ecoclimatic schema acquires the transformability which allows it to be incorporated in a general framework of architectural empirical research, in which it develops its taxonomic character.

#### 4.2 THE ECOCLIMATIC SCHEMA

It is possible to identify and describe the conceptual bases and the descriptors produced by them starting from a commonly shared eco-climatic schema. The three specific domains participating in this schema are Climate (C), Building (B), and Man (M), which are mutually related:



Each domain may become predominant by transforming and explaining in its own empirical or scientific manner the sets and systems of relationships formed with the other two, in this case secondary domains. We are, therefore, dealing with three distinct, more or less defined, but highly interacting scientific areas: Meteorological and Climatological Sciences, Building and Urban Sciences, Social and Human Sciences. The epistemological input that each one of these brings to the schema is obviously varied and highly complicated even without the complications of contiguous areas of scientific investigation as, for instance, building climatology, socio-climatology, psycho-climatology,

physiology, urban sociology.

The relevant literature shows that the general meaning which each particular domain acquires in the fields of architectural or building climatology constitutes the major problem of their description, thus forming the core argument of research in these fields. Take, for instance, the concept of climate. From a purely climatological point of view, climate may be defined as the characteristic weather conditions at a given place averaged over an extended period of time<sup>3</sup>. From a psychological and sociological point of view, climate may be defined as source of stimulation which favours certain behaviour patterns or certain performances, or as stress which is compensated by certain socio-cultural activities<sup>4</sup>. In this way, it has its particular effects on social organization, human behaviour, socio-economic activities and other socio-cultural aspects of a given society, even crime and race riots<sup>5</sup>. Finally, from an architectural view, climate could be seen as affecting buildings' survival as well as an environmental field affected by them. Conceptual bases, therefore, produced within these domains or by the interaction of them, should acquire their primary meaning within an homogeneous conceptual framework which may be provided in the context of the ecoclimatic schema. The schema as a form of integrated and structured totality of these three conceptual domains makes possible the production of conceptual bases drawn out, not from the domains themselves, but from their mutual interaction.

C.B. Wilson<sup>6</sup> has formulated a mathematical model by expressing the

3. See, for instance, GATES, D., (1972), p.3, GEIGER, R., (1965), p.3, SMIC report, *op.cit.*, p.28, etc.
4. RYD, H., (1972), p.51.
5. See SEWELL, D.W.R., (1966) and (1968), and MAUNDER, W.J., (1970).
6. WILSON, C.B., (1973).

formal interactions among the concepts involved in the ecoclimatic schema. In particular, the model is developed by expressing the relationships between Man and Building through the environmental fields - atmospheric and electro-magnetic radiation:

$$E_1 = B \cdot (E_0) \quad (1)$$

where:  $E_0$  = the environmental field before the existence of the building.

$$E_1 \cdot (H): H \rightarrow H + \quad (2)$$

$H+$  = Human being in a state where it does not require transformation of  $E_0$ .

$$E_1 \cdot (B): B \rightarrow B \quad (3)$$

WILSON, C.B., (1973), p.415.

The philosophy behind Wilson's model reflects some fundamental principles of the description of the conceptual bases which may derive from the ecoclimatic schema. A first one is that any of these bases can only be expressed in systematic terms with the others. A second principle is that, theoretically, the ecoclimatic schema, so developed in systematic terms, may produce a self-sufficient conceptual framework for comprehensive description of the microclimatic and ecoclimatic phenomena of the built environment. Wilson has further developed the model to show that dealing with physical relationships in architecture, the second and most controversial principle could be sufficiently accepted, but, he points out that in practice the complexity of relationships deriving from the model calls for an investigation for more "appropriate" and "economic" descriptors.

On the basis of these principles which are assumed at a first stage I will try to examine the particular form and organization of the simpler relationships deriving from the mutual interaction of the domains in the ecoclimatic schema. Such analysis attempts to examine the basic levels of "logical complexity" at which microclimatic and ecoclimatic

descriptors are generated and, at the same time, to examine possible transformations of the conceptual basis from one level of logical complexity into another. Such an analysis is an essential step towards the implementation of appropriate descriptive bases for ecoclimate within the general framework of architectural empirical research, and the presentation of the conceptual and methodological problems that such a systemic description brings about.

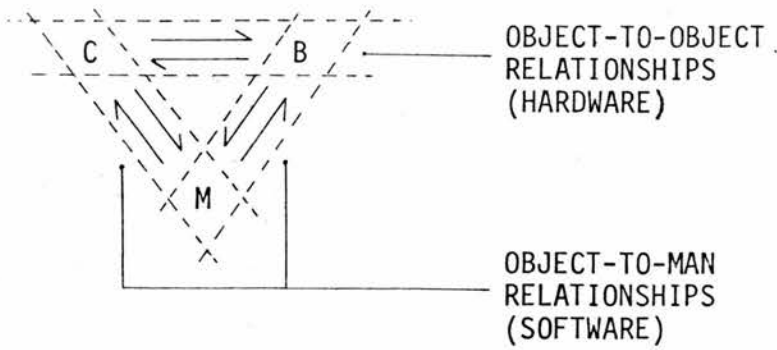
The rest of this chapter considers the basic complexity levels and the abstract descriptors produced by them. These descriptors acquire their meaning in the following chapters of this work where they are organized and explained by empirical evidence within a broader architectural framework.

#### 4.3 COMPLEXITY LEVELS DEFINED BY THE ECOCLIMATIC SCHEMA

On the basis of the nature of the "domain-relata"<sup>7</sup> involved in the ecoclimatic schema we can distinguish two different types of inter-relationships formed among them. One category includes physical inter-relationships between two distinct sets of environmental objects (climate and buildings) which theoretically could be expressed by syntactic formulations (e.g. by mathematical equations). Secondly, relationships formed between Object and Man, that is Climate-Man and Buildings-Man interactions:

7. *The term refers to the domains (C), (B) and (M) of the ecoclimatic schema (section 4.2), each one of which can only be defined in relation to the others.*



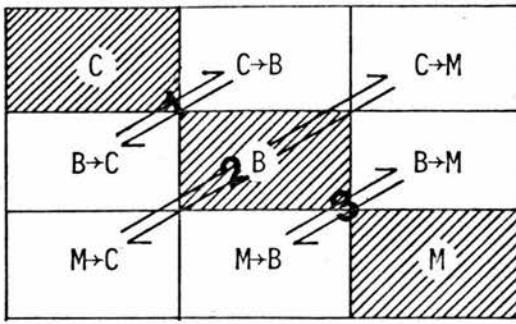



At this level of dual organization of the ecoclimatic schema the conceptual bases and the descriptors produced could be represented in the following diagram:


	C	B	M	DESCRIPTORS FOR C,B,M GENERATED IN THE CONTEXT OF:
C	C	C-B	C-M	Climatology, meteorology, microclimatology
B	B-C	B	B-M	Building and urban sciences Architecture
M	M-C	M-B	M	Social and human sciences
DESCRIPTORS GENERATED IN DIFFERENT CONTEXTS - REFERRED TO THE SAME CONCEPTUAL DOMAIN	Climate	Building	Man	SIMPLE DESCRIPTORS GENERATED AND REFERRED TO THE SAME CONCEPTUAL BASIS (FIRST LEVEL OF COMPLEXITY) OF THE GENERAL SCHEMA

The first level of complexity generated within the ecoclimatic schema corresponds to the main diagonal where the ecoclimatic descriptors are generated from the context of one conceptual domain and they refer to the same one. The second level of complexity includes the dual relationships among the domains-relata of the ecoclimatic schema:

A.



 1st level of complexity. Simple descriptors generated in each conceptual base.

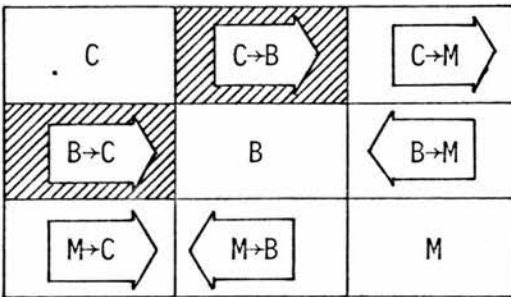
 2nd level of complexity. Mutually related conceptual bases.


**1** : Modifying mutual actions of C and B.


**2** : M - C interaction


**3** : M - B interaction


B.



 indirect to ecoclimate conceptual bases.

 Direct

 Conceptual bases referred to the "hardware" organization of the ecoclimatic environment.

 Conceptual bases referred to the "software" organization of the ecoclimatic environment

Even at this level of abstract organization of the ecoclimatic schema some currently used ecoclimatic conceptual bases are reflected in the background of the dual organization appearing in the above diagrams. The base  $B \rightarrow C$  is what is commonly called the "climatic modification function of buildings". In this sense building can be seen as a filter which modifies the external climate. The basic requirement here is that the modification process should be oriented towards the appropriate microclimatic and ecoclimatic ranges which are acceptable by people. Accordingly, the base  $C \rightarrow B$  indicates that "climate is

capable to act as a form-generating or form-modifying factor". The potential of this process is maximized under conditions of limited environmental control which might be the outcome of extreme climatic conditions or even of weak building technology. This base has been analysed and discussed extensively by architectural climatologists who try to look diachronically at the environmental problems of building design. A notable example is Rapoport's analysis of this base using numerous examples. He argues that even in the most severe climatic conditions descriptors produced by this base do not sufficiently explain the process by which urban microclimate or ecoclimate is generated<sup>8</sup>. He then calls upon the human factor which also participates in this process as it is actually indicated by the  $C \rightleftharpoons M$  and  $B \rightleftharpoons M$  conceptual bases.

To examine the nature of the relationships which belong to the second category of object-man interaction, we may look at a similar situation faced by ecological psychologists, who are dealing with relationships between human behaviour and physical surroundings. They argue that man's behaviour is influenced by the physical surroundings within which it occurs. Environment influences behaviour and behaviour influences environment in an eternal vicious circle. This problem is well-known to environmentalists of any discipline.

Ecological psychologists suggest that the only way to avoid the above conceptual circle is to approach environment and behaviour independently of one another. On this argument Barker develops his

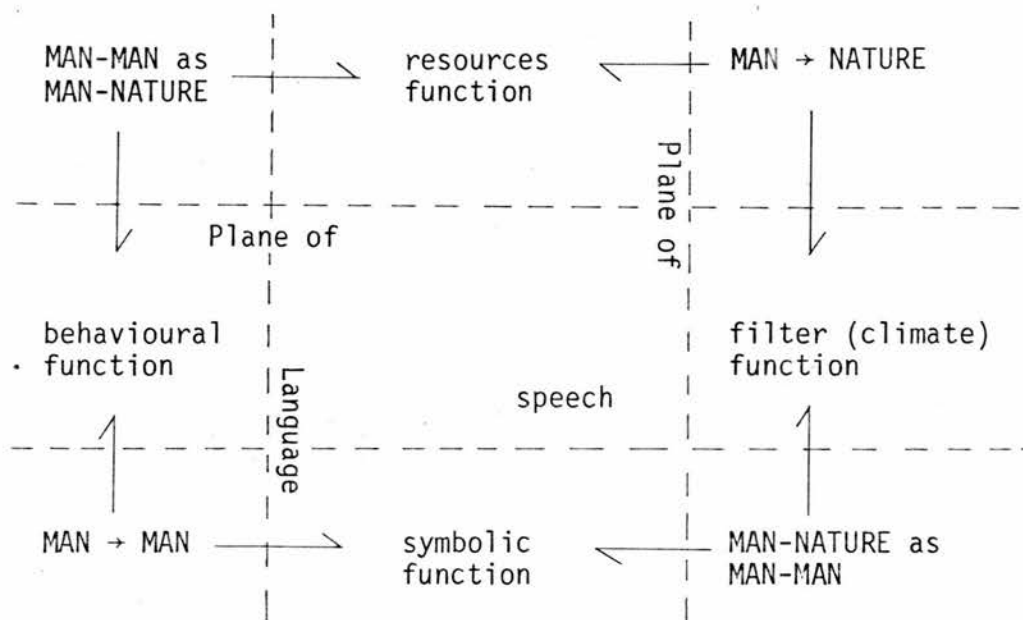
8. *Rapoport, for instance, suggests that "the existence of fairly frequent anticlimatic solutions leads one to question the more extreme climatic deterministic views, and suggests that other forces must be at work", RAPOPORT, (1969), p.21. These "other forces" are, for Rapoport, determined by socio-cultural needs, construction, materials and technology available.*

theory of "environmental settings"<sup>9</sup>. He argues that inside an ecological unit (which comprises physical, social and behavioural aspects) the individual will exhibit a characteristic overall extra-individual pattern of behaviour (although the individual behaviour will be different from person-to-person inside the same environmental unit). The method which has been followed by Barker in the development of this hypothesis is to shift behavioural analysis to the higher level of "molar behaviour" which, he argues, is independent of individual differences in behaviour.

In order to clarify these two levels of analysis - molar behaviour/individual behaviour - Barker suggests that the distinction should be thought of in the same way as the distinction in physics between light and vision or sound and hearing. The analogy with the Chomskian levels of "competence" and "performance" or "language" and "parole", or the biological levels of "genotypes" and "phenotypes" is quite clear. It implies a sort of "environmental grammar" imposed on man which could be studied in its own right. The interesting connection of this argument with the ecoclimatic software conceptual bases is in terms of explaining the institutional character of certain ecoclimatic phenomena and, therefore, their general social impact on man. In architecture these levels have been recognized long ago, but it is only recently that they have been developed and expressed in theoretical architectural models.

9. *What is of extreme importance behind Barker's ecological approach to psychology is his major assumption that the ecological behaviour should be studied in the complexity that exists in real-life situations, and not within laboratory experiments or piecemeal field works. Within the physical environment - behaviour interaction Barker underlines that it is imperative to approach behaviour and environment on descriptive levels provided by "whole-life-spaces" and particularly through "real-life settings". See BARKER, R., (1968), pp.4-8.*

A good example is Hillier et al's "four-function" model<sup>10</sup> where the language-level, corresponding to Barker's level of molar behaviour, is considered as the precondition for the speech-level, which corresponds to Barker's individual behaviour. I will return to this point later in the next part of the thesis where the level of investigation is shifted from systemic to structural grounds.



Hillier and Leaman's 4-function model  
(Hillier et al., 1974)

The set of interrelationships  $C \rightleftharpoons M$  manifests four interrelated functions: physiological, psychological, sociological and cultural. In particular, the conceptual base  $C \rightarrow M$  indicates the effects of climate - direct or indirect - on man. On the other hand, the base  $M \rightarrow C$  shows the

10. Hillier, B. and Leaman, A., explain their 4-function model by emphasizing that it is important to distinguish between two levels of understanding or describing the man-nature or man-man relationships. On the one hand, there is the "observable object-level" realization of these relationships which corresponds to the level of "speech" and, on the other hand, there is a higher level of resources and social signification which corresponds to the level of "language". It is very characteristic that building as "climate modifier" has been considered at the level of speech but acquires its language level signification through a mapping which transforms the climate modification function to symbolic and social orders. See HILLIER, B., LEAMAN, A., (Jan. 1974), p.8 and HILLIER, B., MUSGROVE, J., O'SULLIVAN, P., (1971), pp.21-22. Also, for a more elaborate version of the 4-function model see HILLIER, B., LEAMAN, A., (April 1974).

overall reaction of people to climate carried out consciously or unconsciously through their adaptive mechanisms or their general actions and behaviour. This reaction can be explained by the fact that:-

"variation in stimulation can occur not only when the external environment changes, but also when the organism itself behaves."<sup>11</sup>

This suggests that man's reaction to climate not only consists of sets of internalized or externalized actions of modification at both physiological or behavioural form, but also of actions of modification manifested at higher behavioural and cultural levels.

The non-deterministic character of climatic effects on built-form is manifested through the set of relationships  $M \rightleftharpoons B$ . This abstract conceptual base is the most neglected area of concern in architectural and building climatology because it does not include the crucial C. Its major importance in the organization of ecoclimatic phenomena and research will become apparent in the next chapter of this thesis, through the search for a general framework for architectural research. It is, in fact, within this base that ecoclimatic phenomena pick up their real architectural value and can be explained adequately in the broader context of architectural experience. Buildings, here, should be thought of in their broader sense of spatial organization artificially created by certain socio-cultural and economic activities to fulfil and perpetuate their existence. The  $M \rightarrow B$  base may express form-modification or form-production through man's social values, institutions, actions, norms or symbols which sometimes - though not always - conflict with the form modifying function of climate. The  $B \rightarrow M$  base expresses the transformation of man's nature and social life through the built environment that he creates.

11. FISKE, *et al.*, *op.cit.*



So far, we have discussed the second level of logical complexity, that is the dual organization of the ecoclimatic schema. But these relationships exhibit a high degree of interdependence which means, in turn, that we should transpose the level of consideration from that of "relationship" to that of "system". The transformation from relationship to system becomes methodologically inevitable when we try to describe integrated structures or structures of wholes. The argument is well presented by A. Angyal<sup>12</sup>. He assumes that scientific thought consists of logical manipulations of relationships, and due to the belief of many writers that structures of wholes cannot be described in simply relational terms, the implication follows that these wholes are not directly accessible to logical manipulation. He goes on to suggest that the description of structures of wholes requires the transformation of logical units to a completely different "logical genus" suitable for the treatment of wholes and he proposes that such a logical genus is the system. The same argument is put forward by Christopher Alexander who argues in his famous paper *The City is not a Tree* that people tend to think in terms of mathematical "trees" rather than in terms of "semi-lattices" which are analogous to environmental structures<sup>13</sup>.

Angyal's argument becomes clearer if we consider the way in which he differentiates the logical characteristics of relationships and systems. The relationship requires two and only two relata while the

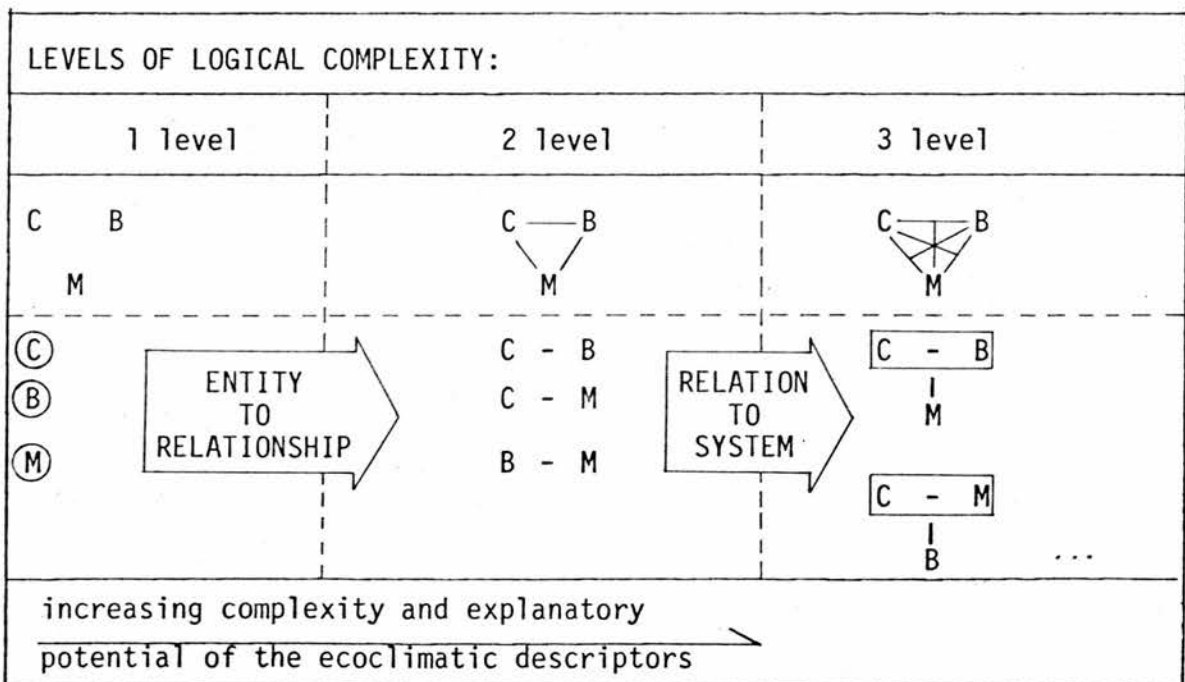
12. ANGYAL, A., "A Logic of Systems" in EMERY, F.E., (ed.), (1969), pp. 17-29.

13. "These experiments suggest strongly that people have an underlying tendency, when faced by a complex organization, to recognize it mentally in terms of non-overlapping units. The complexity of the semi-lattice is replaced by the simpler and more easily grasped tree form". See ALEXANDER, C., "The City is not a Tree", in BELL, G., TYRWHITT, J., (ed.), (1972), pp.401-428.



system may involve an unspecific number of members. The relationship requires an aspect out of which it is formed (e.g. diversity, identity, similarity) while the system does not require that its members should hold immanent qualities amongst themselves, but only that the members participate in the system by means of their distribution or positional value within it. Finally, the most important distinction is concerned with the way in which space and time are involved as dimensional domains. In relationships, the function of the dimensional domain is simply disjunction of the relata in terms of space and/or time. For instance, the comparison of two relata is possible only in different spaces or in different times. But in systems the dimensional domain participates not only in the separation of the parts but also throughout the formation of the system<sup>14</sup>.

The logical shift from "relational" ecoclimatic conceptual bases to systemic ones also implies the transformation from a surface level of analysis to a much deeper and abstract one, where the important thing is not to describe reality as it is observed but to understand how the system as a whole generates itself and produces its own internal order and structure:



14. ANGYAL, A., *op.cit.*, pp.18-25.

It is at this third level of logical complexity in particular that the structure of ecoclimate can be identified and comprehensively explained, not only because the conceptual bases and descriptors acquire the necessary degree of integration and abstraction at this level but, most importantly, because it is the only level at which the evaluation of ecoclimatic phenomena is possible. Unfortunately, although architectural history shows that man has always carried out the production of his ecoclimatic environment at this third level, architectural empirical research on climate, apart from very few exceptions, is still carried out on the second "relational" way of approaching the problems. This calls for a careful investigation of the present literature on microclimate and ecoclimate and its evaluation in terms of contemporary architectural empirical research and practice. By doing so, the possibility of identifying the levels at which the relational approach acquires problem-solving capacity, and those at which it does not, may be provided. At the same time, it is possible to look at the barriers of methodological descriptive and general epistemological character (which the tradition of scientific knowledge carries within it) which are imposed on attempts to transform conceptual bases and descriptors from the second to the third level of logical complexity.

There is no doubt that the whole investigation of the relationships between man and his physical environment has been greatly influenced by the epistemological background which underlies theoretical or empirical research into the human environment. In these terms, the assumed models of man become very significant, particularly in structuring predominancies of different environmental parameters and in assessing different evaluation systems for the planned environment. The following models of man are especially dominating in empirical

research on building and architectural climatology and affect not only the predominancies or the systems of evaluation but the ecoclimatic descriptors themselves. Five categories of these models which have been clearly distinguished by Harriet Ryd<sup>15</sup> are presented here in order of increasing complexity:

1. Models made at a physiological level when man is considered as a complicated "machine". The major objective of such models is the mapping of the limits of the environment fields which affect man's physiological functions. These are considered to be the maintenance of thermal balance and breathing, visual and auditory capacities.

2. Models made at a psychological level have been applied particularly in studies of man's perception of the surrounding physical environment and the way in which these surroundings govern man's psychosomatic reactions and, therefore, his behaviour and activity. The process by which stimuli are perceived, internalized and transformed into psycho-somatic reactions is very complicated<sup>16</sup> and it is the responsibility of these psychological models to simplify the situation through assumptions which are sometimes assessed in an axiomatic manner. For instance, the intra-psychic level at which most research using psychological models is carried out, regards man as a black box in which only a few factors which affect man's actions and behaviour can be clearly defined without any reference to his logical capacity.

3. Models made at a social level are far more integrated and comprehensive than others because they take into consideration the social dimensions of man. Models of this kind used in environmental

15. *Ryd, H., has distinguished five different views of man commonly held in the contemporary epistemology of sciences concerned with human practices: (i) the physiological being; (ii) the psychological being; (iii) the social being; (iv) the cultural being; and (v) the ecological being. See RYD, H., (1975).*
16. *See FISKE, et al., op.cit. and GIBSON, J.J., (1966) for detailed discussion on the mechanism and the complexity of this process.*

research (and particularly in architectural climatology) have not been developed adequately since they have been formulated on the basis of micro-scale investigation carried out in synchronic levels and mostly by means of relational approaches<sup>17</sup>. Diachronic studies based on macro-scale investigation - both in terms of space and time - are essential in assessing the social dimensions and evaluation of climatic factors, since the process of internalizing socially the environmental stimuli and the patterning out of commonly shared "moral behaviour" is a diachronic process and, therefore, should be studied in well-defined historical perspectives.

4. Models made at a cultural level tend to focus mostly on the way in which man affects his surroundings rather than the way in which he is affected by them. Such models are usually expressed in the form of semantic differential techniques based on bipolar or even unipolar scales with the objective of identifying the "general opinion" about a particular environmental phenomenon. Since these models do not restrict themselves to manifest activities of man but are particularly interested in latent reactions to the environment, they are highly subjective.

5. Models made at an ecological level consider man as a species amongst other species with whom he has to share the use of the earth's resources<sup>18</sup>. In this way man becomes an important element in an ecosystem where the objective is not man's desires, but the balance of the ecosystem as a whole. When "ecosystem" is understood in its proper meaning, that is in an integrated way, where physical, cultural and sociological dimensions are drawn together and balanced, the ecological

17. See, for instance, the type of research proposed for the investigation of the social dimensions of weather and climate modification in SEWELL, D.W.R., (1966) and (1968). Also see Ch.9 of this thesis.

18. RYD, H., (1975), pp.10,11.

model of man may become a comprehensive and significant framework for assessing integrated environmental descriptors as far as human needs are concerned.

Architecture as a discipline has the additional responsibility of explaining the products of its practice. This means that since micro-climatic and ecoclimatic phenomena are viewed as products of architectural or planning activities they should be described and explained within the broader architectural context rather than in those available from, for example, physiology, psychology or sociology. This does not deny the important contribution of these sciences to the multidisciplinary area of architectural research but it simply means that these sciences, though capable of providing useful information for architecture, have limited explanatory potential for complex architectural phenomena.

Architecture, therefore, has to build its own disciplinary models and methodological frameworks to explain for itself what, so far, has been explained with immediate reference to other sciences which, as far as architecture is concerned, are partial. It is necessary to re-investigate and reformulate these models within the domain of architectural phenomena. In order to do this two things are assumed. First the acceptance of a broader framework in which empirical research in architecture can be organized and, second, the organization and integration of ecoclimatic studies within this framework. These two points are discussed in the next chapter.

## CHAPTER 5

### ECOCLIMATIC STUDIES ORGANIZED WITHIN A GENERAL TAXONOMIC FRAMEWORK OF ARCHITECTURAL RESEARCH

#### 5.1 INTRODUCTION

The description and evaluation of microclimatic and ecoclimatic studies within the context of architectural empirical research presupposes first, an assumed but well-defined framework of taxonomic character at a level of abstraction sufficient to account for the complex variety of architectural empirical research, and second, the necessary transformation of this framework generated by the "ecoclimatic schema" and the explanation of this transformation in terms of existing ecoclimatic conceptual bases and descriptors developed especially in the last few decades of architectural climatological research. This chapter discusses the first of these points. The second point is discussed in the next parts of the thesis.

The necessity of adopting such a general base for an integrated assessment of the wide variety of ecoclimatic studies becomes obvious when the general methodological, descriptive and evaluative difficulties are considered. On the other hand, the involvement of the M→B conceptual base within the ecoclimatic schema indicates exactly the necessity of relating partially developed ecoclimatic domains of research to the broader spectrum of architectural theoretical-practical activity, because it is in this spectrum that they become architecturally



meaningful and amenable to comprehensive description and evaluation.

The starting point is the general requirement that such a framework should explain - though not always at a surface level - the volume of empirical research in architecture as it has been developed in a variety of ways and levels of complexity, accompanied by different epistemological backgrounds and orientations. In this context a number of questions become crucial and require some preliminary investigation. First is that of architectural complexity as it is organized and approached in terms of scales and levels of consideration. Second, there are questions of the major conceptual bases which produce the basic generators of description which underly empirical research in architecture. Finally, there is the question of the particular character of architectural actions, as they are shaped and transformed both from the point of view of the complexity involved and the conceptual background of architectural operations.

## 5.2 THE CONCEPT AND CHARACTER OF ARCHITECTURAL COMPLEXITY

A considerable number of architectural theories deal explicitly or implicitly with the general problem of minimizing the high degree of complexity in which architectural phenomena are apparently organized. Both "glass-box" and "black-box" approaches deal directly with this problem of simplification and, in fact, the whole bulk of "architectural design methods" and "model-building" activity is an expression of this attempt. Design, for instance, has been described as a "variety reducing process" where, most interestingly, this variety does not come from the environment only but also from the design methodology itself<sup>1</sup>.

1. See GORDON BEST *"Method and Intention in Architectural Design"* in BROADBENT, G., WARD, A., (1969), pp.147-165.



One way of identifying - at a first level - the different types of complexity which have been recognized and, most importantly, have been internalized by architectural theory and practice, may be through the different types of models which express such complexities. However, any attempt to clarify the concept of architectural complexity should, primarily, face the question of what type of complexity it intends to describe. A better understanding of this can be reached through consideration of the basic functions which any model should reflect. Echenique's definition of a "model" may serve as a starting point in this discussion<sup>2</sup>.

According to Echenique a model is defined as

"a representation of a reality in which the representation is made by the expression of certain relevant characteristics of the observed reality and where reality consists of the objects or systems that exist, have existed, or may exist."<sup>3</sup>

It is obvious that the interpretation of reality by the model builder is included in the model. This is supported also by the fact that observation and abstraction are inherently involved in the process of model-building.

The same concept of model is taken up by Chorley and Haggett who describe the need for minimizing environmental complexity in models as "the need for idealization". They write:

"The traditional reaction of man to the apparent complexity of the world around him has been to make for himself a simplified and intelligible picture of the world."<sup>4</sup>

According to them the model as a simplified structured reality presents

2. ECHENIQUE, M., "Models: A Discussion", in MARTIN, L. & MARCH, L., (1972), pp.164-174.
3. *Ibid.*, p.164.
4. CHORLEY, R.J., & HAGGETT (1967), p.22.

subjectively significant features or relationships in some sort of generalized form. "Subjectivity", therefore, emerges as a necessary characteristic of a model since the model itself is nothing else but subjective interpretation of the objective world. On the other hand, "objectivity" is the "end" towards which the model-building activity is striving. The dialectics between subjectivity-objectivity are of utmost importance in modelling. Chorley et al. suggest the following functions which every model may reflect:

- (i) Psychological function: enabling some groups of phenomena to be visualized and comprehended, which they could not otherwise be because of their magnitude and complexity.
- (ii) Acquisitive function: providing a framework where information may be defined, collected and ordered.
- (iii) Logical function: explaining how a particular phenomenon comes about.
- (iv) Normative function: comparing new phenomena with more familiar ones.
- (v) Cognitive function: communicating specific ideas.
- (vi) Systemic function: providing a framework where an idea of reality (or possible realities) can be tested<sup>5</sup>.

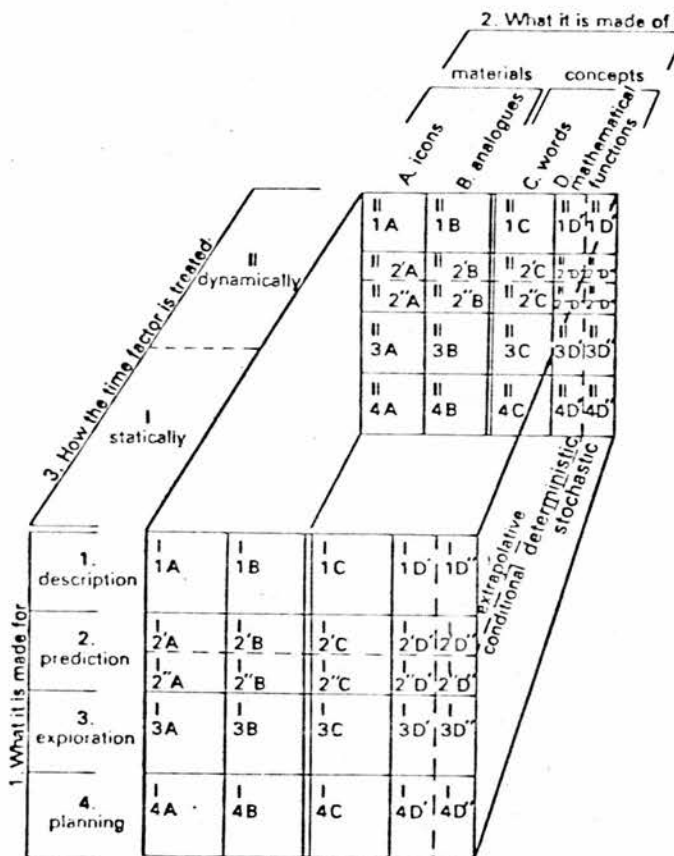
Echenique adds to these functions two more:

- (vii) Partitive function: providing a framework where partial studies can be defined, knowing their interaction with the rest of the system.

5. *Ibid.*, p.24. They refer also to "organizational", "fertility" and "constructional" functions performed by models but, in my view, these are already reflected within the six summarized here.

- (viii) Evaluative function: providing a framework where the effect of different decisions within a system can be simulated<sup>6</sup>.

The predominance of one or more of the above functions within a model attribute to it its particular character in terms of the complexity to which it refers and the way in which it approaches this complexity. Furthermore, Echenique attempts to classify the different types of models so produced, by proposing the following "model of models".



Model of models according to Echenique, M.<sup>7</sup>

From the above characteristics of modelling, it becomes apparent that environmental complexity is recognized in three overlapping forms.

6. ECHENIQUE, M., *op.cit.*, p.168.

7. *Ibid.*, p.169.

The first is "numerical" complexity which is reflected especially in the psychological, normative, systematic and partitive functions. The second is "informational" complexity in the acquisitive, cognitive and evaluative functions. In fact, informational complexity is a specific type of numerical complexity and it is distinguished here only in terms of methods of approach. For instance, while numerical complexity is mostly dealt with by assuming or defining certain levels of abstraction, informational complexity is simplified by means of taxonomic, ordering or analogical techniques. Finally, the third form of complexity belongs to a higher level of "logical" complexity which becomes the most important and significant one since it is reflected in all the functions of a model.

The problems of complexity which arise in the organization of architectural phenomena within the context of architectural empirical research belong, in their greatest part, to the higher form of logical complexity. For instance, a house as a system is not necessarily less complex logically than a city or a region, since "complexity" is governed by how the system is defined<sup>8</sup>. Logical complexity is generated mainly from the relationship between observer and the object of observation and is expressed either in the attempt of the observer to understand and define the object of his investigation, or in his attempt to take a particular position in respect to the object of his investigation.

N. Wiener's work in a majestic effort to resolve the problem of the possible extension of mathematical methods of prediction to the social sciences, makes the well-known point that the nature of the social sciences is such that it is inevitable that their very

8. McLOUGHLIN, J.B., (1970, c.1969), p.234.

development depends upon the "coupling" of the observer with the observed phenomenon. He argues, specifically, that in the field of the social sciences the object of study is necessarily affected by the intervention of the observer, and that, moreover, the resulting modifications are on the same scale as the phenomena that are studied<sup>9</sup>. Apostel expressed this point analytically when he argued that:

"The mind needs to see the system in opposition and distinction to all others; therefore, the separation of the system from others is made more complete than it is in reality ... The system is studied with certain purpose in mind; everything which does not affect this purpose is eliminated."<sup>10</sup>

Lévi-Strauss, though in agreement with Wiener's assumptions, points out that these assumptions may not be applicable to comprehensive social phenomena such as language, when they are studied through structural linguistics<sup>11</sup>.

To the question of the role played by this observer-object particular coupling, in terms of understanding and resolving logical complexity in social sciences and in architecture, I will return again in the last part of this thesis where a new descriptive framework of microclimate and ecoclimate is introduced. There it is apparent that, as far as architectural empirical research is concerned, it is extremely difficult for the observer to consider himself excluded from the reality he investigates, especially because of the strong influence of both scientific paradigms and ideology in those fields which describe human practices.

9. See WIENER, N., (1948), pp.172-173

10. APOSTEL, L., "Towards the formal study of models in the non-formal sciences", in FREUDENTHAL, H., (ed.), (1961), pp.15-16.

11. LÉVI-STRAUSS, C., (1972, c.1958, 1963), p.56.

### 5.3 CONCEPTUAL BASES AND GENERAL DESCRIPTORS AS MEANS OF APPROACHING LOGICAL COMPLEXITY IN THE BUILT ENVIRONMENT

#### 5.3.1 Objective and Subjective descriptors

For the purpose of developing this section we do not need to proceed to the epistemological question of the particular forms that the subjective-objective relationship takes in the different fields of social sciences, although such a discussion might be of much interest. What I will assume and explain, however, is that description in social sciences or in the so-called sciences of the artificial, and especially in architecture, is carried out simultaneously at both "subjective" and "objective" levels.

The explanation of this assumption will be given here in terms of the most commonly shared conceptual bases and general descriptors used in architectural empirical research and on the basis of a general model-paradigm for the organization of empirical research in architecture, which has been developed by T. Kotsiopoulos<sup>12</sup>. His model is mainly of taxonomic character and was constructed so that the dialectics between subjective-objective descriptors of the broader artificial environment were taken carefully into consideration. Although Kotsiopoulos originally constructed his model in order to deal with participatory structures and process and to evaluate their role in the general process of production of the environment, he suggested that the model could be applicable in other areas of architectural inquiry, as long as a specific "prism" (for instance, the ecoclimatic one) is used to view the built environment as a whole<sup>13</sup>.

12. See KOTSIPOULOS, T., (1975), pp.39-66 and for a detailed summary, pp.259-262.

13. .. in a personal discussion with T. Kotsiopoulos and the author. The concept of "prism" is used here to indicate the consideration of a given reality through a well organized conceptual base.



Thus, in this chapter I will attempt to develop a general taxonomic model for ecoclimate empirical research on the basic principles of the model of Kotsiopoulos and to evaluate through it the commonly accepted "dual" and "triple" organization of microclimatic and ecoclimatic research.

Objective general descriptors are considered to be those which account for the production of the logical complexity and to which empirical research in architecture is normally referred. These are:

- (i) time, either as historical time or as temporal order,
- (ii) space, either geographical or as scale of reference, and
- (iii) action accumulation for the production of the built environment<sup>14</sup>.

The third of these general descriptors consists of an objectified subjective reference to the built environment since it is based upon a shared epistemological tradition.

The second level of "subjective reference" is concerned with the particular type of logical complexity which is automatically introduced when environment is looked at through a specific "prism". The hypothesis behind this level is that the study of the built environment is possible in two ways: the identification and definition of common conceptual bases, and the determination of the proper levels for approaching complexity. In both cases the subjective reference is crucial and inevitable.

Commonly shared conceptual bases for the study of the built environment are assumed to be:

14. *according to Kotsiopoulos, T., op.cit., p.49.*

- (i) the "social whole" to which the environmental object, included in the prism, is referred,
- (ii) the processes which account for the production of the environmental object of the prism, and
- (iii) the environmental object of the prism<sup>15</sup>.

Each of the above conceptual bases is capable of generating sets of complexity descriptors in a self-sufficient manner for the description of the environment. However, at the deepest level, where the possibility exists of describing the environment in an integrated way, these conceptual bases lose their surface-independence by becoming interactive and highly interdependent. Furthermore, it is at this level that comprehensive description of the environment can be achieved. I will return to and discuss fully in the last part of the thesis, the questions of "deep level" and "comprehensiveness" of description as means of analysing and explaining ecoclimatic structures and phenomena.

Before we proceed to consider the organization of an ecoclimatic taxonomic framework provided by the above descriptors, it is of interest to examine briefly Popper's arguments for the importance of the second and third conceptual bases of subjective reference.

Popper's theory of objective knowledge and particularly his biological approach to his "third world"<sup>16</sup> can be used to illustrate the

15. *Ibid.*, p.50.

16. *Popper makes use of the notion not only of an objective world of material things (world 1) and a subjective world of mind (world 2) but of a third world, a world of objective structures which are the products, not necessarily intentional, of minds of living creatures, but which once produced, exist independently of them. The third world, therefore, is the world of ideas, science, language, institutions, arts, architecture, in short the whole cultural heritage at a given moment in time and space. This should not be confused with the first world which includes brains, machines, books, pictures, houses and so on. See POPPER, K., (1972), p.106.*

importance of studying environmental structures or phenomena "themselves" or the "processes" by which they are produced. According to him the study of the living or non-living structures that animals (or men) produce is associated with two main categories of problems. He argues:

"The first category consists of problems concerned with *the methods used by the animals, or the ways the animals behave* when constructing these structures. This first category thus consists of *problems concerned with the acts of production*; with the behavioural disposition of the animal and with the relationships between the animal and the product. The second category of problems is concerned with the *structures themselves*. It is concerned with the chemistry of the materials used in the structure; with their geometrical and physical properties; with their evolutionary changes, depending upon special environmental conditions; and with their dependence upon or their adjustments to these environmental conditions. *Very* important also is the *feedback relation* from the properties of the structure to the behaviour of the animals."<sup>17</sup> (my emphasis)

Although the above discussion is referred to biological structures and their probable extension into their environment, Popper admits the validity of his argument into the product of human activity, such as houses or tools and, also, works of art, language and science<sup>18</sup>. In the course of his argument Popper goes further to suggest that:

"We should realize that the second category of problems, those concerned with the products in themselves, is in almost every respect more important than the first category, the problem of production "...." the problems of the second category are basic for understanding the production problems."<sup>19</sup>

These claims may apply successfully to philosophical problems of the process of production or the products of "objective scientific knowledge", but they remain highly contentious as far as their application to the process of production and the products of the built environment is concerned. It is the specific character of these

17. *Ibid.*, pp.112-113.

18. *Ibid.*, p.113.

19. *Ibid.*, p.114.

products to become explainable and amenable to evaluation only within the context of the process which has produced them.

Kotsiopoulos has organized the objective general descriptors (Time, Space and Action) to produce taxonomic mechanisms which at an abstract level make possible the transformation and the mapping of architectural empirical research within the dimensional domain which these descriptors define (see figures on next page).

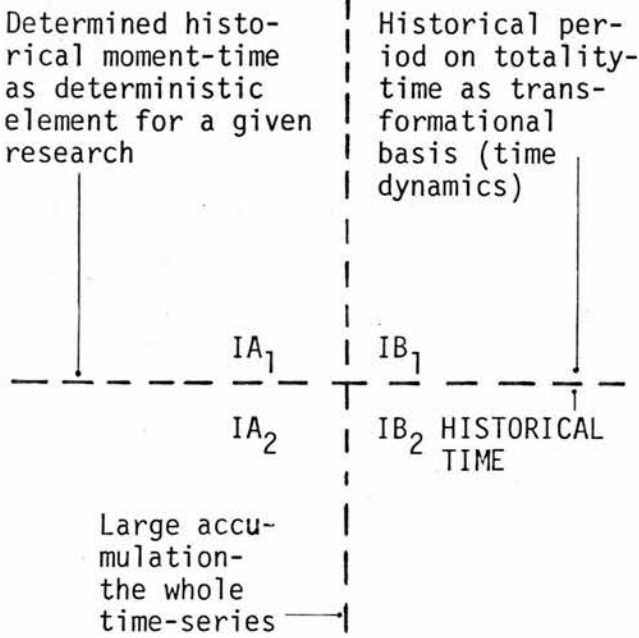
Such a taxonomic framework for empirical research in architecture, though capable of defining areas of research in general terms, does not say much about their specific type. It describes in a general sense the logical complexity to which architecture refers, without proceeding to the proper level at which this logical complexity may be resolved in terms of particular areas of architectural empirical research. This can only be done through "subjective interpretations" carried out within well organized conceptual bases.

The organization of a set of subjective interpretations introduces a particular prism through which the taxonomic framework of objective descriptors becomes oriented. The dialectics between the objective general framework and the "subjective" prism serve as a sufficient base on which to classify the environmental phenomena covered by the prism within the broader context of architectural research.

The intention here is to explain how the ecoclimatic prism - developed in the previous chapter - can be introduced within the broader architectural framework. The important point in the following analysis is that since the ecoclimatic prism consists of subjective interpretations of a class of environmental phenomena, it inevitably falls into the domain of "subjective references" (p.133) and therefore

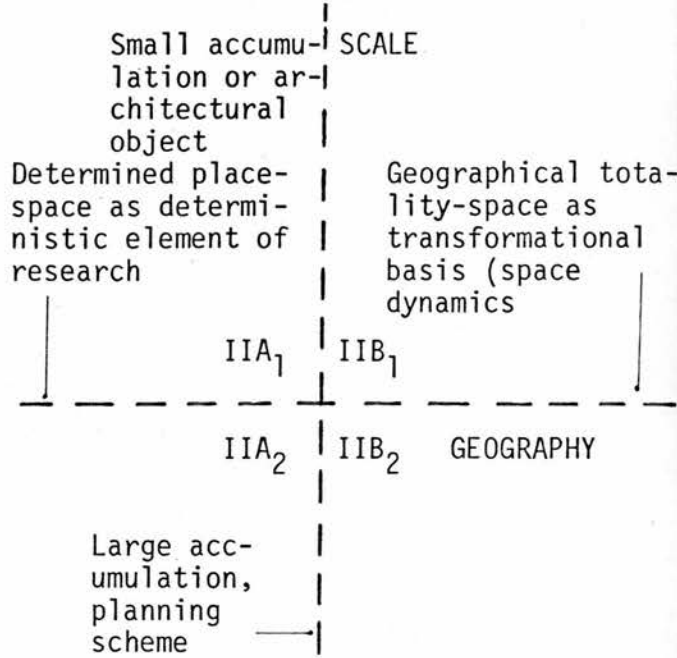
SYSTEM I:Based on the mechanism "time"

TIME ACCUMULATION

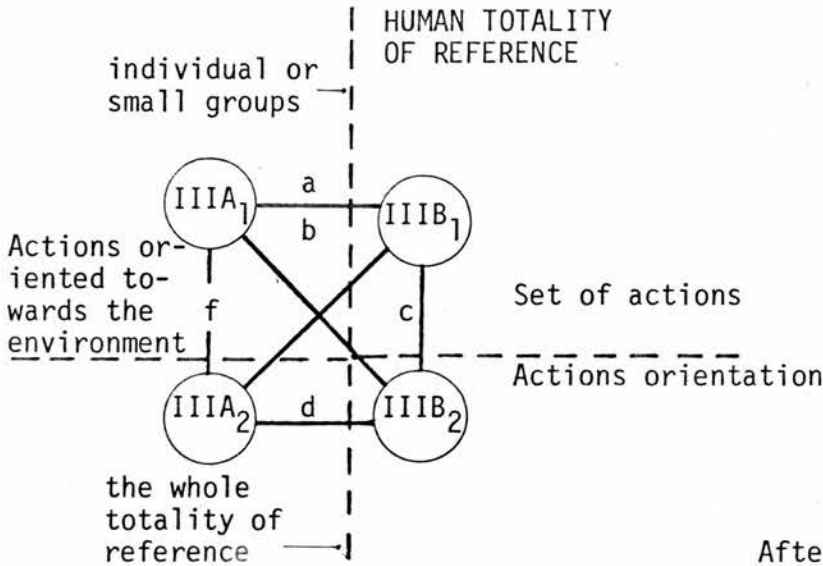


SYSTEM II:Based on the mechanism "space"

SPACE ACCUMULATION



SYSTEM III:Based on the mechanism "action accumulation for the formation of the environment"



After Kotsiopoulos (1975) pp.55-56.

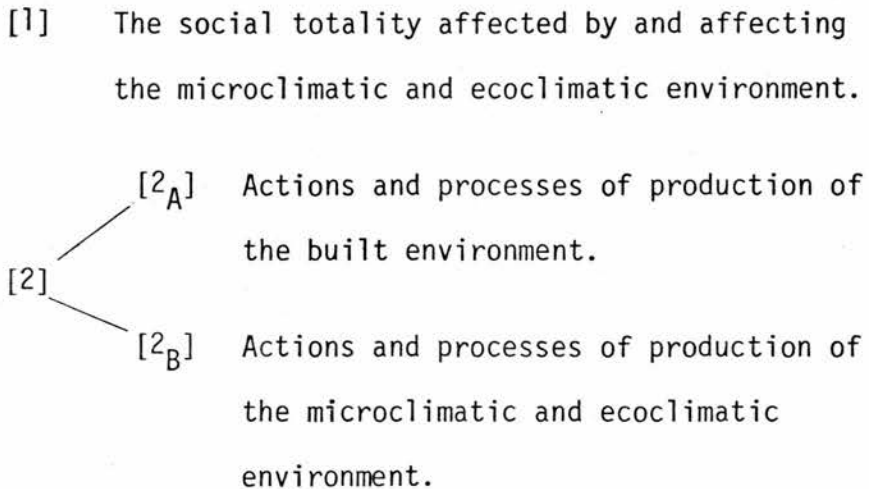
An example of how these mechanisms are combined to define specific areas of architectural research is shown below:

	IA <sub>1</sub>	IA <sub>2</sub>	IB <sub>1</sub>	IB <sub>2</sub>
IIA <sub>1</sub>	○			
IIA <sub>2</sub>				
IIB <sub>1</sub>		○		
IIB <sub>2</sub>		○		

- Part of the time-series (e.g. design process) of an object in a given geographical place and at a given historical time.
- The total time-series of an object in a given historical moment but in a comparative geographical investigation.
- The same as the previous one but in reference to a planning schema and not to an object.

After Kotsiopoulos (1975) p.56.

acquires a set of primary subjective general descriptors. The base of these descriptors is independent of the type of prism one chooses to study. In the case of microclimate and ecoclimate, these general subjective descriptors are shown in the following figure:



[3] The microclimatic and ecoclimatic environment.

Architectural research usually moves from the social totality (made up of social relationships, human needs, and so forth) to the action and processes involved in the production of the built environment and thus transfers its conclusions indirectly onto the environmental object. This process is exactly the opposite of that followed in sociological or psychological studies where the starting point of the investigation is the environmental object itself. In particular, sociological studies use environmental objects as starting points of their investigation and through the study of the actions which produce or modify these objects develop useful conceptual tools for the description of society.

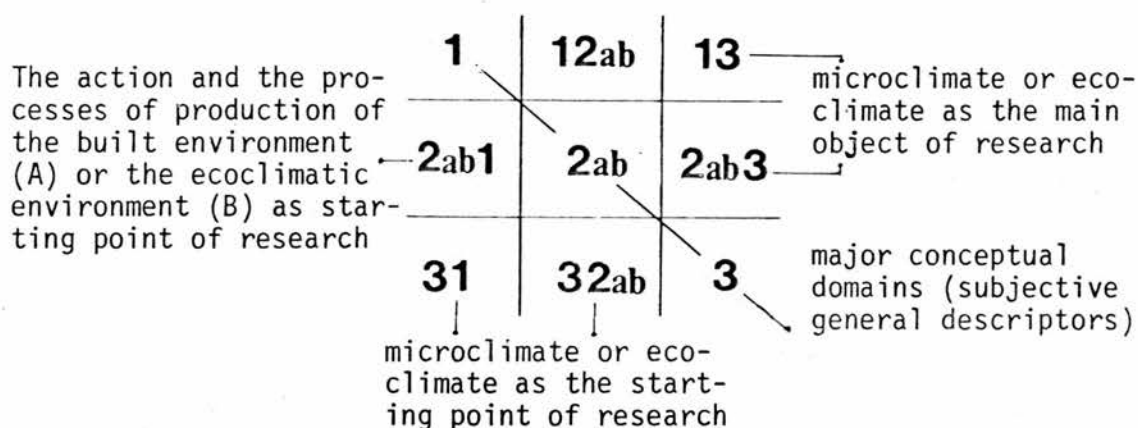
The differentiation of general descriptor [2] into [2<sub>A</sub>] and [2<sub>B</sub>] is forced by the particular character and nature of the environmental object "ecoclimate" or "microclimate" to undergo not only intended but

also unintended transformations or modifications. It is difficult to define what exactly these are, but we may assume that both processes, deriving from the general actions of production of the built or the artificial environment, are significant in formulating the microclimatic and ecoclimatic environment at least today.

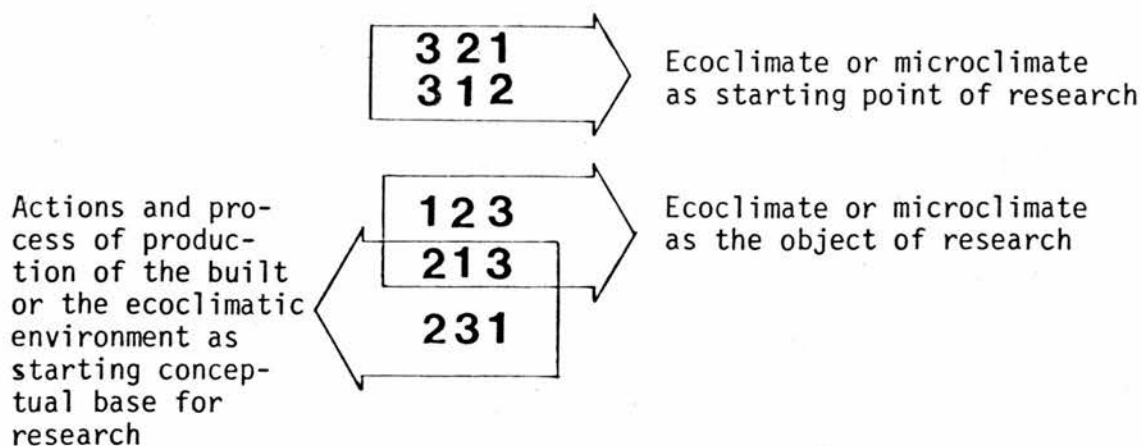
### 5.3.2 Dual and triple organization of subjective ecoclimatic descriptors; the taxonomic framework

Here, I shall try to give an example of how these subjective descriptors ([1], [2<sub>A,B</sub>], and [3]) produce taxonomic models for organizing ecoclimatic research within a broad architectural framework by providing the necessary conceptual bases which define particular areas of research. Such simple conceptual bases are formed by dual or triple organization of the subjective general descriptors according to the following model:

#### DUAL ORGANIZATION OF THE GENERAL SUBJECTIVE DESCRIPTORS

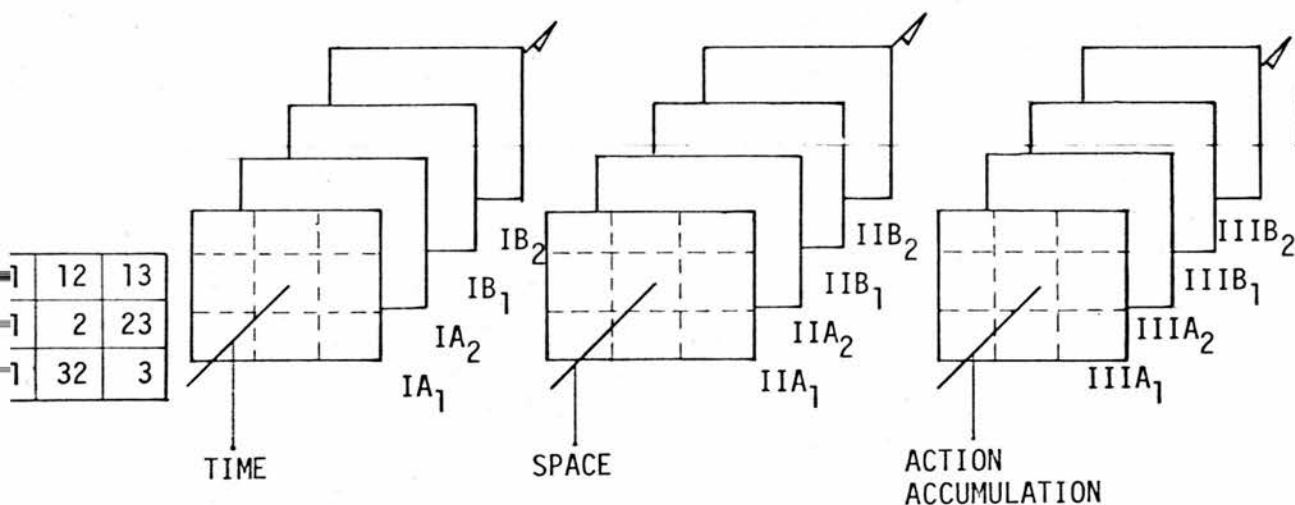


#### TRIPLE ORGANIZATION OF THE GENERAL SUBJECTIVE DESCRIPTORS

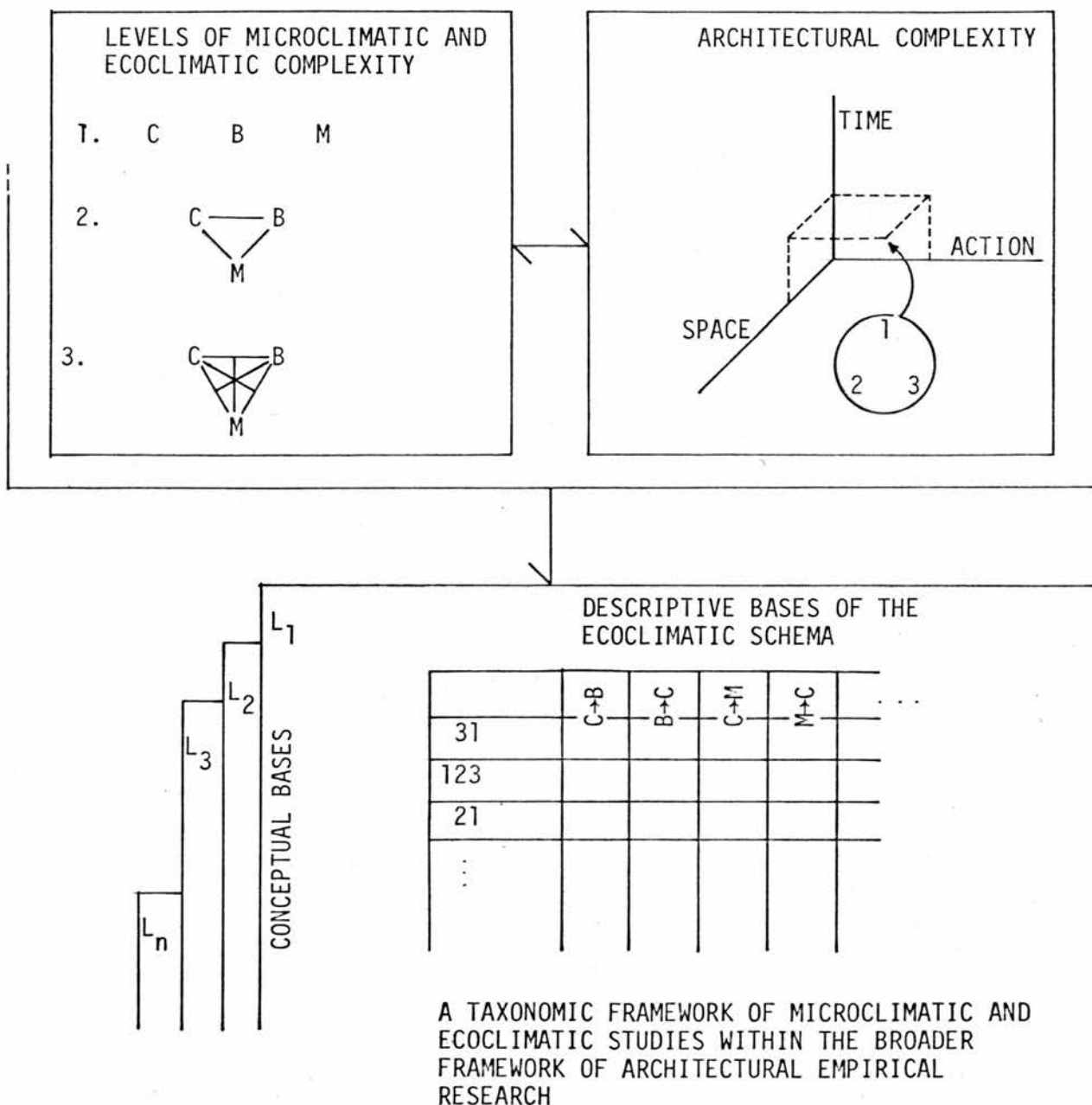




"Starting points" and "orientations" are extremely significant, not only in terms of determining conceptually the epistemological background for the implementation of specific areas of research, but also in terms of taxonomizing these areas within a broader architectural context. For instance, at the level of dual organization, the conceptual base [12] expresses a particular area of environmental or climatic research in which descriptors are generated to describe and explain the way in which social totality influences the production of the built environment or, in the case of [2<sub>B</sub>] the production of the ecoclimatic environment. Accordingly, the base [21] generates descriptors which may be used to explain how the process of production influences the social totality in which it occurs. It is important to remember, however, that it is necessary to specify particular combinations of subjective descriptors ([1], [2], [3]) within the context of the objective ones (Time, Space and Action Accumulation). It is in this way that the character of logical complexity can be specified both in terms of the ideological context inherent in the subjective reference and in terms of the commonly accepted objective reference of architectural operations, so that each conceptual base can be described objectively in terms of Time, Space and Action Accumulation:



The establishment of a general framework in which microclimatic and ecoclimatic studies can be classified within the architectural empirical research necessitates the explanation of these models in terms of the conceptual bases and the general descriptors of the "ecoclimatic schema". This in turn implies a sort of hybridization of the above model and the ecoclimatic schema. This is theoretically possible since the model already includes the subjective references ([1], [2], [3]) which form the major conceptual domains of the ecoclimatic schema in a specific manner. This process is reflected in the following general diagram:



#### 5.4 CONCLUSIONS

I have attempted to show here that the ecoclimatic problems of the built environment acquire their meaning and can be evaluated only within a broader architectural conceptual framework. This framework not only recognizes the importance of their socio-cultural and institutional dimensions, but it also organizes and presents the different images of the ecoclimatic phenomena: their social and institutional image, their activity image and their environmental image. Furthermore, it establishes "starting points" and "orientations" amongst these images for ecoclimatic research.

In this framework the attempt to evaluate the potential of "relational logic" to provide an adequate methodological framework within which an integrated approach to the ecoclimatic environment could be developed, has resulted in the recognition of some critical limitations of this approach. Although at certain levels of investigation the use of relational logic is inevitable, the need for a more comprehensive "structural logic" seems to be imperative at the deeper levels which are required for a thorough examination and evaluation of ecoclimatic phenomena.

However, the conceptual domains upon which climatic and ecoclimatic research for the built environment has been based have been formulated within an epistemological framework of "relational logic". This, in turn, has affected the descriptors produced by these conceptual domains and the meaning they have acquired at different levels and scales in the built environment. Accordingly, it seems very probable that this state of affairs accounts for the majority of the research gaps which may be identified by the introduction of a general taxonomic framework of ecoclimatic research. (See Part III and

particularly Chapter 9).

Following a major assumption deriving from C.B. Wilson's model, I also came to the conclusion that the formulation of a self-sufficient conceptual framework for a comprehensive description of the micro-climatic and ecoclimatic phenomena of the built environment is possible only at the level of triple organization of the ecoclimatic descriptors (see p.138 ). Accordingly, the shift from the 2nd "relational" level of logical complexity to the 3rd "systemic" and "structural" one appears to be inevitable and requires the formulation of models at an optimum level of abstraction which are capable of explaining the total structure of ecoclimatic phenomena within the proposed taxonomic framework.

In particular, the development of a taxonomic framework of architectural empirical research was considered necessary in order to tackle significant questions of the character of architectural complexity, the major conceptual bases which generate levels of description in architecture and the particular character of architectural actions which account for the production of the built environment. I have argued that problems of complexity and especially those referred to the organization of ecoclimatic phenomena within the context of architectural research, belong, in their greatest part, to the higher form of logical complexity. This logical complexity is influenced primarily by the particular position that the observer takes against the object of his investigation. It has been argued, also, that in architecture the observer is unavoidably linked with the reality he observes and this coupling of the observer with the observed phenomena greatly influences the outcome of his actions and the production of the architectural environment. The dialectics, therefore,

between subjective and objective descriptors in architecture should be taken into consideration and resolved *within the core* of any methodological framework applied to the investigation of architectural phenomena.

As a methodological consequence of the above argument, the need emerges to adopt a general taxonomic framework of ecoclimatic research which will provide room for the dialectics between objective descriptive generators like "time", "space" and "action", and subjective descriptive generators like "social whole", "process of production" and "environmental object". A significant conclusion is that, although at a surface level of analysis the subjective generators appear to be independent, at a deeper level, where the comprehensive description of architectural phenomena becomes possible, the interdependence of these generators becomes profound and presents a structured totality. Thus the comprehensive description of ecoclimatic phenomena and structuralist methodology are unavoidably interconnected at proper levels of abstraction.

In summary, the major argument behind the taxonomic framework which has been developed is that significant areas of microclimatic and ecoclimatic research can be identified, described and evaluated only in relation to both the complexity and the logic defined by the ecoclimatic schema and the objective-subjective references of architectural empirical research. It seems, therefore, that the use of a structuralist methodology is inevitable for the exploration and development of an integrated and comprehensive approach to ecoclimatic or other environmental problems of the built environment. This task is undertaken and explored in detail in Part IV and the Appendices I and II.

However, it is worth exploring the need for a structuralist

methodology further in terms of the empirical evidence provided in various spheres of established architectural and building climatological research. Part III attempts to organize and review a number of architectural climatological studies and to point out the necessity of integrating them within established areas of architectural empirical research through taxonomic models of the type developed here. It also becomes necessary to study newly developed areas of ecoclimatic research (for instance, psycho-climatology and socio-climatology) in this context and to evaluate their starting premises and orientations in relation to the taxonomic model of architectural empirical research and its major descriptive generators. Emphasis has naturally been given to the methodological part of these works, and arguments are raised which are concerned with their effectiveness in dealing comprehensively with major ecoclimatic problems, on the one hand, and with design action, on the other.

## PART III

### TRENDS IN ARCHITECTURAL CLIMATOLOGICAL RESEARCH - REVIEW AND EVALUATION

#### INTRODUCTION

#### CHAPTER 6

##### MODIFICATIONAL AND TRANSFORMATIONAL PROCESSES

#### CHAPTER 7

##### CLIMATE AND BUILDINGS

#### CHAPTER 8

##### CLIMATE AND MAN

#### CHAPTER 9

##### TOWARDS MORE COMPREHENSIVE CONCEPTUAL BASES FOR ECCOCLIMATIC RESEARCH



## INTRODUCTION

The review, undertaken in this Part of the thesis, of some basic material directly or indirectly concerned with the ecoclimatic environment, is dominated by the effort to identify and evaluate major research concerns and orientations of architectural climatological studies "within" the taxonomic framework of architectural research which has been established. The material gathered and selected for this task constitutes a small portion of the total of the work related to ecoclimatic and microclimatic environments, but it contains a wide and representative enough sample to serve the purpose adequately. Most of the diversified sources of information from which the material has been drawn have been reviewed in the preceding parts of the study<sup>1</sup>. Here, however, one of the objectives will be to organize this review of architecturally related climatic phenomena in terms of their associations and relationships with the general taxonomic model; an approach which eventually results in the formulation of particular areas of ecoclimatic inquiry. The areas of research produced in this way are also explained in terms of the specific descriptive bases organized in the context of the ecoclimatic schema examined earlier in Part II.

1. *A number of other works, specialized in different aspects of applied climatological research, can be used to supplement this review. Extensive discussions are provided by: GRIFFITHS, J.F., (1966) on the general development of Applied Climatology especially after World War II; GEIGER, R., (1965) on the Theoretical and Applied Microclimatology; MAUNDER, W.J., (1970) and GATES, D., (1972) on the general man-climate and climate-man interactions; and also more specialized studies like BRUCE, W., (1960) for a detailed review of the human physiological relationships to climate; ARONIN, E.J., (1953), OLGAY, V., (1963), FITCH, J.M., (1972), GIVONI, B., (1976), and ARENS, E., (1972) for different research orientations and areas of application of climatological knowledge in architecture, planning and environmental design.*

A major reason for following such an approach is to avoid methodological preconceptions in order to establish more relevant associations between specific problems and phenomena of the built environment and particular "conceptual bases", "starting points" and "orientations", for their investigation. Another major objective is to support the argument set out in the previous Part of the study, that a comprehensive explanation and evaluation of the climatic phenomena of the built environment requires a broad methodological framework which may be derived from the structuralist paradigm.

The compartmentalization of the structure of ecoclimatic problems has become an "a priori" assumption for the majority of the theoretical arguments and the empirical studies concerned with the climatic conditions of the built environment. The established rationale is what makes the core of the general level, at which the present review is developed, imperative in attempting to examine the basic principles by which an integrated approach to ecoclimatic problems can be achieved. Within this context, therefore, I intend to look at the various stages of the interaction between the different scales of the built-environment and the different scales of the microclimatic environment and to evaluate current research orientations in this field in terms of their practical applications in design. Particular emphasis has been given to the various ways in which the "hardware" climatic organization of the built environment is associated with its "software" ecoclimatic one.

The growing interest of the sciences which deal with "hardware" "software" relationships in the built environment has produced such a large number of methodological or experimental studies that even a simple enumeration of them is beyond the need and the objectives of this review. However, I should stress that in the majority of these

studies an increasing need to establish a holistic concept of the man-physical environment interaction has become imperative. Unfortunately, the recognition of this necessity is accompanied by an unmistakable feeling that architectural practice pays less attention to the ecoclimatic, microclimatic and the overall ecological problems of the built environment than it did in the past.

Some of the reasons for the present stage of failure of architectural empirical or theoretical work to deal comprehensively and efficiently with man's ecoclimatic environment can only be clarified at general levels much deeper than those concerned with the surface organization of architectural reality. At a first level of consideration, it might be said that the reasons for failure can be found in the difficulties architects and planners have in formulating the design problem and in conceptualizing the environmental situation which the building is supposed to modify or support. Similar reasons might be found in architects' and planners' difficulties in reconciling the many contradictory requirements in the various control mechanisms they must employ to deal with the environmental problems of architecture. However, even if through the most careful consideration of the problem-situation and exploitation of the conventional design action tools, many of the above difficulties could be overcome, a number of microclimatic and especially ecoclimatic problems will remain unsolved because of the nature of the climate-man and climate-building relationships.

Problems related to the climate of the built environment and to its ecoclimatic organization can be partly resolved within the boundary of the building or, at best, within the boundary of its neighbourhood. The fluctuations of the macro-environment both in time and space are

so large and unpredictable that the problem should be dealt with in terms of landscape and planning considerations.

Unfortunately, a coordination of these dimensions of the eco-climatic problems is incompatible with current architectural practice with destructive consequences for the individual building, and for the urban environment as a whole. The architect is commonly involved in a "defensive" design policy to keep out polluted air, to sacrifice visual requirements in order to avoid noise pollution, to compensate severe exposure by means of maximizing thermal control and so on.

As J.M. Fitch writes:

"The contemporary designer runs the risk of accepting electrical air filters as a satisfactory substitute for clean, fresh air; of feeling that electronically operated louvers are preferable to natural foliage; of preferring sound insulation to plain ordinary silence. There are, as we have seen, many specific situations in which our synthetic environments are superior to nature's. But this is not adequate basis for the mechanistic conclusion that we 'don't need nature any more'. On the contrary, with the complexity of modern building we need nature more than ever before. It is not a question of air conditioning versus sea breezes, of fluorescent tubes versus the sun. It is rather the necessity for integrating the two at the highest possible level."<sup>2</sup>

In environmental terms, therefore, the climatic problems of the building are unavoidably linked with the landscape and other characteristics of its surroundings. At this level, conventional design alone becomes an ineffective tool within the established professional role of the architect and, furthermore, the separation of design, planning and landscaping processes from the total process of production of the built environment, reflects a high degree of artificiality. At the same time, design action becomes a major source of difficulties in dealing with climatic problems, especially of small building developments. The recognition of these difficulties

2. See FITCH, J.M., (1972), p.237.

implies a higher level of synthesis than those usually assumed in architectural practice. Such a level is briefly described by Fitch. His answer to the problems of expanding the design approach to the individual buildings is what he calls "environmental zoning". He argues:

"What is urgently required is a new sort of *environmental zoning* which would establish area-wide or city-wide norms of orientation, density and height. Such norms would establish an overall topology to which the individual building could conform. They would give the fabric of the city as a whole the type of surface response dictated by the actual climate of the area."<sup>3</sup>

We may generally agree with Fitch's conception of "environmental zoning" as a necessary and useful step towards an integrated and comprehensive approach to the climatic problems of the built environment, but we should question at the same time the monopoly he advocates for design action. It is imperative that we should consider primarily the social significance of both problems and solutions of the built environment before any normative design prescription is given.

In social terms, the various climatic problems of the individual building are linked not only with the user of the individual building and his capacity for acquiring comfort standards - higher or lower according to his economic status - as conventional design practice assumes, but primarily with the general process of producing socially acceptable - and, therefore, socially evaluated - solutions to these climatic problems. Especially today, when problems of energy, resources and population have been internationally recognized as major social problems, the social character and evaluation of planning and design strategies (including the ecoclimatic organization of the built environment) should not be only recognized but, most importantly,

3. *Ibid.*, p.261.



should acquire a normative power<sup>4</sup>.

However, architectural practice strongly suggests that the major part of the failure in dealing with climatic and broader environmental problems in both environmental and social terms, stems from the lack of an adequate conceptual and theoretical background within which holistic assessments of environmental factors can be developed. Fitch has expressed this attitude clearly:

"The central reason for this failure is lack of an adequate theoretical - one might properly say, philosophical - apparatus."<sup>5</sup>

The present work deals with the problems related to the search, both for a broader conceptual framework where environmental problems and especially climatic ones can be viewed integrately and in a socially evaluable manner, and for the methodology within which such an approach can be developed. I have already shown that it is necessary to look at the first set of problems in close connection with the general areas of architectural empirical research (in Part II) and I have promised to show that the epistemology of structuralism can provide the grounds to deal with the second set of problems (in Part IV). In this part, therefore, I will try to evaluate the arguments developed in Part II, and to provide an index of examples for Part IV, by looking at the nature of empirical research conducted in the past twenty-five years or so in the fields of architectural and building climatology. Specifically, I will concentrate on the following areas: (i) the microclimatic and ecoclimatic modification processes; (ii) the climate-building interaction; (iii) the man-climate interaction and (iv) the developing areas of socially based climatic research.

4. *The socio-political character of the world's major ecological and economic problems has been recently recognized even in reports directed to the Club of Rome. See TINBERGEN, J., (1977).*
5. FITCH (1972), *op.cit.*, p.265.

## CHAPTER 6

## MODIFICATIONAL AND TRANSFORMATIONAL PROCESSES

## 6.1 INTRODUCTION

The concepts of "modification" and "transformation" are commonly used in the terminology of both ecoclimate and architecture to denote different, though sometimes analogous, processes of change. Roughly speaking, "modification" is employed in the description of environmental change, while "transformation" is employed to describe change in architectural phenomena of more integrated and synthetic character<sup>1</sup>.

In general, the use of these terms reflects different characteristics of the processes of change, which are of interest in the conceptual domains in which they are used, and in this respect their distinct and exclusive use may be partly justified. But in this work it is important to explain and define the different processes signified by these notions in terms of the magnitude and character of change which they are supposed to denote. This is essential for two main reasons. First, to avoid any conceptual or terminological confusion which may arise in the process of integrating and explaining ecoclimatic studies

1. *It is characteristic that in the terminology of the majority of works concerned with climatic aspects of the built environment terms like "transformation" or "transition" are almost totally excluded, while changes or developmental processes are described as "modification" and/or "adaptational". The opposite is true for architectural research with more general interests.*



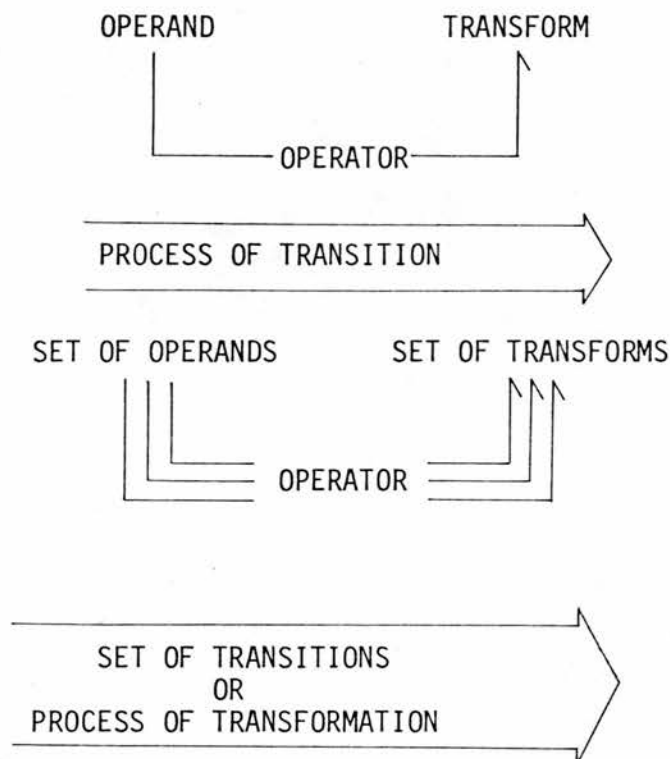
within the general framework of architectural research; and second, because there is a general assumption in this project that eco-climatic processes are extended beyond the limits of "modification changes" towards more integrated "transformational" levels. The recognition of this becomes very significant when considering the methodological implications which are involved in examining eco-climatic phenomena of the built environment. Thus, before we proceed any further, it is essential to explain briefly the use of these notions to be made in this chapter.

## 6.2 THE CHARACTER OF MICROCLIMATIC AND ECOCLIMATIC MODIFICATION

"Modification", "transformation" and "transition" are central concepts to all sciences including those which describe human practices. They are involved in and reflect the dialectics between stability and change in the context of which a whole conceptual and terminological complex has been produced to describe different aspects of this interaction. The recent science of Cybernetics discusses in detail the fundamental concept of change and provides an appropriate starting point for an attempt to define the concepts of modification, transformation and transition.

Change presupposes two things: an "object" which is transferred from one stage to another in a continuous or in a step-manner; and a "factor" which acts upon the object to cause this transfer. The object, before the change occurs, is called the "operand", the factor which acts on the operand is called the "operator" and the final stage in which the operand is transferred is called the "transform". In this case the change that occurs is called "transition". "Transformation" is defined in this context as a set

of transitions by which a set of operands is transformed through an operator to a set of transforms<sup>2</sup>.



The cybernetic distinction between transition and transformation becomes less clear if one attempts to apply it to those complex processes of the environment which include change. For the time being, therefore, we shall have to assume a more literal and less formal definition of these two concepts referring particularly to the magnitude of change involved. Thus, transition is defined as the process where change is involved at a surface level, while transformation is defined as a deeper level of change where deeper characteristics of the structure of operands are transformed<sup>3</sup>.

2. See, for instance, ASHBY, R.W., (1964), p.10.

3. The concepts of "transformation" and "transition" are indirectly discussed within an appropriate architectural structural framework in Appendix II, where they are explained through particular architectural examples.

The notion of modification, especially as it is used in architectural and building climatology and other environmental sciences, implies changes which might occur either at a transitional or at a transformational level. The major characteristic of this process is that the operator takes the form of a "filter", through which the operand is modified. The filter itself has its own specific characteristics which might also be transmitted or transformed. Thus, the operand and the operator take interchangeable positions and they are involved in a continuous process of mutual interaction which accounts for the greater difficulties in studying these processes analytically.

The following example is given to illustrate and develop the notion of modification and the different types and levels which are generated in the context of microclimatic and ecoclimatic studies.



When we refer to changes in climatic fields produced by buildings we describe this process as "the climatic modification function of buildings". In this case the climatic field  $C_1$  is changed into  $C_2$  through the intervention of building which acts as an "operator" or "filter". At the same time we may refer to the change produced by a climatic field on built form and we describe this process as "the built-form modification function of climate". Again, the built form  $B_1$  is modified into  $B_2$  through climate which acts as an operand or filter. Beyond that, and according to the ecoclimatic schema, climatic fields interact with man in many different levels. Therefore, we may

be concerned with "the behaviour modification function of climate or building" and even with the "climatic modification function of human behaviour"<sup>4</sup>.

From a rather systemic point of view it is important to realize that the notion of ecoclimatic modification implies different types of change, not only in terms of magnitude, but also in terms of "operand-operator" bipolars. The complexity generated in this manner is obviously enormous considering that almost every type of modification should be studied in its own epistemological context. On the other hand, certain types of ecoclimatic modifications have not studied to an extent which permits desirable generalizations.

However, in reviewing ecoclimatic studies it is important to identify the basic processes of ecoclimatic modification both from the point of view of the particular types of the bipolars (operand-operator) involved, and the particular modification level (transitional or transformational) at which the research is carried out. By doing so the relevance of ecoclimatic studies to the conceptual bases established by the subjective generators of architectural empirical research becomes more clear and at the same time research gaps become apparent and amenable to further investigation.

### 6.3 STAGES OF MICROCLIMATIC AND ECOCLIMATIC MODIFICATION

The term "stage of modification" refers here to the particular scale in which a given type of modification process occurs, together with the phenomena that may be encountered in this scale. It forms in this sense a complementary attribute of the process of modification and it is used here to specify its particular character. The bulk of

4. See Part II, Ch. 3 of this thesis.

the work carried out in architectural and building climatology has been orientated towards an analytical and empirical description and definition of those stages which are concerned with the climate modification function of the built environment, or the so called "site modification"<sup>5</sup>.

The following table gives the general organization of this type of work and outlines briefly the results held so far after many years of experimentation and theoretical work:

SCALE	MODIFIED CLIMATIC ELEMENTS	TYPE AND MAGNITUDE OF MODIFICATION/ DESCRIPTION OF	*
REGIONAL SCALE	(i) TEMPERATURE	<p>..COASTAL EFFECT: Seasonal temperature cycles of coastal areas caused by the heating and cooling of water. Changes of 5<sup>0</sup>C and higher have been observed.</p> <p>..ALTITUDE: Variation of temperature due to altitude. In Britain an average 0.4<sup>0</sup>C per 100m in the winter and 0.6<sup>0</sup>C in summer have been observed. A by-effect of this modification are the well-known 'frost-pockets' caused at night by Katabatic winds. Such drops in temperature can exceed 10<sup>0</sup>C.</p> <p>...SLOPE EFFECT on solar heating of ground and air. Surface heating depends on the angle of 'inclination to the solar beam'</p>	

5. *For an extensive and well-formulated review concerned with "site modification" see ARENS, E., (1972).*

SCALE	MODIFIED CLIMATIC ELEMENTS	TYPE AND MAGNITUDE OF MODIFICATION/ DESCRIPTION OF
		and the shading duration. Modification of several degrees C are caused.
	(ii) WIND	.SURFACE GEOMORPHOLOGY: Roughness or flatness of the site highly modify the locally occurring wind speeds. ..ALTITUDE: Wind speed generally increases with altitude.
	(iii) INSOLATION	Geomorphic and landscape characteristics
	(iv) RAIN	(e.g. slopes, forestry, lakes, etc.) are
	(v) AIR-HUMIDITY	critical in modifying these climatic elements.
URBAN SCALE	(i) TEMPERATURE	.HEAT ISLAND: Due to high radiation absorptivity the lack of water surfaces, the high thermal conductivity of surfaces and the heat production in buildings elevate the temperature in cities. Temperature differences of 7 <sup>0</sup> C are often observed.
	(ii) WIND	.URBAN INFLUENCE ON GRADIENT WIND: A considerable reduction (= 30%) of wind velocity within cities due to friction and roughness of the built environment. Additionally, the wind direction can be changed as much as 90 <sup>0</sup> by channelling in streets.

SCALE	MODIFIED CLIMATIC ELEMENTS	TYPE AND MAGNITUDE OF MODIFICATION/ DESCRIPTION OF
		<p>..INDUCED LOCAL WINDS by the urban area. Caused by the temperature differential between the city and the surrounding country. Speeds of <math>2-3\text{m.s}^{-1}</math> have been observed.</p>
	(iii) INSOLATION	<p>.SOLAR INTENSITY AND DURATION: Industrial cloudiness may reduce direct solar radiation by up to 40% and even more in winter. Between 100 and 300 hours are lost per year in an urban environment like London. Further reduction is caused by the particular geometry of the buildings.</p>
	(iv) RAIN	<p>.CLOUDBURSTS due to thermal convection and dust above cities.</p>
	(v) HUMIDITY	<p>.REDUCTION OF RELATIVE HUMIDITY due to the lack of water surface and the existence of higher temperatures.</p>
BUILDING SCALE	(i) TEMPERATURE	<p>.Temperature differences of considerable degree can be observed within a distance of 10 meters and lower. Shading of buildings, thermal conductivity of surfaces, micro-landscape characteristics natural or artificial, enclosed spaces etc., cause a mosaic of temperature</p>



SCALE	MODIFIED CLIMATIC ELEMENTS	TYPE AND MAGNITUDE OF MODIFICATION/ DESCRIPTION OF
		differences.
	(ii) WIND	<p>.WIND DEFLECTION around buildings. Wind tunnel studies aimed at developing methods of ameliorating ground wind for pedestrians in the vicinity of buildings have given remarkable examples. Almost total modification of wind can be achieved by manipulation of building surfaces in certain areas.</p> <p>..LOCAL WIND CIRCULATION in open spaces produced by gradient wind and isolation differences.</p>
	(iii) INSOLATION	<p>.SHADING: Calculation methods computerized or not, charts, instruments and models are available in the literature.</p> <p>..ALBEDO: Site influence due to the reflectivity of the building surfaces.</p>
	(iv) RAIN	.TOTAL MODIFICATION is achieved by the provision of overhead shelter, walkways, etc.

\*The table has been combined on the basis of information given by ARENS, E., (1972), MAUNDER, W.J., (1970) and GATES, D., (1972)

At the level of investigation where the emphasis has been given mostly to the building, acting as a filter or climatic modifier, the modification process is characterized by three stages<sup>6</sup>:

operator	operand	stage	Description
B	→ C	1	Conversion of macro-climate to the microclimate around the building <sup>7</sup> .
B	→ C	2	Conversion of the microclimate to the indoor climate by considering the physical properties of the building envelope itself <sup>8</sup> .
B	→ C	3	Further modification of the indoor climate through service installations, decoration, furniture, etc <sup>9</sup> .

6. *The concept of the building as a "climate modifier" has been developed primarily by HARDY, A.C., and O'SULLIVAN, P.E., in their paper "The Building: A Climate Modifier", Heating and Ventilation for a Human Environment, Institute of Mechanical Engineering, London, November 1967. The importance of this function of buildings in architectural research has been emphasised in HILLIER, B., MUSGROVE, J. and O'SULLIVAN, P., (1971) through their concept of 4-function model. There it becomes apparent that it is imperative to incorporate and extend isolated studies of this function into a more integrated framework provided by the conceptual bases 1, 2 and 3 (see p. 137 of this thesis).*
7. *For interesting examples of this type of research see, for instance, O'SULLIVAN, P., (1970) and KRATZER, A., (1962 e 1937) and other relevant information concerned especially with climate and planning.*
8. *Examples of research on this stage of modification are among others: HARDY, A.C., O'SULLIVAN, P., (1967); PETHERBRIDGE, P., (1965); LOUDON, A.G., (1965) and (1968); HOPKINSON, R.G., (1963); MARKUS, T.A., (1967), and for a comprehensive review of the subject see GIVONI, B., (1976) and other texts on Architectural Climatology or on Building Climatology.*
9. *See research dealing with Ergonomics and Architectural Building Technology specifically concerned with indoor environmental control, e.g. GIVONI, B., RIM, Y., (1962), BLASDEL, H., (1972), CHILES, D.N., (1958-59), CUTTLE, C., (1973), DAVIES, A.D.M., et al., (1971), HAMAKER, J., (1972), LOFBERG, H.A., et al., (1973), O'SULLIVAN, P., (1972), SLIWOWSKI, L., (1972)*

The majority of the studies concerned with the above stages of the process of climatic modification caused by the built or urban form are orientated towards an analytical investigation of the environmental object itself. Such an investigation is usually carried out through the study of the physical properties of climatic fields, the mechanisms and the different forms of the building and the methods by which appropriate data can be obtained in order to permit calculations of the modified climate. In these respects these studies are of utmost value to general ecoclimatic research, but they acquire their major significance at a more synthetic and comprehensive level, beyond the analytical one at which they are carried out. Furthermore, an integration of these studies can provide the mechanism necessary for a "climatological mapping" of the built environment on different scales and also an explanation of the dynamics of such a mapping in terms of measurable properties of both climatic fields and built form. The latter, for instance, can be achieved by establishing relationships between, for example, temperature rise outdoors and urban density.

The most interesting contribution of these studies, apart from the practical data and methods they offer, is to be found in their orientation towards the process of production of the ecoclimatic environment, by establishing the design criteria necessary for economic and acceptable buildings. In fact they do so by concrete suggestions concerning the location, orientation, density as well as the characteristics of the building in terms of its form or the materials used in its construction.

The type of modification which has been characterized as "the building modification function of climate" has also received

considerable attention, though in a completely different methodological context. This point has already been discussed in Ch. 2 of Part I where the requirement of approaching this function through different lines of investigation including the "criticality" of climatic forces, the necessity of viewing these phenomena in well-defined historical perspectives, as well as in relation to the opposite process of "the climatic modification function of buildings", has been stressed. Again, the stages of modification involved in this process are the following three:

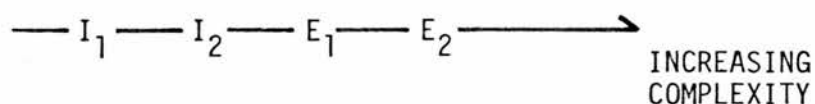
Operator	Operand	Stage	Description
C →	B	1	Urban form modifications in terms of planning characteristics concerned, for instance, with traffic design, orientation of streets, vegetation and surface characteristics, density, spacing and topographical arrangements, etc.
C →	B	2	Built form modifications concerned with the choice of materials, shape, fenestration and orientation, general lay-out in terms of vicinity, etc.
C →	B	3	Internal space modifications in terms of service technology, decoration, lay-out and orientation of rooms, etc.

Not so much is known about the type of modification process which might be called "behaviour modification function of climate", although even climatologists are arguing that:

"If in order to raise man's standard of health and thereby his general efficiency in the community it is important to study the effects of microclimate on crops and cattle, it is imperative that even greater attention be paid to the influence of microclimate on man himself."<sup>10</sup>

The following figure represents the different levels and stages where this process of modification is studied. It also represents a typology useful for the integration of these studies within the general framework of architectural empirical research where, in fact, they acquire their specific architectural significance. It is beyond the scope of the present work to make an extensive analysis for each type of modification, but nevertheless, representative examples from each type and level are discussed in due course, especially in connection with the general tendencies and orientations of current ecoclimatic research.

Operand Level		
CM (I <sub>1</sub> )	Individual Level (I)	1 Physiological
CM (I <sub>2</sub> )		2 Psycho-behavioural
CM (E <sub>1</sub> )	Extra-Individual Level (E)	1 Psycho-behavioural
CM (E <sub>2</sub> )		2 Cultural



10. LAWRENCE, E.N., Microclimatology and Town Planning, p.231.

## CHAPTER 7

### CLIMATE AND BUILDINGS

#### 7.1 THE CLIMATE-BUILDING INTERACTION : RESEARCH

The nature of climate-building interaction has already been stressed, especially in terms of the different conceptual and epistemological backgrounds which underly both climate and building in the literatures of Climatology and of Architectural Science. It has been maintained, for instance, that a building should be understood through its "total" response to the physical and cultural environments which that building affords, and that both physical and cultural studies on buildings should take into account, from the earliest possible stage, their impact on one another. Thus, any comprehensive approach to building design should condemn a conceptualization of building as a tool which frees man for other activities by creating an environment which protects him from the undesirable effects of the weather, as being deterministic and only partially true. In fact, the building is reduced to such a tool only in cases where severe climatic forces must be overcome and probably not even then. Rapoport's concept of "climatic scale", discussed earlier, has shown that on purely climatic grounds the need for shelter may range from the need for no shelter at all to the need for maximum protection<sup>1</sup>. But that does not mean that maximum protection is all a building gives.

1. Refer to the discussion in Ch.2, pp. 58-64, esp. footnote 3.



More often than not, theoretical discussions about the climate-building interaction are abstracted from the reality of design action and, for the sake of achieving simplification as well as more rigorous formulation, confine themselves to the deeper levels at which they can be expressed in terms of physics. However, even at these levels the study of climate-building interaction is a very complex task. The physical environment, within which the climatic environment forms a major part, should be thought of as being a composite structure formed from many coexisting and interacting elements which are distinct in physical terms. These elements of the physical environment which can be immediately and directly modified by buildings are: (i) atmospheric, (ii) thermal, (iii) luminous, (iv) aqueous and (v) sonic.

At a general level the study of climate-building interaction presents two interconnected views of the situation. On the one hand climate influences the form of buildings and consequently their performance and, on the other, buildings influence climate itself. I have already referred to these aspects speaking about the major types of modification processes involved in the climate-building interaction<sup>2</sup>. The majority of the studies in this area of research have been restricted to the first or the second part of the interaction, while no serious attempts have been made to weigh the impact of one type of modification on the other. Thus, questions related to the impact of the building modification function of climate (e.g. atmospheric pollution) over the climate modification function of buildings (e.g. deterioration of buildings by pollution) are almost unexplored in the field of building climatology.

2. See Ch.6, pp. 161-163.



Similar questions would probably suggest studies like those of Lindquist and Rylander<sup>3</sup> where an intention might be to find design methods or models to predict beforehand the microclimatic mapping of the area (at various scales) where a certain building development is to take place. In studies of this kind the dynamics of both modification processes should be examined and possible feedback recommendations could be made to improve the overall performance of the built environment and of the urban microclimate. It is obvious that such a research programme should be developed in all three stages of modification<sup>4</sup>.

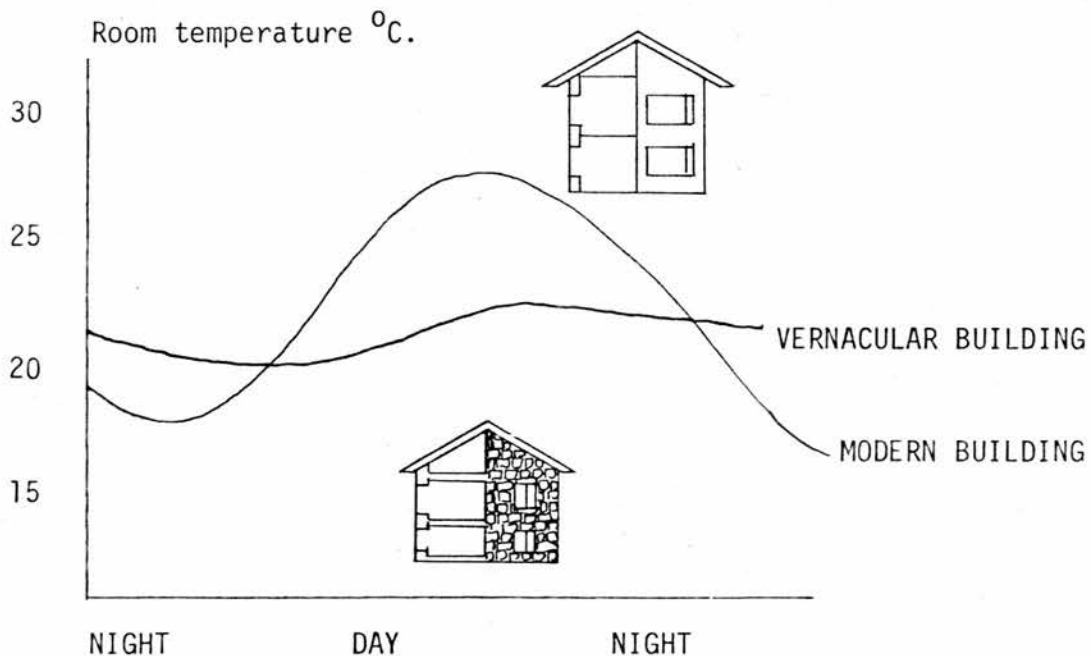
However, for each modification process, research tends to concentrate on individual climatic elements and, furthermore, on examining only partially the influences that this element may have in terms of building design. Although classic textbooks on architectural climatology have turned their attention towards a more integrated assessment of climatic parameters, in terms of their influence on the structure and the design of buildings, the majority of the methods introduced are not comprehensive enough for the designer, and in practical terms are usually unusable. It seems that this inadequacy does not arise from the absence of serious research into the main physical principles regulating the relationships between climatic parameters and elements of built-form, so far as these relationships are examined in isolation from each other. For instance, studies on the thermophysical properties of building materials, the thermal effects of building materials in predicting indoor temperatures, the

3. LINDQUIST, S., RYLANDER, B., "Change in Local Climate - The Influence of Building Development", National Swedish Building Research Summaries, R59:1973.

4. That is: Stage 1 → Stage 2 → Stage 3, see sec. 6.3.

control of incident solar radiation, the thermal effect of windows and the efficiency of shading devices, have all been investigated in great detail. The failure occurs in those methods which try to bring these studies together so that the overall thermal performance of building can be achieved by design, choice of materials and technical means.

It is interesting that these problems of the integration of climatic parameters, in which the contemporary design of buildings repeatedly fails, have been more successfully solved by the vernacular or even the primitive builder in most parts of the world. These people had the means of locating, orienting and designing buildings or groups of them in much more efficient ways (climatically speaking) than has contemporary practice.



After H. Ryd (1972) p.54.

It can be shown statistically that the vernacular builder had at his disposal better methods of building good houses. He produced the building in such a way as to ensure the best possible climate within

or outside the building envelope. On the other hand, contemporary practice produces buildings regardless to the climatic environment than to the immediate availability of heating, cooling and air-conditioning equipment. This failure of conceptualizing the eco-climatic problems has been criticized by building climatologists who justifiably question the ability of architecture and building technology to deal in terms of specialized knowledge with the physical control of the interior environment<sup>5</sup>. Furthermore, some researchers go so far as to question the potentiality of the present architectural educational and professional systems to produce the appropriate architectural roles necessary to conceptualize these problems<sup>6</sup>. I think that a great deal could be gained by trying to answer these questions seriously and, certainly, by questioning some of the major assumptions underlying current orientations of research in building climatology.

The economic powers of the "developed" societies through whatever means they see fit and, especially, through patronage or the operation of the market forces, prescribe the creation of types of buildings and of fit environments. To these economical orders the architectural profession and research respond passively, proposing enclosed spaces, more refined technology, massive framed buildings and so on, because this is exactly what architects have been taught to do and what society's economic system permits them to do. But although these

5. For a brief discussion see HAMAKER, J., "Whether Physical Control of Interior Environment should be included in the Sphere of Knowledge of Architectural and Building Technology", in *Teaching the Teachers on Building Climatology, Volume of Preprints, Paper No. 28.*
6. See, SEALEY, A.F., "Awareness and Application" in *Teaching the Teachers on Building Climatology, op.cit., Paper No. 64.*

buildings are questionable on a number of grounds, culturally, economically, functionally and environmentally, they are assumed to be the only possible way of dealing with environmental problems even when architectural history has proved this assumption to be totally wrong.

To illustrate this argument, let us consider some examples of current research in architectural and urban climatology. Givoni<sup>7</sup> for instance, writing on the effects of town planning on the urban climate, summarizes the elements affecting this relationship:

- (a) the location of the town in the region,
- (b) the size and density of the built-up area,
- (c) width of the streets and their relation to the prevailing winds and sun position,
- (d) building materials,
- (e) the total area and distribution of "green" areas,
- (f) some details of the design of buildings.

This type of work, though very useful in defining the major aspects of the interaction between climatic environment and different scales of environmental objects which theoretically may permit a spatial mapping of the climatic reality, is totally confined within the conceptual domain of either the environmental image or the impact that this image may have in terms of the production of the climatic environment. Thus, while major decisions are taken in terms of descriptors provided generally in the conceptual domain (*social totality* → *process of production* → *environmental object*)<sup>8</sup>, planners

7. GIVONI, B.M., "Effect of Town Planning on the Urban Climate", in *Teaching the Teachers on Building Climatology*, *op.cit.*, Paper No. 18.

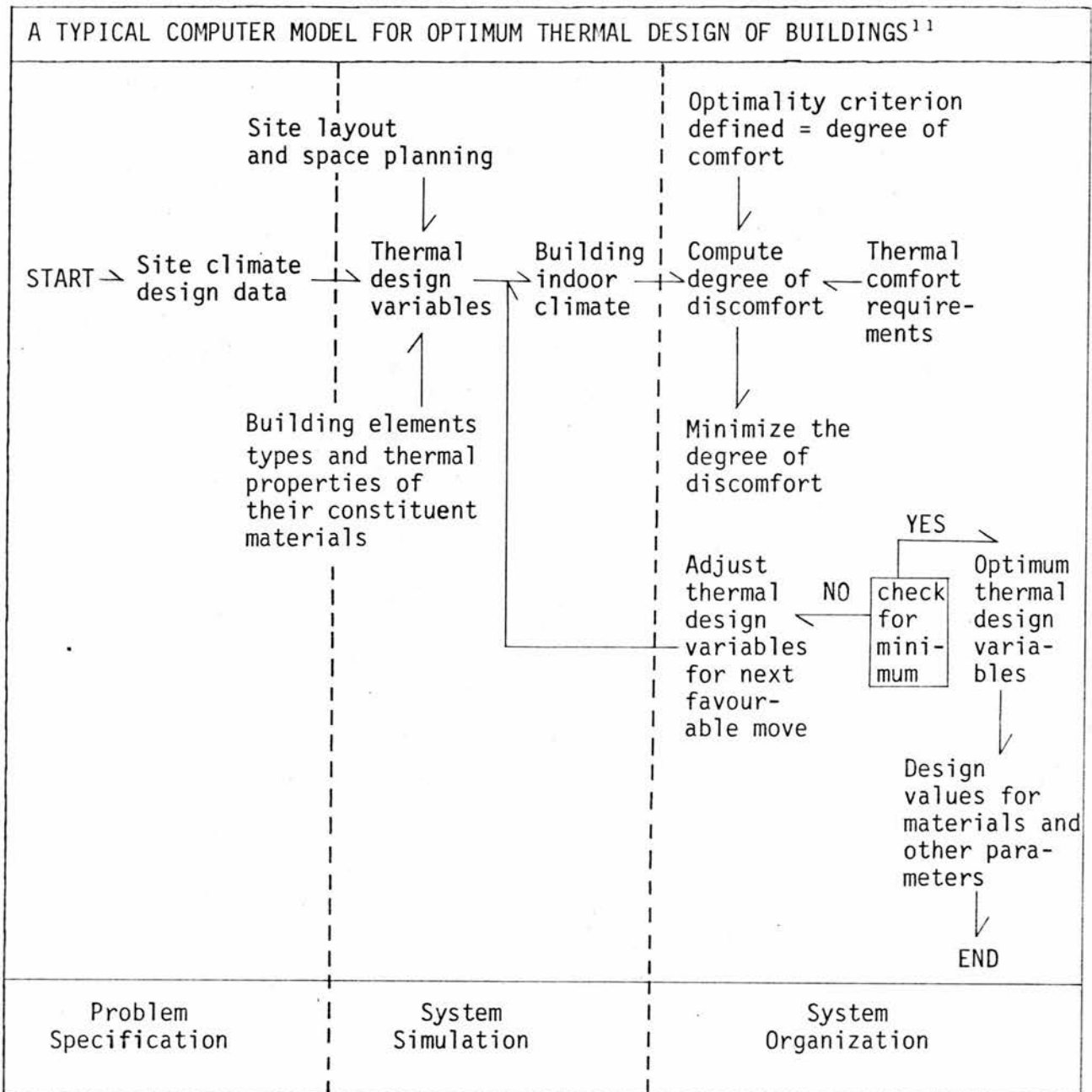
8. See Ch.5, Part II.

and designers as professionals are left to assume that they have to conceive and solve their problems in terms of the (d) and (f) parts of the whole process presented above<sup>9</sup>.

At the second stage of modification, the relationship between outdoor temperature fluctuations and indoor thermal climate makes a common and well-established theme for building climatological research. The majority of these studies assume that the four basic elements in this interaction are: outside microclimate, the structure of the building including the thermal properties of building materials, the layout of indoor space and the occupants. These factors are assumed to be enough to describe a system leading to the "thermal well-being" of the occupants<sup>10</sup>. The problems associated with this type of research are both computational and conceptual. Computational difficulties arise with: (i) quantitative generalizations regarding the influence of the urban climate on the thermal behaviour of a structure or on the resulting indoor climate, and, (ii) the inadequacy of meteorological data together with the absence of any microclimatological data. The more serious conceptual problems relate, as in the previous example, to the type of description assumed for the occupants, for instance whether they are biologically, psychologically or socially considered.

9. (d), (f), are referred to Givoni above: "building materials" and "some details of the design of building". It is easy to imagine in this situation that the climatic conditions within which the majority of architectural actions occur in reality, are already predetermined through decisions taken at much higher level and outside the span of the traditional role of the architect.

10. See, for instance, BUCHBERG, H., (1969) and BASNETT, P., (1972).



Computerized methods of dealing with the problem of thermal design, like the one shown in the above diagram, have so far revealed a number of important details about the mechanism of the building "filter" for all the modificational stages and especially for stage 2. At the same time such studies present serious disadvantages. Milbank,<sup>12</sup> for

11. Adapted from GUPTA, G.L., (1970).

12. MILBANK, N.O., (1974).

instance, reviewing this area, suggests that: (a) existing computer programmes for thermal prediction do not produce suitable information for architects; (b) they do not take into account the need for different types of information, of different roles in the design process and at different stages of the design process; and (c) thermal design in isolation is unrealistic in that models should accommodate integrated information for ventilation, lighting and structure as well. I would like to add to Milbank's remarks that the problem does not lie so much in the further development and refinement of these models as in the assumed "comfort requirements" that these models accept as central. This problem, as we shall see later, demands better conceptual tools rather than more refined computational methods.

The problem of climatic data is central to any discussion of the climate-building relationships. It has been suggested repeatedly in the literature of the subject that ordinary climatological averages, extremes and frequency distributions are not representative enough to be used immediately in the planning and design process. Satisfactory data for planning design purposes have been computed but the methods used are still undeveloped<sup>13</sup>. The reason behind the inadequacy of climatic data is that they are collected from meteorological stations primarily with the purpose of recording climate and forecasting weather.

13. *Lacy, for instance, who has done considerable work on the application of climatic data to building design, supports this argument and suggests that the "design-data" problem mainly stems from lack of knowledge of the ways weather and climate affect buildings. (see LACY, R.E., "General Data - Climatological Databooks" in Teaching the Teachers on Building Climatology, (1972) pp. 183-187. See, also, BOYD, D.W. "Preparing Climatological Data for the Design of Buildings" in Teaching the Teachers on Building Climatology, Vol. of Preprints, Paper No. 5. But, I think that I would agree with Prof. C.B. Wilson that the real "design-data" problem essentially lies in the failure of architectural and building climatology to develop methods and techniques appropriate to deal "simultaneously" with design and scientific climate analysis.*



Thus, the decision-making process in planning and design lacks the appropriate climatological information. The decision-making is also affected by the conflict amongst climatic parameters and the resolution of this lies in constructing predominancies among the parameters<sup>14</sup>. This problem of predominance is also related to the appropriateness of data since proper informational input is essential in constructing rational evaluation systems.

A prototype for "design-data information" which is often used in current architectural practice has been developed by V. Olgyay in his classic book "*Design with Climate*"<sup>15</sup> (see figure next page).

Further developments, with the aid of electronic computers, have produced more accurate methods of computing climatological design data, especially in terms of integrating multi-variable ecoclimatic problems. It would be possible today to develop procedures which would take into account not only average and extreme values of single climatic elements, but the full spectrum and complex nature of climatic conditions and their interaction with buildings<sup>16</sup>. But even these methods do not ensure the appropriateness of data to the various design problems. The difficulties lie mostly with the basic assumptions by which simplifications and approximations concerning the interplay of climatic forces with the built form - necessary in meeting practical design requirements - are achieved. The generalizations involved in most of these methods are of the same nature as those of

14. See, for instance, TAESLER, R., "*The Relevance of Urban Climate to Building and Planning*", in *Teaching the Teachers on Building Climatology, Vol. of Preprints, Paper No. 69.*

15. OLGAY, V., (1963).

16. See TAESLER, R., *op.cit.*, p.195.

# REGIONAL EVALUATION

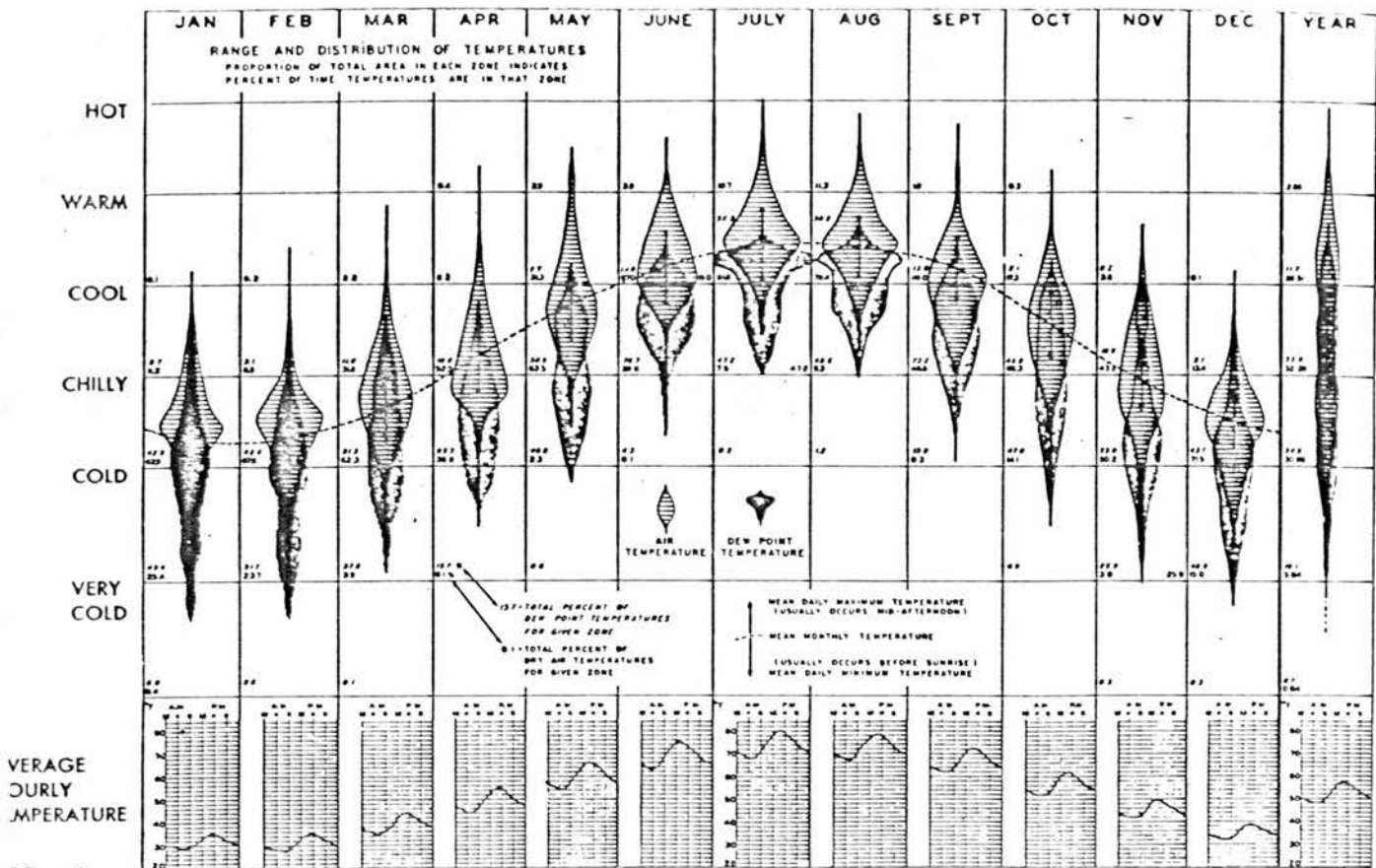
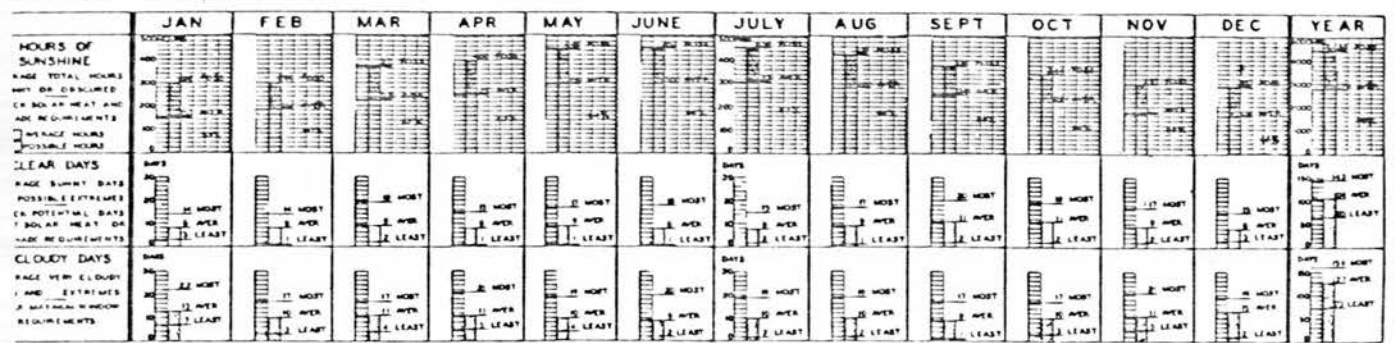


FIG. 1.

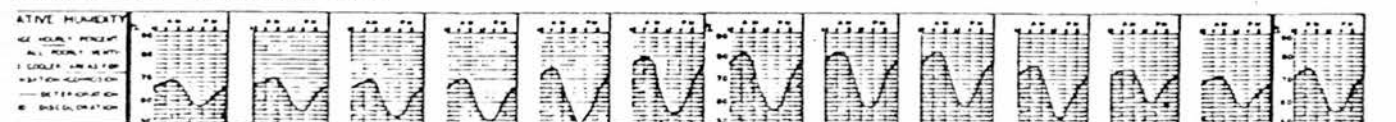
## SOLAR ANALYSIS



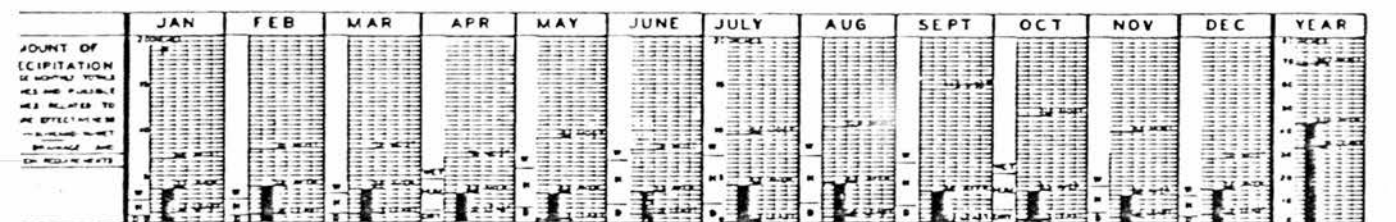
## WIND ANALYSIS



## HUMIDITY ANALYSIS



## PRECIPITATION ANALYSIS



Regional Climate Analysis for Metropolitan New York - New Jersey area.  
Source: V. Olgyay (1968), figures 47-48.

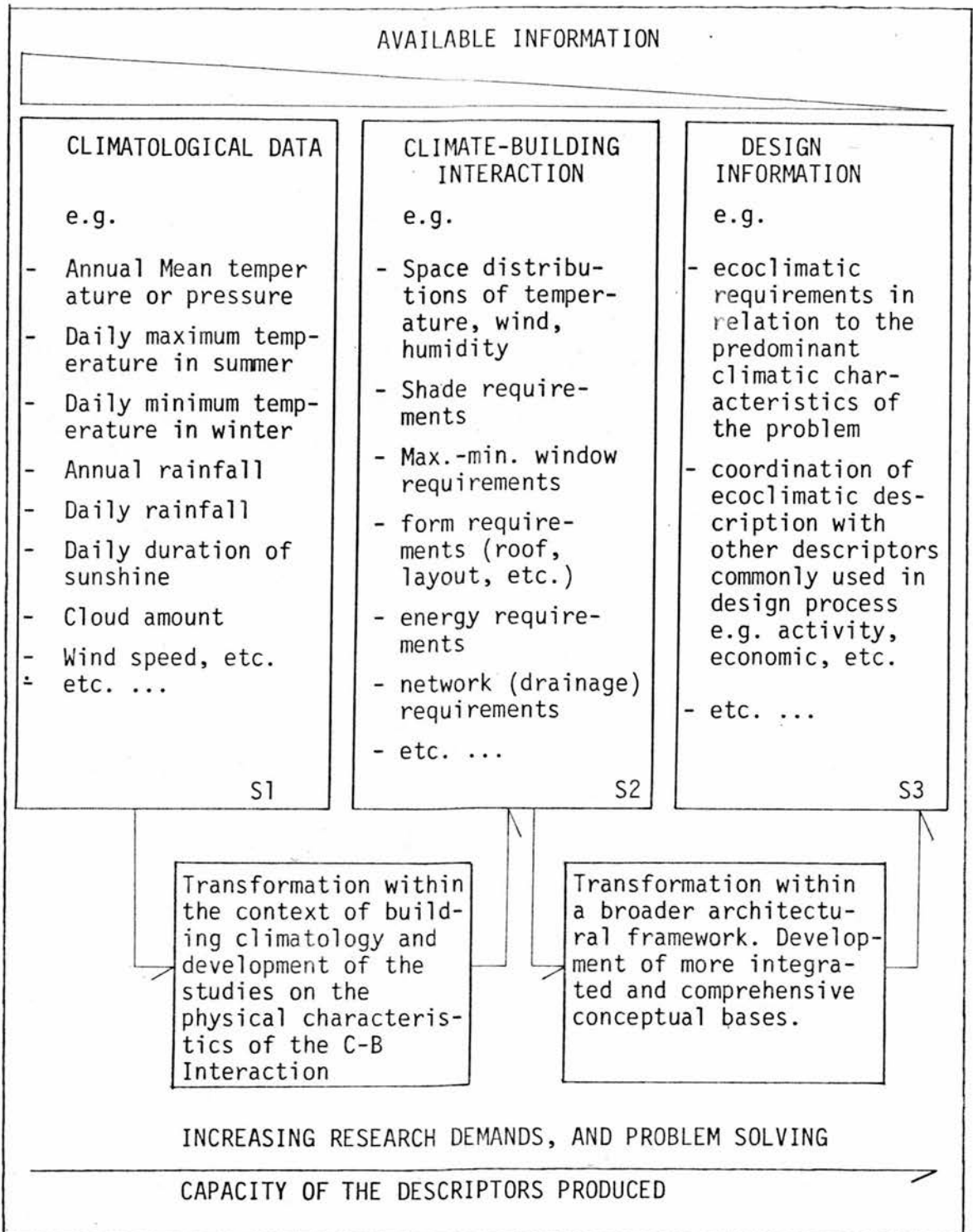
the Olgyayan approach, and this represents one important reason for failure in practical design applications. For instance, neither the degree of accuracy nor the predominance of one element over the others are factors which can be generalized to meet the variability of design problems on different time and/or spatial scales. Nevertheless, these problems arise whenever the study is conducted within a purely climatological and meteorological context.

Thus, C.C. Wallen, summarizing the conclusions of the "Teaching the Teachers in Building Climatology" colloquium - which was held in Stockholm in September 1972 under the auspices of the International Council for Building Research (CIB) and the World Meteorological Organization (WMO) - emphasized the problems related to the relevance of meteorological and climatological information on building design and planning processes:

"A fundamental conclusion of the colloquium in connection with the general aspects of the application of meteorological information was that human requirements of an indoor climate was not yet sufficiently known ... It was concluded that it is essential that the attention of meteorologists, architects, and engineers be drawn to the need for both design and construction while, at the same time, studies in the field of human biometeorology of the human needs of an indoor climate should be promoted."<sup>17</sup>

The essential problem therefore is that of transforming climatologically relevant data to design relevant information. Such a process seems to me to present three distinct stages:

17. See, *Teaching the Teachers on Building Climatology, (1972), Conclusions, p.289.*



As a further illustration of this problem, it is interesting to follow briefly the structure of research which lies behind the wind-building and wind-man interaction in order to clarify further the difficulties associated with isolated studies which deal only partially with the ecoclimatic problems of the built environment.

Wind is a climatic element easily identified and measured and, therefore, studies on wind-building interaction are well developed in the field of Building Climatology. Thus, a number of generalized recommendations for planning and design of buildings have been produced, the inadequacy of which in certain cases shows the major difficulties of transforming climatic information to the second stage of C-B interaction and then to the third one of building design.

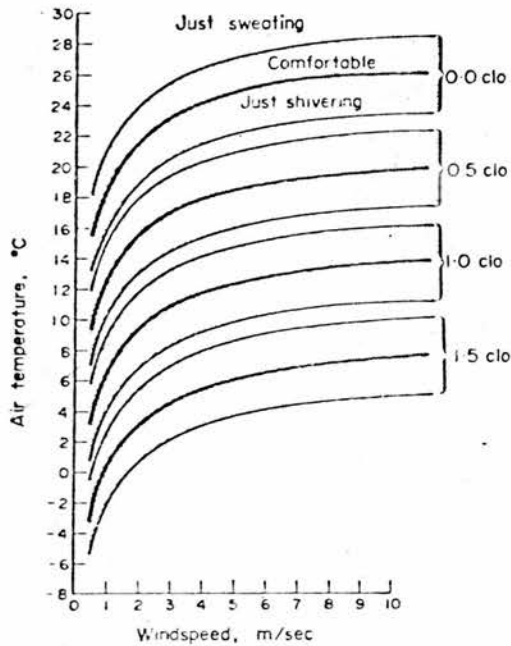
Through experimental techniques and mostly through wind tunnel experiments it is theoretically possible to produce to an adequate degree of accuracy the micro-wind mapping of an existing or a proposed building development. It has been shown, for instance, that in the second stage of wind modification such a mapping can describe efficiently the general air patterns around a building or a group of buildings.

Additionally, the mechanical effects of wind on people have been described in terms of causal wind speeds:

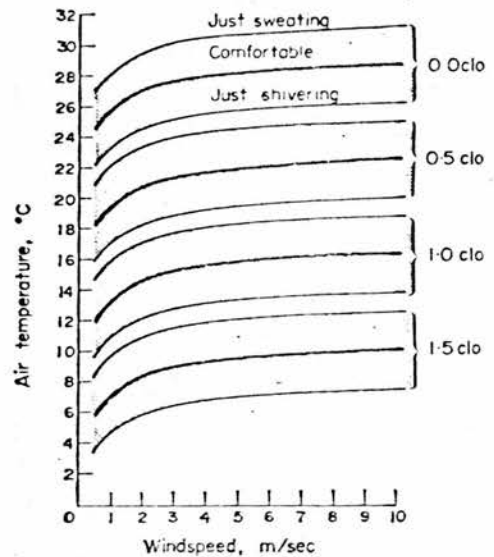
Beaufort Number	Wind Speed m/s	Effect
0.1	0 - 1.5	No noticeable wind
2	1.6 - 3.3	Wind felt on face
3	3.4 - 5.4	Hair is disturbed, clothing flaps
4	5.5 - 7.9	Raises dust, dry soil and loose paper. Hair disarranged
5	8.0 - 10.7	Force of wind felt on body. Limit of agreeable wind on land.
6	10.8 - 13.8	Umbrellas used with difficulty. Difficult to walk steadily.
7	13.9 - 17.1	Inconvenience felt when walking.
8	17.2 - 20.7	Generally impedes progress
9	20.8 - 24.4	People blown over by gusts

According to B.R.S. Digest, 141/1972

Furthermore, the thermal effects of the wind have been described by the use of comfort equations developed largely from work originating in research on comfort indoors:



Comfort conditions for strolling in full sun.



Comfort conditions for strolling in shade.

After A.D. PENWARDEN<sup>18</sup>

But this information is largely inapplicable in design. In a few cases designers may have gone as far as to utilise the 5 m/s limit<sup>19</sup> of wind speeds at pedestrian level or to correct the pedestrian pathways microclimatically in order to avoid the deflection of the wind towards the ground by tall buildings. But only in a very small

18. PENWARDEN, A.D., (1974).

19. For a discussion on the application of this limit in the design of buildings see PENWARDEN, A.D., *ibid.*



majority of buildings and developments is the effect of the buildings on the wind or the wind on people taken into account at all. The question, therefore, is why the research results produced so far, although simple and apparently straightforward, have not been effectively taken into the design process.

It might be argued that such standards could be of practical value in the design of buildings only when a more integrated assessment of climatic elements such as sunshine, air temperature, clothing and activity of people taken into account, or when these standards leave room for the dynamic subjective responses of people to the environmental conditions out of doors. Or it might be argued that the general assumption behind this type of research, that climatological knowledge (e.g. an equation of comfort) developed for indoor conditions could be applied to conditions outdoors (e.g. in determining comfort criteria for a woman strolling around a shopping centre), is totally wrong and misleading; that such knowledge should be reconsidered since the man-environment system presents "structural" differences between indoors and outdoors which go beyond the quantitative ones; and that such a structural difference is that indoor environments are designed for specific activities, whereas outdoors the activity often responds to the climatic conditions.

Here again, research is needed on the conceptual and descriptive bases assumed for the research strategy. It becomes clear that even at an elementary level research should be based on assumptions formulated within broader frameworks such as suggested by the eco-climatic schema and the general taxonomic model of empirical research in architecture which were developed in Part II of this work.



## 7.2 THE CLIMATE-BUILDING INTERACTION : PRACTICE

We may now look at the other side - at practice - to discuss and consider certain architectural movements, buildings and projects closely related to efforts to produce ecoclimatically well-organized spaces. In this way it may become apparent that certain specific designs or even architectural movements cannot be adequately explained without recognizing that the ecoclimatic internalization of space has been a generating factor in the whole design process. I should point out, however, that the subject of this section is extremely large to be covered fully. Here, I have only attempted to sketch a survey and analysis of a few examples in order to suggest the conclusions which might emerge from a further study.

Consider, for instance, the recent "glass house" movement. Greenhill and Jenner, designers of one such scheme, wrote:

"The starting point of this scheme is the idea of exploring what happens to established attitudes to community housing when everything is put *under one roof*. The simple form of the commercial glass house provides the image of a light-weight umbrella under which traditional concepts of planning and social space can be reinterpreted."<sup>20</sup>  
(my emphasis)

To explain the above remark, Sean Mulcahy, reporting on their design, stated:

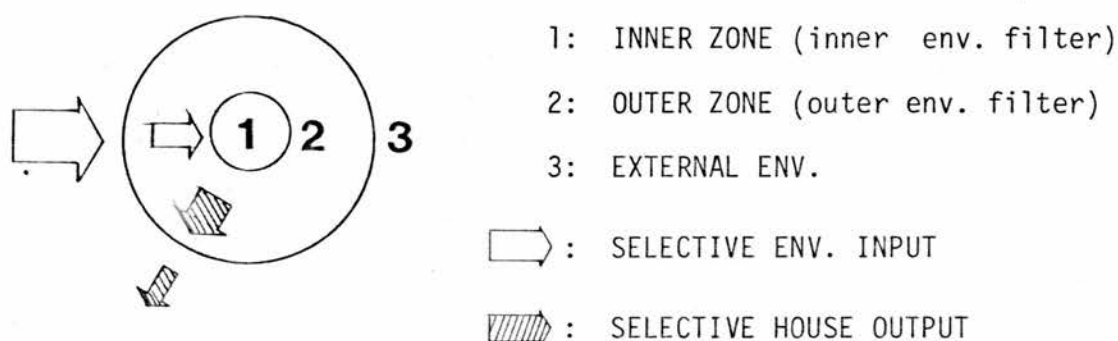
"Considering thermal matters, it is clear that for a start there is a benefit in winter of shelter from wind ... Winter sun penetration through glass house roofs would be slight (...). In spring and autumn much of the day could agreeably be spent in the communal garden; the houses would also benefit from sun penetration in these seasons."<sup>21</sup>

The basic idea behind the design of the glass house is that the climatic environment of the living spaces should be reinterpreted in a

20. AD/3/1975, "Glass House", p.144.

21. *Ibid.*

manner that can facilitate daily family routines and activities. Such a design produces different ecoclimatic zones, especially in terms of "double control" of the thermal environment, daylight and sunshine. This double control is achieved by the provision of two habitual zones. The inner and warmer zone usually accommodates the more sedentary living activities. The outer, temperate zone is used for work. Obviously, the glass house is a notable modern attempt generated by the necessity to control "through design" the ecoclimatic environment within the building.



Ecoclimatic considerations have also influenced the early views of organic architecture<sup>22</sup>. Far from interpreting this movement as a return to natural forms, we may look for a more appropriate environmental explanation. It seems that in environmental terms, two main assumptions have been used as generative forces behind this movement. The first is concerned with the production of an ecoclimatic system that could maintain a stable interior microclimate, minimizing the requirements of the structure for mechanical heating or cooling.

22. The term "organic architecture" is used here in its narrow sense to denote the type of architecture generated on the basis of good balance between building and physical environment. In the broader sense the term can be traced back to the architecture of Frank Lloyd Wright in the context of which it describes building's response and organization in relation to the total environment. However, even in the latter sense the present discussion seems to be relevant. See, R. BANHAM's analysis of Wright's work in the so-called "Prairie houses". R. BANHAM, (1969), pp.104-121.

Apart from the glass house attempt, examples of such considerations can be extended to large envelopes like those proposed by Buckminster Fuller<sup>23</sup>. The second assumption is concerned with the production of small scale ecosystems, self-sufficient in terms of food, water, heating and cooling, power for cooking, refrigerating, lighting, communicating and other household appliances. The "autonomous house" is an interesting example of this attitude, while proposals for large scale megastructures form different areas of architectural and planning inquiry. It should be pointed out, however, the enormous difference between autonomous houses - aimed at family or community independence - and the totalitarian proposals for megastructures. Paolo Soleri's work deals with many of the problems related to megastructures in a manner revealed in the following quotation:

"Since integrity, the goal of integration, is the "first" law of conservation of energy, and since the good city is ideally suited for a reintegration of all things which have parted, poor and rich, elementary and sophisticated, active and contemplative, dynamic and placid, doing and dreaming ... Since the good city is a power-house which can do "more with less", we assume here that the energy crisis, a crisis of spiritual energy as much as of physical energy, will have a time resolution on the double level of the physical and metaphysical via the city and only via the city."<sup>24</sup>

However, such proposals as these concerned with large enclosures which could accommodate whole communities (e.g. shells, spaceframes, air supported structures, glass domes) need very careful consideration beyond the level of their environmental and technological justification. Obviously, such a technological achievement provides the possibility for exercising maximum environmental and microclimatic

23. Refer to MELLER, J., (ed.), *The Buckminster Fuller Reader*, Penguin, 1972, (c.1970).

24. SOLERI, P., *Lecture presented by the Richard Demarco Gallery's Edinburgh Arts '74*.

control. Dietz, for instance, referring to these structures, describes them as follows:

"Rain, snow and wind are eliminated but sunlight may penetrate strongly or weakly, depending upon the transparency and composition of the enclosure. The usual weathering effects brought about by combined temperature variations, atmospheric gases and moisture, including freezing and thawing, are either eliminated or greatly reduced. Greater freedom in arrangement of living spaces is made possible. Materials can be chosen largely as space dividers primarily for privacy, acoustical control, and control of light. Materials such as light-weight foamed plastics or inorganic foams, usually not weather-resistant, can be employed."<sup>25</sup>

Apart from these obvious advantages though, there are socio-psychological problems associated with such a large scale technological alteration of the climatic fields. These problems are not only adaptational, though these are quite important, but they are also connected with the whole socio-economic structure under which such technology can be brought about. By achieving at one point in time the necessary technology to exercise immediate microclimatic control over a town does not mean that we have in front of us the solution to the ecoclimatic problems of the town, but only the replacement of one set of problems, which in any case are more or less well known, by another unidentified set of psychological and socio-economic problems.

Therefore, this type of proposal (large enclosures highly controllable microclimatically) which so far has been confined in the B-C interaction should be expanded into the areas of empirical architectural research described as [32] and [3→2→1] (that is environmental object → process of production and environmental object → process of production → social totality) in order to develop

25. DIETZ, A.G.H., *"Building Science, Design and Environmental Control"*, Transactions of the Bartlett Society, Vol. 8, pp.61-71, 1969-70, see p.66.

the integrated frameworks which are necessary for thorough evaluation.

These points are expressed by Dietz as follows:

"If large enclosures become feasible, designers will have much pioneering design to carry out, but behavioural scientists may have even more new territory to explore. How will human beings react to large enclosed spaces in which the environment is much more nearly controlled than is usual outdoors, but not so much as traditional indoors?"<sup>26</sup>

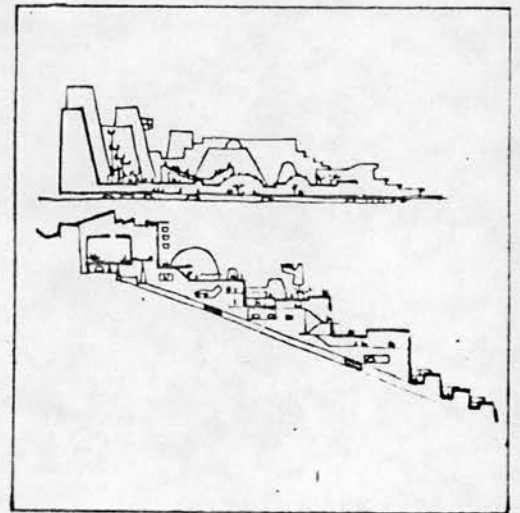
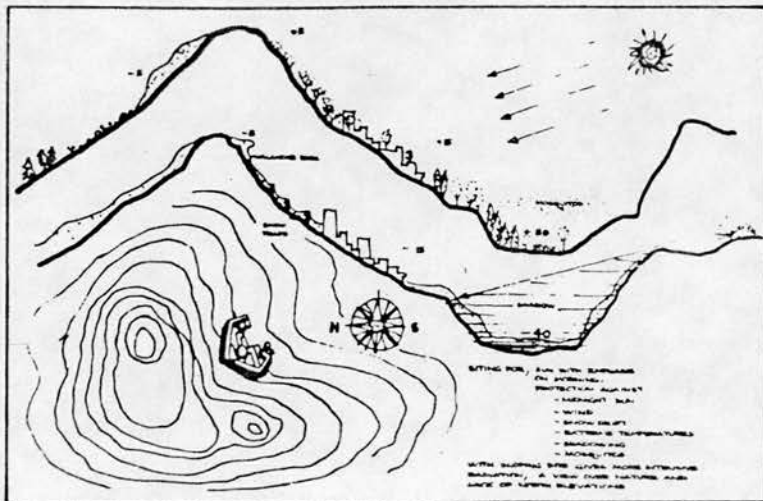
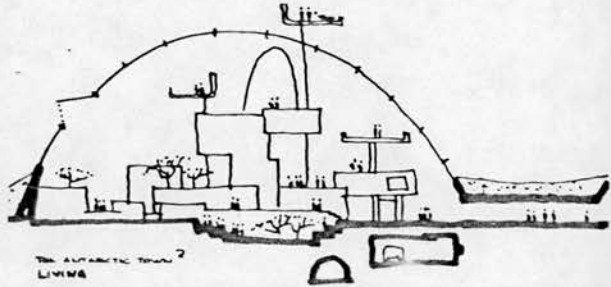
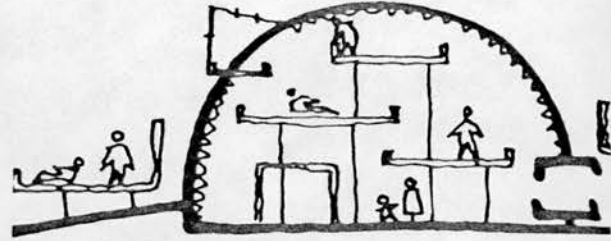
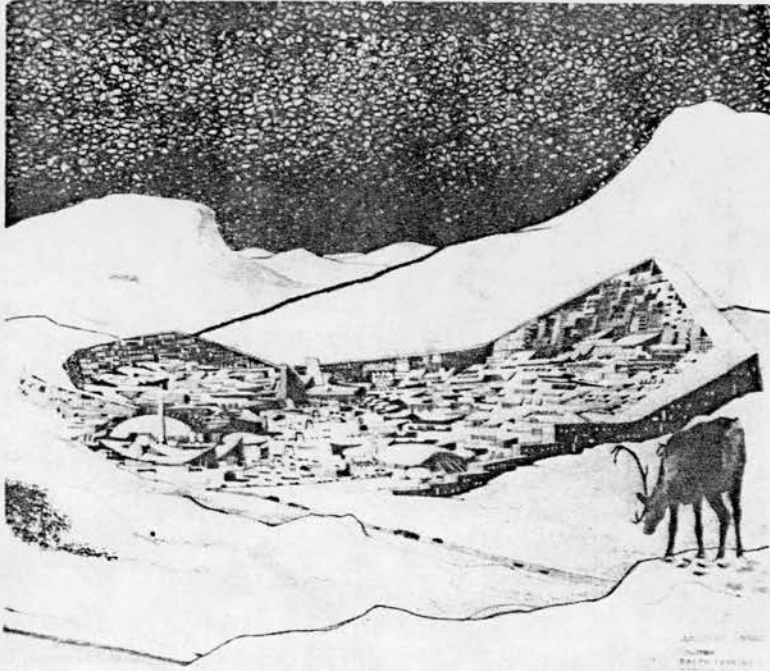
Architectural movements like these which are technologically feasible - though some of them socio-economically utopian - reinforce our earlier assumption that the ecoclimatic conceptualization of the habitat increasingly becomes the generative force in defining particular strategies for practical design action. This becomes even more obvious in the following examples where the ecoclimatic strategy has been internalized by individual architects and successfully expressed in their buildings.

Related to this manner of integrated and, in some senses, revolutionary thinking, is the more pragmatic work of Ralph Erskine who has produced a number of original structures for the Swedish arctic environment. Working with extreme climatic conditions he successfully employed all the three stages of climatic modification (urban, building and indoor scale) and thus he formulated long-range solutions. An interesting part of Erskine's work is the conceptual basis upon which he formulated his design approach to the problems of an arctic environment. His assumption was that the psychological and sociological problems of physical isolation, severe cold and dark of arctic winters could be ameliorated through careful ecoclimatic design. His concept of "megastructure" would create environmental

26. DIETZ, A.G.H., *op.cit.* p.70.

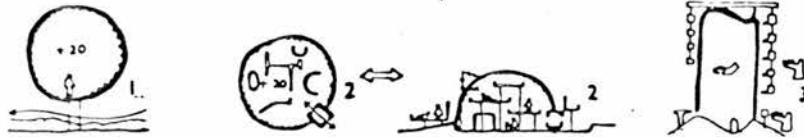


conditions with much more favourable psychosomatic effects which may allow more richness in the social life of the people.

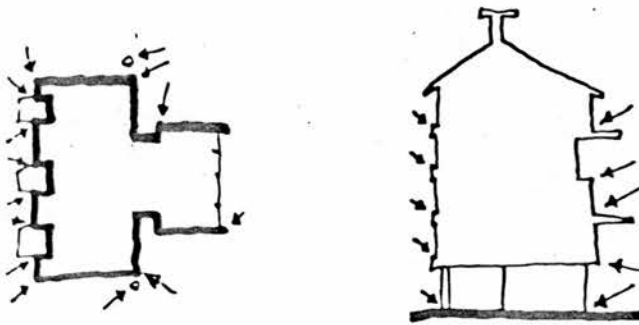


Town is conceived as a south-facing megastructure rimmed by housing. See A.D., Vol 47, No. 11-12, 1977, special issues on the work of Ralph Erskine.

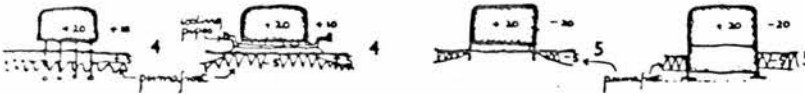




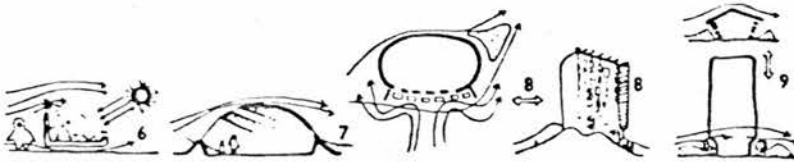
**HEAT LOSSES** 1 heat loss through large surface area 2 structural protection. It is important not to break the enclosing envelope unnecessarily 3 structural separation



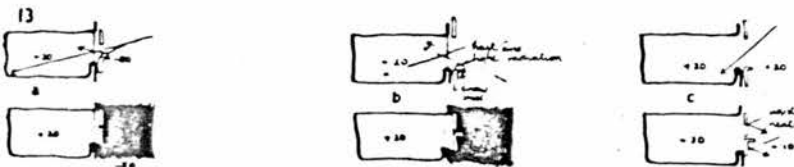
**RISK POINTS FOR FROST DAMAGE.**



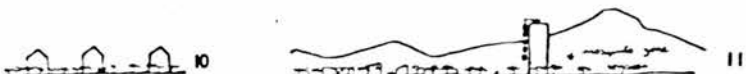
**FROST** 5 winter 4 summer



**WIND** 6 in spring and summer (and even winter) sun or artificial radiation give comfort if protection is offered for even slight air movement 7 sun radiation and protection from air movement in cold climates, but air movement keeps mosquitos away 8 use of air breaks to slow movement over main façade 9 Swedish barn and, below, its application for snow clearance



**SUNLIGHT** 12 a winter b summer day c summer night 13 the need for a variable window: examples day and night a winter b equinoxes c summer

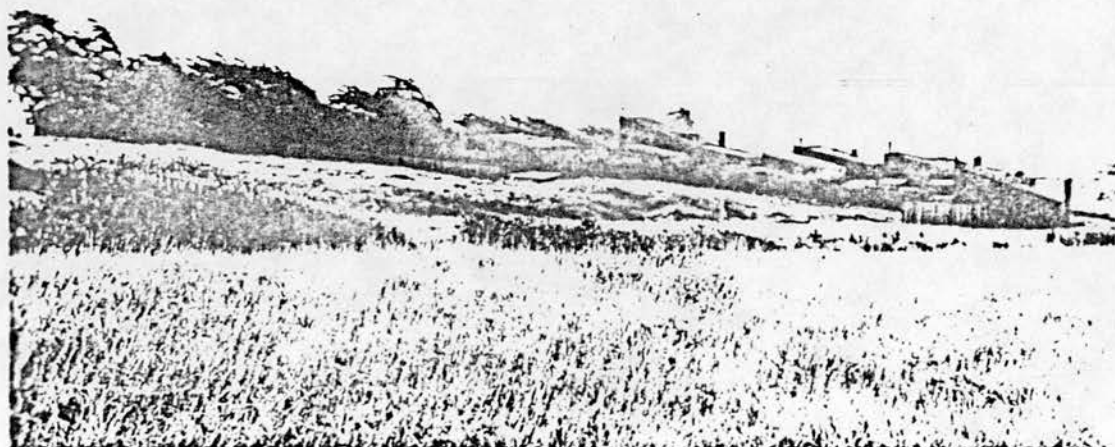
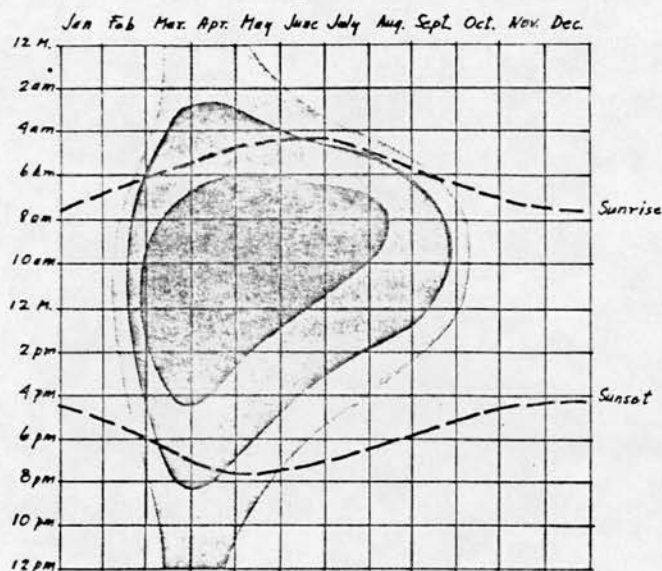


**VEGETATION** 10 3-4 storeys not in scale and not suitable 11 buildings in scale with the low vegetation or with an extensive or mountainous landscape—the monumental situation of man

27. Ralph Erskine's study on arctic architecture, Source: FITCH, J.M., 1972, pp. 274-276.

Lawrence Halprin, as a practising architect and landscape architect, and as an architectural theoretician, has designed and built on an ecoclimatic basis. His well-known work at Sea Ranch, California is a remarkable example of the successful conceptualization of the ecoclimatic problems in that area.<sup>28</sup> Halprin, in order to meet the bioclimatic requirements for outdoor comfort, sheltered his houses by massing them as windbreaks and at the same time he exposed them to sun. Thus, he formulated a favourable microclimating mapping in the vicinity of these buildings.

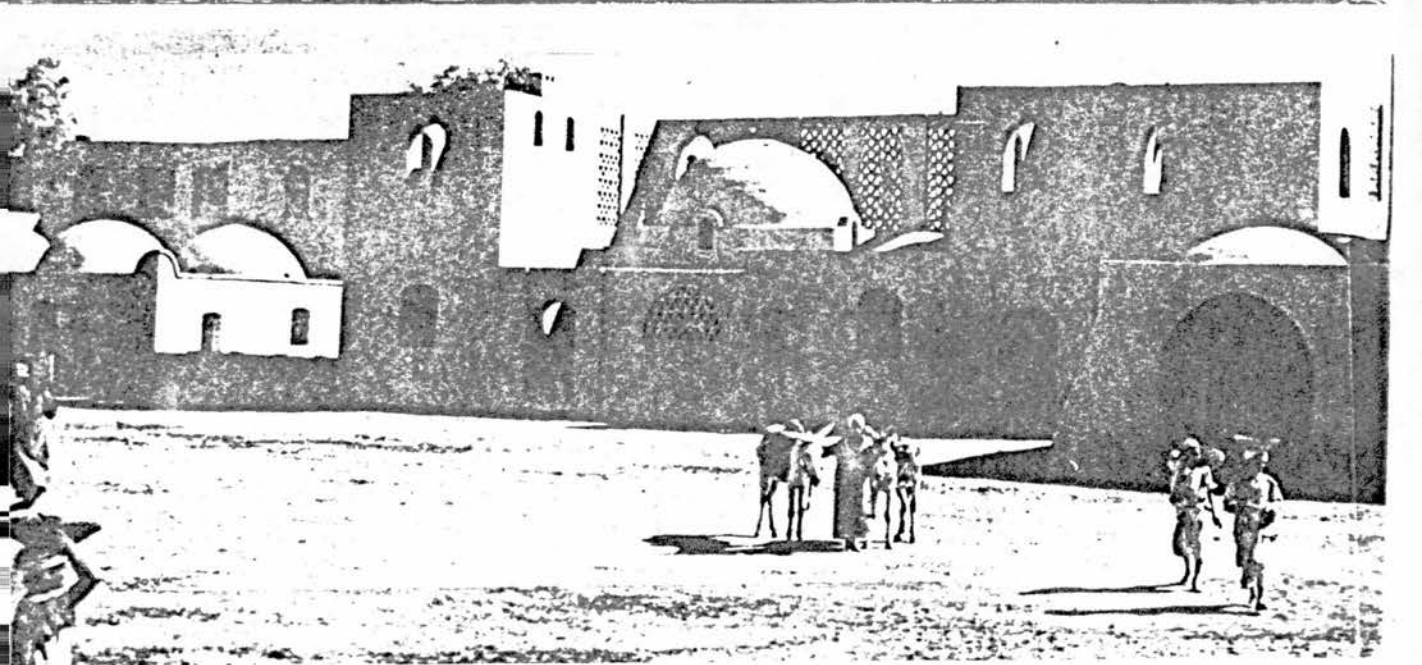
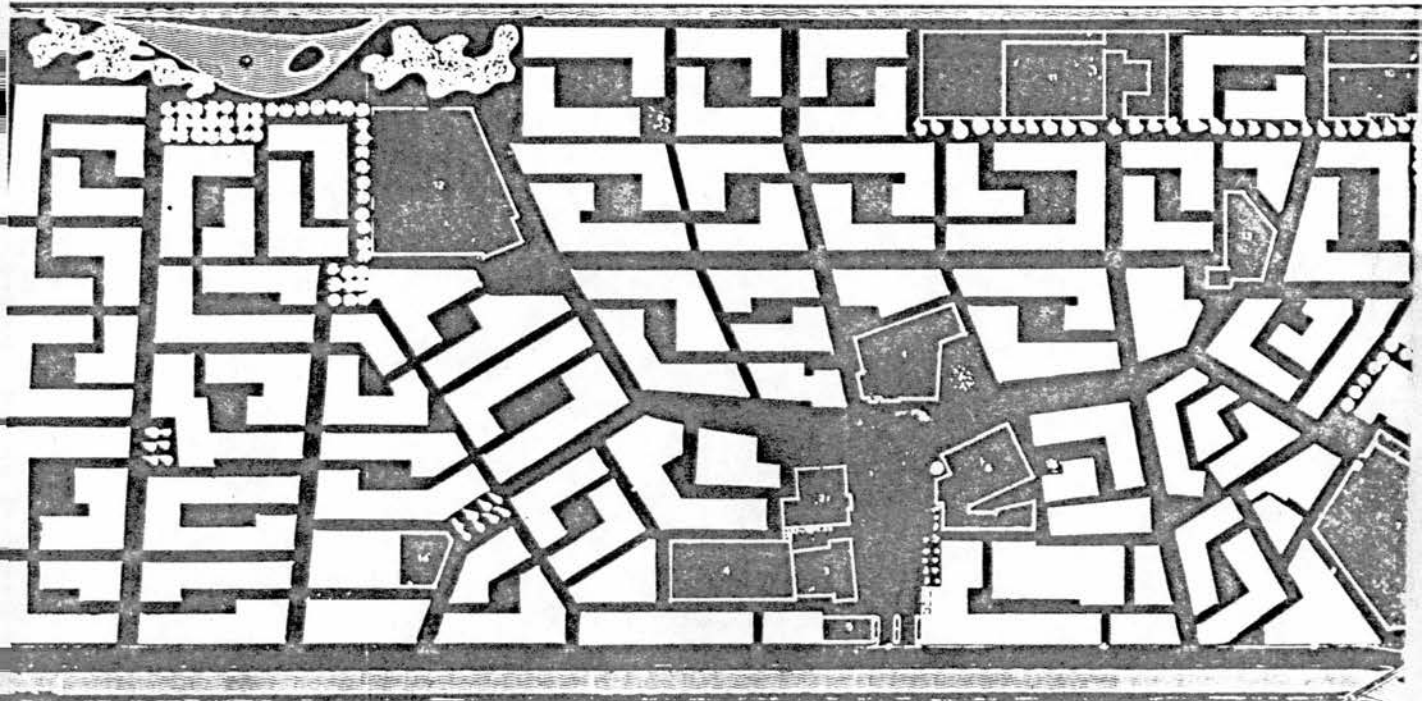
Bioclimatic analysis of microclimate at Sea Ranch.



View of house cluster shows how profiles conform to cedar windbreaks.

28. Source: FITCH, J.M., (1972), pp.282-283.

Another example of successful architectural manipulation of the environmental problems created by both severe climatic conditions (hot and dry) and weak environmental technology (as that available in Egypt) is the model town Gournia near the ancient city of Luxor built by Hassan Fathy. Fathy used traditional methods of building (mud masonry, mud brick vaulting, limiting openings, shading devices used in folk practice, and so forth) as well as traditional methods of planning the village (e.g. narrow, curving streets, walled yards).<sup>29</sup>



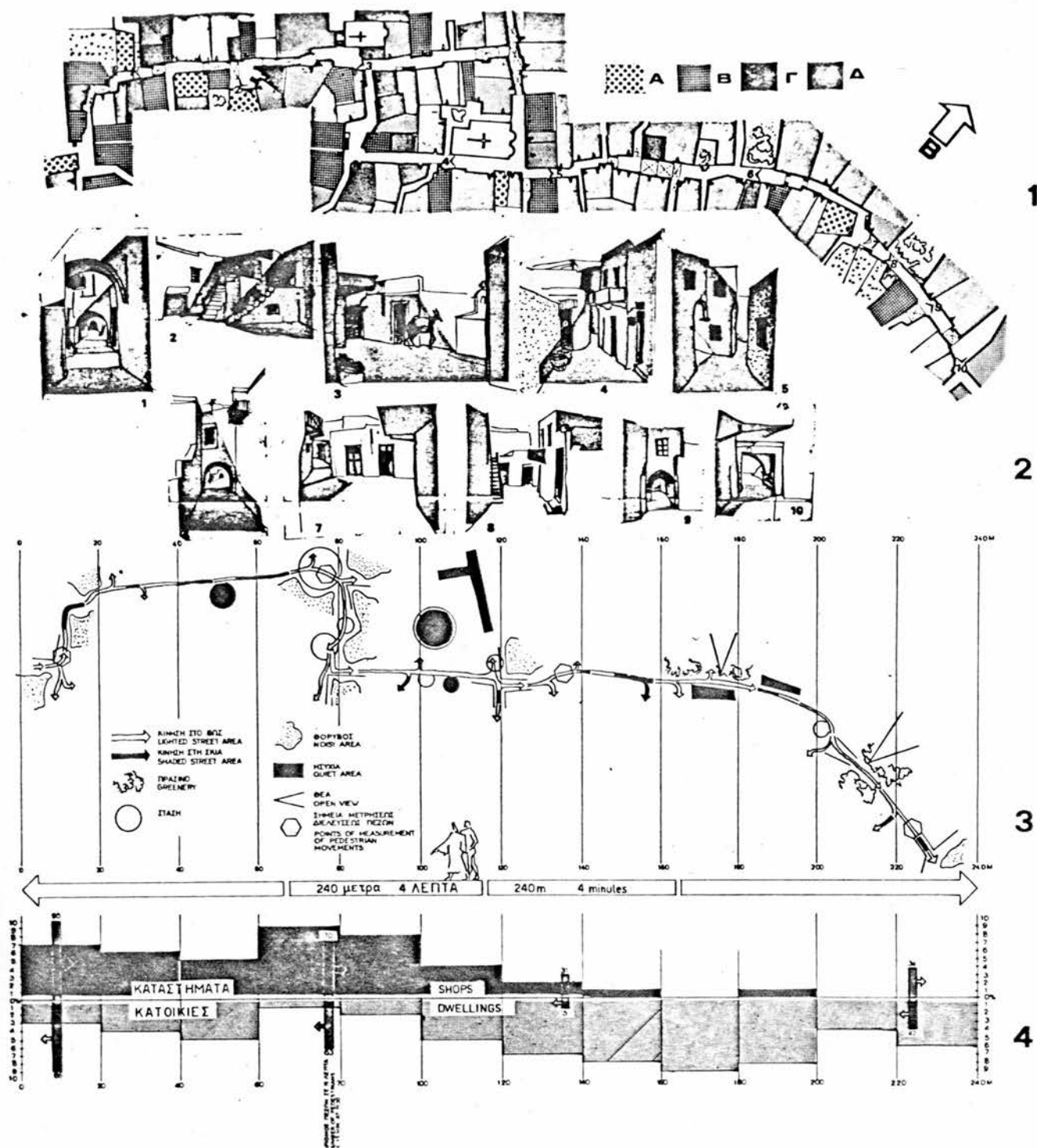
29. *Plan and street view of New Gournia, FATHY, H., (1973).*

Even at the level of microclimate and ecoclimatic analysis, there are a number of limited examples which show different approaches to identify and describe some of the ecoclimatic problems of the built environment. The study of A.P. Polichroniadis and K.M. Chatzimichalis, reflects an integrated approach to what they call "structure of the physical environment in the Greek island of Naxos"<sup>30</sup>. It is interesting to observe that the environmental descriptors they use (movement in sunlight, movement in shade, noisy area) are much closer to design than the conventional climatic descriptors such as temperature distribution, degree of comfort, and so on (see figures on the next two pages).

Approaches such as these last two suggest another important problem which is pertinent to architecture in general and to environmental design in particular. This is how we can extract the principles of design inherent in vernacular buildings and apply them to modern design. The advantages of this type of empirical research in architecture may lead to either a straightforward application of existing successful solutions in traditional building or to the conceptualization of their design philosophy and its transformation for contemporary design.

In the case of environmental design and particularly climatic design the advantages of employing such knowledge are obvious. In many cases air conditioning can be avoided or at least drastically reduced by giving more careful consideration to site orientation, sun path, wind direction and wind flow around and through the building.

30. POLICHRONIADIS, A.P., CHATZIMICHALIS, K.M., *"The Structure and the Elements of the Physical Environment of Naxos"* in DOUMANIS, et al., (1974).



"Elements of the Physical Environment of Naxos":

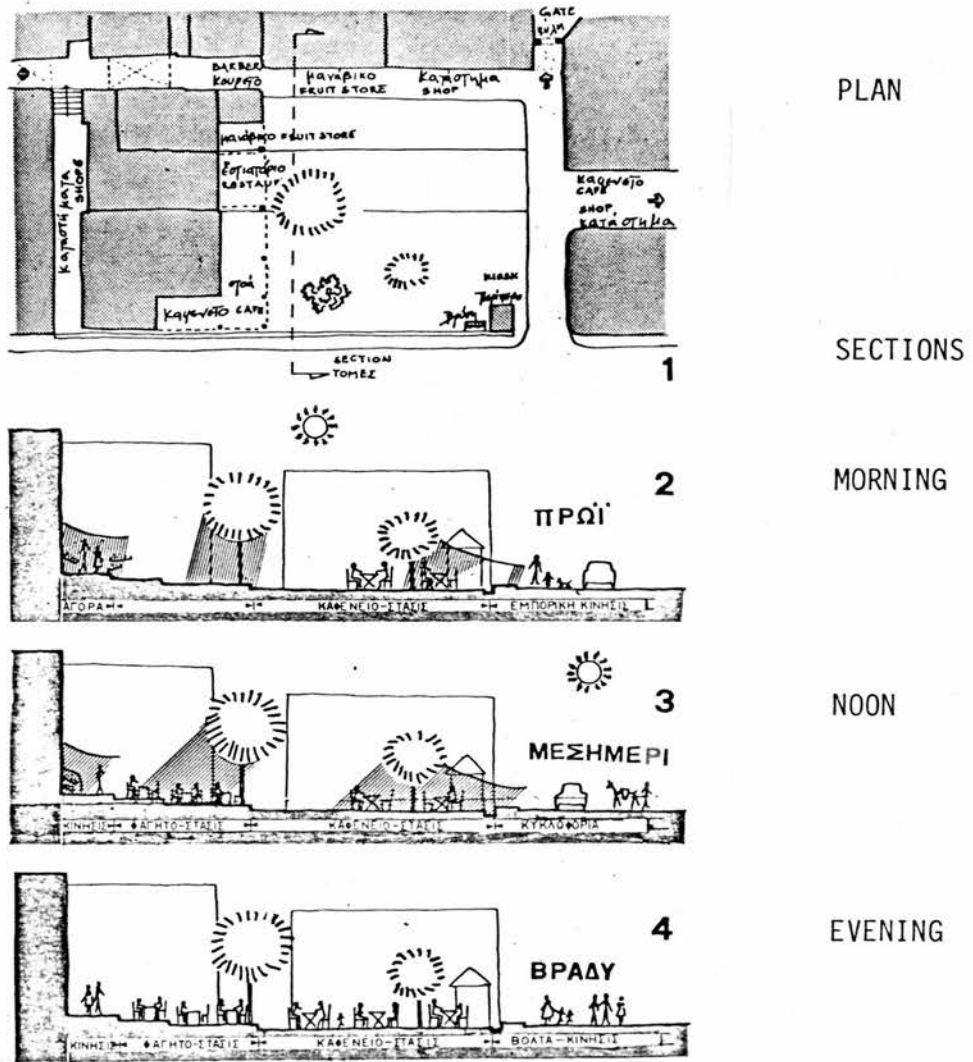
The old commercial street: 1. Space articulation at street level.

A. Cafes and Restaurants; B. Food shops; Γ. Diverse shops;

Δ Dwellings. 2. Images of the street. 3. Analysis of the perceptual organization: 240m - 4-7 min. walk; contrasting impressions as light-shadow, movement-pause, noise-silence, public-private, etc.

4. Density of dwellings and shops along the street; number of pedestrians per 15 minutes. See POLICHRONIADIS, et al., op.cit., p.88.





"Elements of the Physical Environment of Naxos":  
Public square by the seafront:

1. Space articulation

2,3,4: Analysis of successive activities during the day.

Activity patterns and culturally conditioned psychosomatic behaviour can be analysed through simple techniques of observation. Such type of information is much closer to the nature of design process and, therefore, efficient enough to deal with certain ranges of simple ecoclimatic problems.

See, POLICHRONIADIS, et al., op.cit. p.94.



The order of space in terms of indoor, semi-outdoor and outdoor is another aspect successfully solved in many traditional layouts providing a more favourable ecoclimatic complex than the contemporary simplified indoor-outdoor order.

In closing the present chapter, I prefer to postpone general remarks about current theoretical and empirical research on climate-building interaction to a later stage when the man-climate relations have been examined, and thus when conclusions can be drawn on a more comprehensive basis. However, it should be stressed that studies isolated at the climate-building level are, more often than not, lacking in the necessary integration of semantic dimensions in the methodological tools they employ for the study of the microclimatic performance of buildings. Furthermore, even in those studies which are generated from bases which include some semantic criteria (such as comfort criteria), the criteria are chosen in an "ad hoc" manner rather than after a systematic examination.

Research concerned with climate-building interaction apparently has yet to resolve the contradiction which arises between the purely syntactic way of looking at the interaction, and the semantically loaded process of design action. The individual designer working with ecoclimatic images manifested in social behaviour and activity patterns of people, in their use of indoor, semi-outdoor and outdoor spaces, in their adaptation or readjustments to particular ecoclimatic arrangements which make, for instance, comfort equations irrelevant, finds difficulty in abandoning these images in favour of well-formulated but contextually limited syntactic approaches. C.B. Wilson has used the following comprehensive formulation of the argument:

"A building is a collection of pieces of materials having particular spatial relationships and as a physical object it may be described in those terms. Embedded in a physical world of space, air and energy, a building has a physical effect on the world. It acts as a transformation, governed by natural laws, and we may describe its physical performance. When people experience a building it interacts with and changes what is already present in their private and shared psychic worlds and this may be called its psychic performance. Both physical and psychic performance depend as much on the properties of the world in which the object is embedded as on the object itself. The building may be thought of as projecting into the physical world and into private and shared psychic worlds."<sup>31</sup>

Knowledge, therefore, about the microclimatic performance of buildings, though important and necessary, is not enough, in itself, to generate appropriate design strategies which deal efficiently with the climatic problems of buildings. To achieve this, knowledge about how people experience the microclimatic environment of buildings is also, if not more, significant. It is only at the level defined by the triadic structure of the ecoclimatic schema - proposed earlier in this thesis - and the ecoclimatic approach it generates that a synthesis between the microclimatic performance of buildings and the psychic response they generate in people may be balanced. The discussion in this chapter has indicated that such an ecoclimatic balance has been achieved mostly in vernacular buildings and very rarely in modern ones.

Furthermore, the discussion in this chapter has traced some of the reasons for the failure of current climatological research to provide comprehensive guidelines for architectural practice and has emphasized the inefficiency of the methodological tools employed in conceptualizing, describing and synthesizing the ecoclimatic environment of buildings at the level of its microclimatic performance. An

31. WILSON, C.B., *The Old Push-and-Pull: Two Problems in Design/Research Structures*, Edinburgh Architectural Research, Vol. 1, 1973, pp.7-8.

understanding of this failure clearly suggests the priority of the kind of research suggested by C.B. Wilson in the following statement:

"If we are going to progress towards using our knowledge of the physical behaviour of buildings and psycho-physical responses of people in a synthetic and *form-generative* form rather than simply for evaluation purposes, we have to discover how to express the object-to-response transformations in a way which allows their inversion, and we have to find *appropriate ways of describing buildings*."<sup>32</sup> (my emphasis).

32. *Ibid.*, p.10.

## CHAPTER 8

## CLIMATE AND MAN

## 8.1 THE NATURE OF ESTABLISHED DESCRIPTIVE THEORIES OF THE INFLUENCE OF CLIMATE ON MAN

The climatic environment possesses not only a highly complicated structure in terms of the interactions of the physical elements involved, but also a high level of conceptual complexity in terms of its overall effects on man and his activities. Man's responses to climatic influences are very complex even at the level of his biological organization, not to mention those related to his psychological or socio-cultural nature. It has been argued that the inadequacy of our conceptual tools and scientific methods to deal comprehensively with such complexity justifies to a certain degree the tendency to distinguish the investigation of these phenomena into two levels of interaction: the physiological level, where man is considered as an assembly of organic materials functioning with certain climatic elements under more or less specific physical or biological laws; and the psychological or behavioural level, where man is considered as an organism which responds to climatic stimuli in a manner which differentiates him from the rest of living organisms. However, knowledge about the second level of interaction is still very limited.

The artificial separation of the total structure of the climate-man interaction, though convenient and comprehensive enough in

certain problem areas of human physiology and human psychology, is not without serious consequences when applied to more complex phenomena of human life. R. Dubos, for instance, emphasized that:

"human beings may suffer and even die under circumstances which seem highly favourable to physiological performance, whereas paradoxically others will prosper even though conditions appear almost incompatible with the maintenance of life."<sup>1</sup>

However, one need not deny the importance of the relationship between climate and human physiological needs in order to emphasize the psychological ones. Instead, there is an obvious and repeatedly emphasized necessity, even within the very specialized areas of physiological or psychological study of man, of relating the psychological needs of man to his physiological ones. But so far there is no systematic study of this relationship.

Particularly in architecture, where the relevant phenomena of climate-man interactions have to be considered at the higher level of synthesis appropriate for their comprehensive explanation, the necessity of developing general models which could permit a more integrated assessment of climatic influences on man has become imperative. Unfortunately, the literature of architectural climatology shows no systematic effort to build its own disciplinary models and methodologies which may taxonomize, synthesize and develop further the epistemological input from sciences such as meteorology, climatology, physiology, psychology, sociology and ecology.

Yet it could be argued that architectural modifications of the climate-man interaction should be thought of, even at a minimum level, as combining two major operations: direct improvement of the

1. DUBOS, R., (1965).

actual climatic living conditions at a physiological level, and psychosomatic compensations for unfavourable, or reinforcements of favourable, aspects of climate that are not amenable to change by reasonable effort. Within an appropriate architectural framework the point can be explained adequately in terms of historical or modern examples of architectural practice which seem to have solved successfully problems of the ecoclimatic environment. For instance, in primitive or in vernacular architecture, the assumed psychosomatic or other cultural compensations are decisive in evaluating the fitness of these structures to the climatic environment. But even contemporary architecture with powerful environmental technology at its disposal continuously creates ecoclimates and environmental settings in such a way that only shifts in psychosomatic reactions and behavioural patterns could make them habitable. Parr, summarizing a considerable number of environmental designs, remarks that:

"... the comforts we may achieve by psychosomatic means may, in the end, prove even more important for the pleasures of urbanism than anything we can do about the weather itself, other than defence against its assaults upon our persons and our homes."<sup>2</sup>

The process of formulating a descriptive framework within which an integrated assessment of both physiological and behavioural characteristics of the climate-man interaction could be attempted, obviously should start within the broader framework of empirical research in architecture. It is almost impossible to formulate comprehensive climatic descriptors for architectural practice without considering the overall influence of building processes on the climate-man relationship, even in its most elementary manifestations. This point was discussed in the first two chapters of this Part of the

2. PARR, A.E., (1968), p.144.



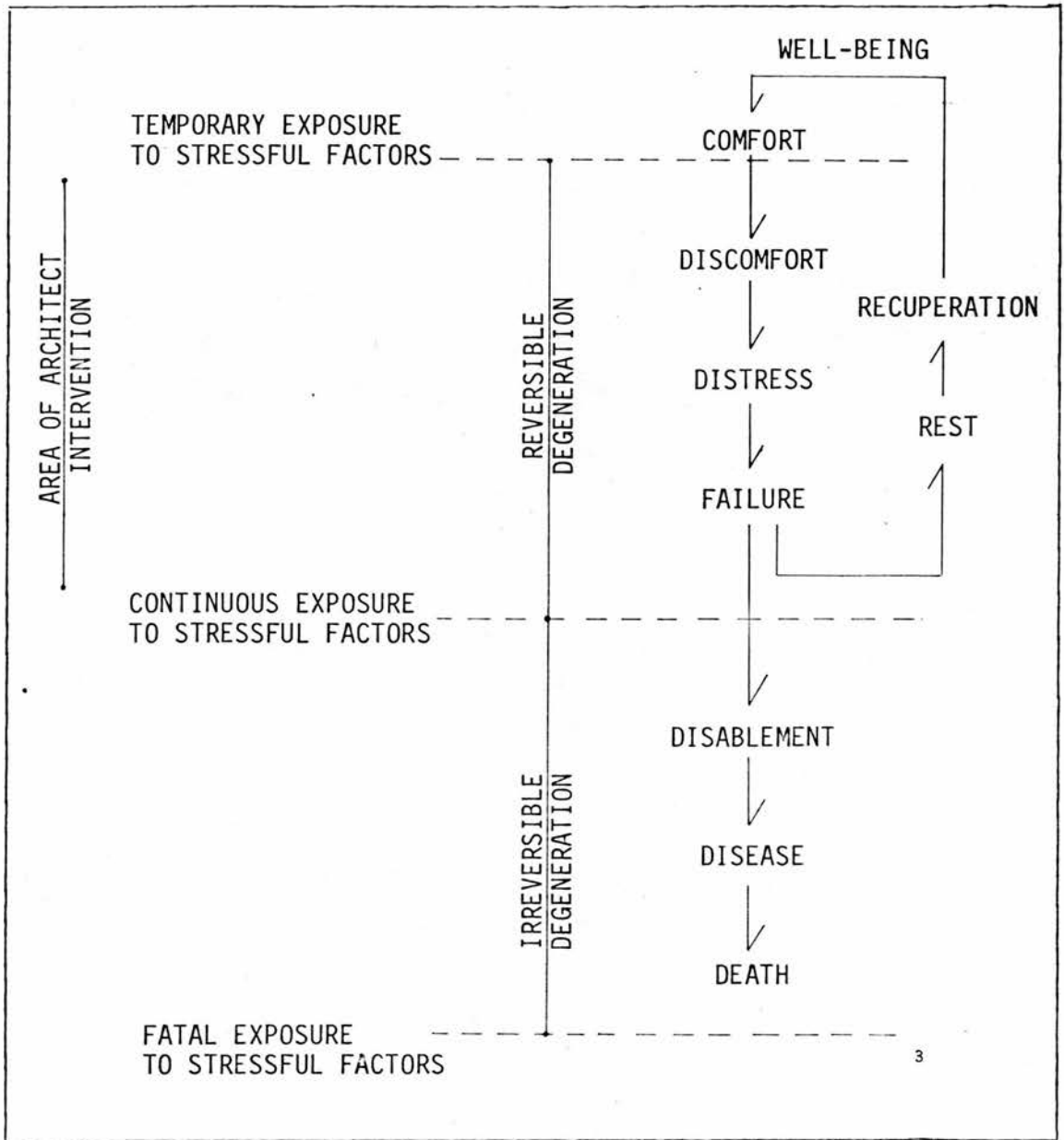
work, and it will be discussed in a more systematic manner in Part IV where a comprehensive description of the ecoclimatic problems of the built environment is attempted. In this chapter, I intend to review some of the descriptive bases which are currently used for the climate-man interaction and to examine both their "behinds" in terms of their scientific evolution and development, as well as their practical application in design.

## 8.2 THE PHYSIOLOGICAL LEVEL

This type of research is generated within the conceptual domain of the assumed biological model of man and is directed towards a mapping of the permissible limits of climatic values necessary for man's survival. At this basic level, research depends naturally on mechanistic models in order to obtain, through systematic observations, the information necessary to define the limits of tolerance in man's interaction with climate.

In this context, the description of climatic influences on man is concerned with states of discomfort, distress, failure and even disablement, disease, or death. The assumed relationship of these states amongst themselves and in relation to climatic exposure is summarized by Fitch in the model shown on the next page.

Using this type of approach, architectural empirical research has built its own models, of a mechanistic type, which attempt to describe the ranges of climatic parameters within which "comfort" situations may be achieved. The most well-known and commonly used

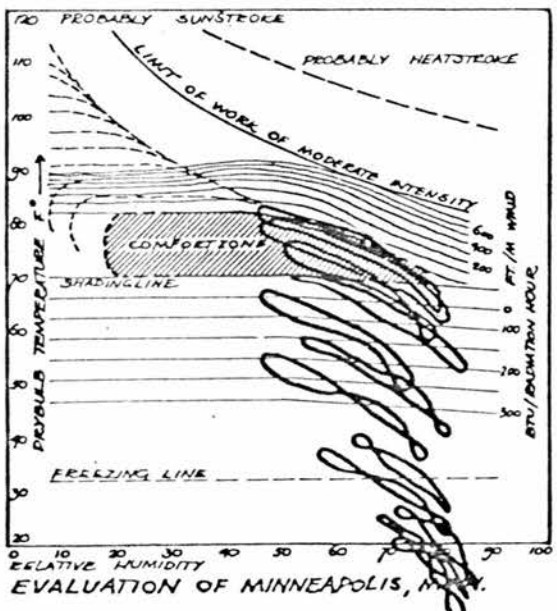
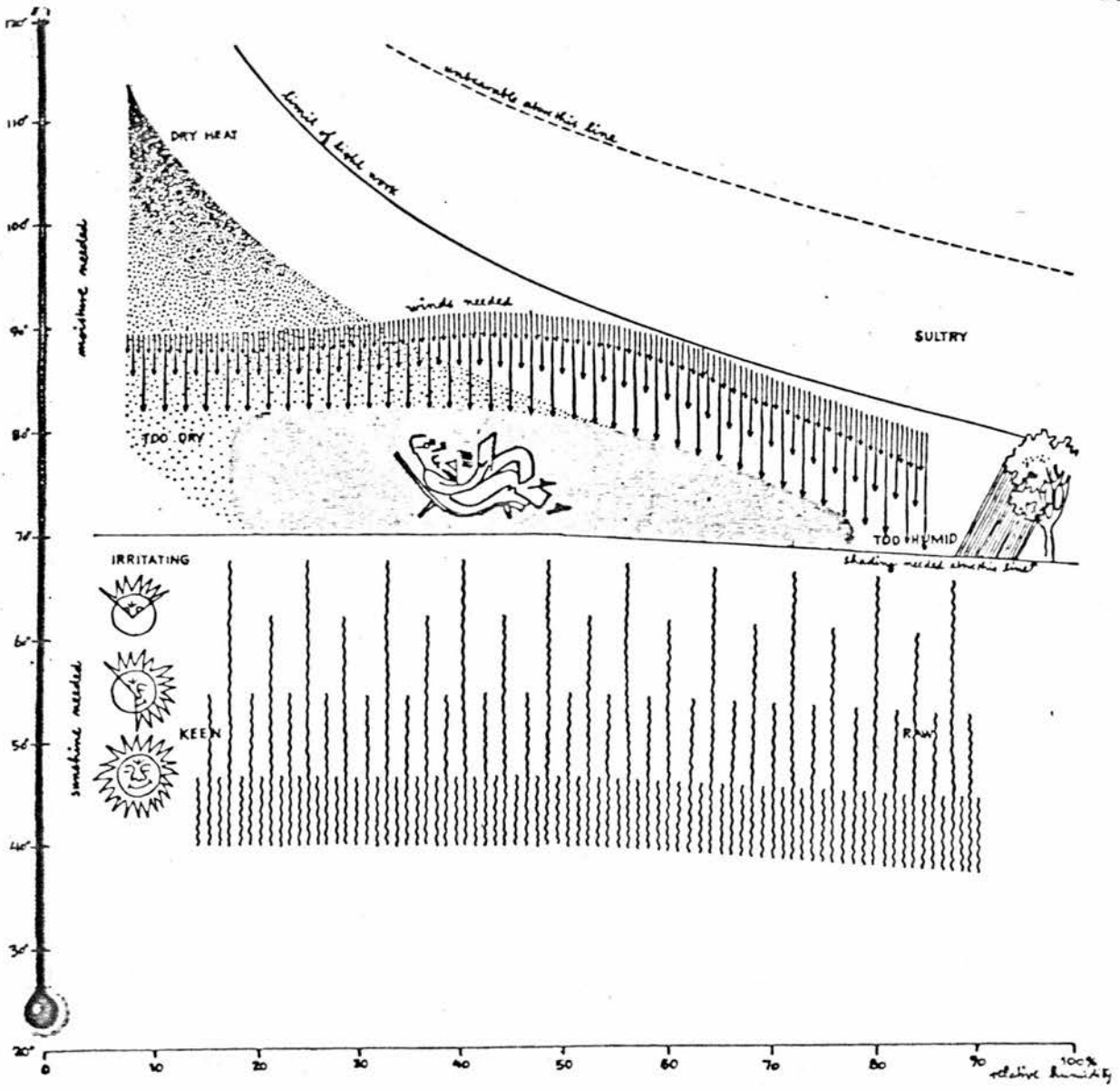


descriptive models of this type are those introduced by V. Olgyay<sup>4</sup> in his book *"Design with Climate: Bioclimatic Approach to Architectural Regionalism"* (see figure next page).

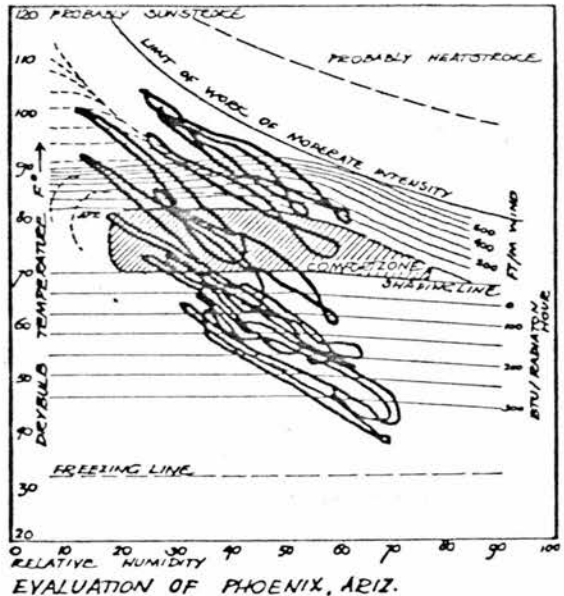
There has been a considerable amount of work conducted at the level of physiological comfort, especially in terms of indoor or

3. FITCH, J.M., (1972).

4. OLGAY, V., (1963).



EVALUATION OF MINNEAPOLIS, MN.



EVALUATION OF PHOENIX, ARIZ.

arctic conditions<sup>5</sup>, while very few attempts have been made, so far, to establish comfort criteria for normal outdoor environmental conditions. The major reason for the failure of research on human physiology to extend its scope of investigation outside buildings and within the moderate environments of our cities is the absence of an established methodological framework for describing the dynamics of both climate and activity outdoors. The difficulties of establishing such a framework within the present "systemic logic" of the general epistemology involved in the subject are discussed in due course<sup>6</sup> where some limited but noteworthy attempts are also reviewed. In the following sections of this chapter the limitations of both the present descriptive levels of physiological comfort and the "behinds" of comfort research are discussed in an attempt to argue the necessity of integrating physiological requirements with broader cultural and socio-economic ones at a level which is extended far beyond those defined by the conventional notion of comfort and the artificial separation of physiological, psychological and sociological considerations of climatic influences on man.

### 8.3 THE PSYCHOLOGICAL LEVEL

So far, psychology seems not to be weather conscious. An exploration of the strictly disciplinary psychological literature looking for empirical evidence on the effect of weather or climate on human behaviour leads, as Bates<sup>7</sup> says, to disappointing results.

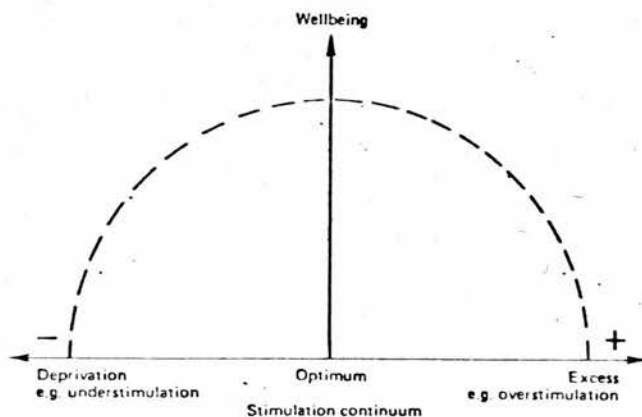
5. *For a detailed review of these studies refer to the bibliographies by BRUCE, N., (1960) and FANGER, P.O. (1970).*
6. *Refer especially to pp. 219-222.*
7. *BATES, M., (1966), p. 401.*

Nevertheless, fields of applied psychology, such as environmental psychology, ecological psychology and perceptual psychology are becoming increasingly interested in climatic influences on human behaviour and psychosomatic reactions<sup>8</sup>. Thus they are beginning to provide a framework within which studies of psycho-climatology may be integrated. Similarly, the newly established fields of architectural psychology<sup>9</sup> and the rather older one of building climatology have recently started to realize the importance of extending their scope of enquiry towards the complex interaction between weather and/or climate and human behaviour<sup>10</sup>.

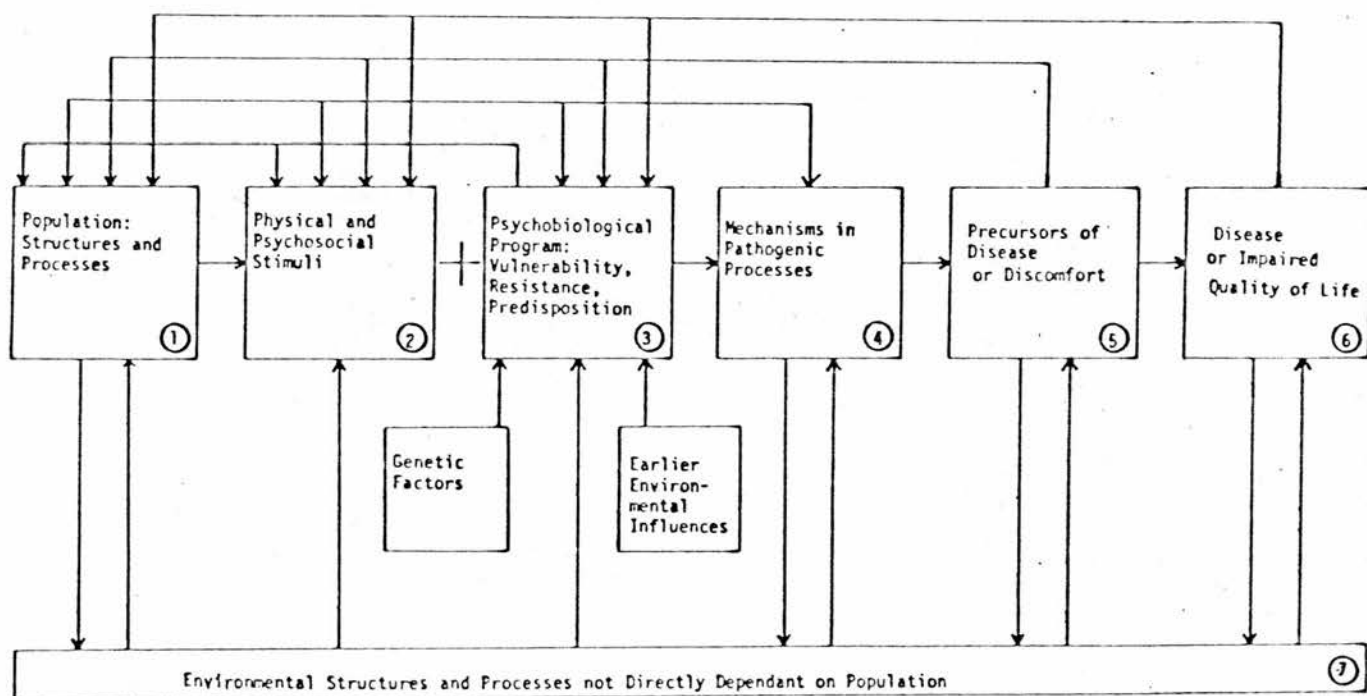
At an analytical level, the interaction between climatic elements and human behaviour is studied through experimental techniques by which sets of operative parameters of the climatic environment, which define a certain "quality" of a climatic element are isolated and studied as "behaviour modifiers". The most commonly assumed "climatic qualities" in these studies are: "light quality" defined by the luminance distribution, level of illumination and colour; "air quality" defined by certain components of air and odours; "sound quality" defined by the sound pressure level, frequency distribution

8. *See, for instance, CANTER, D., (ed.), (1975); HEIMSTRA, W.N., McFARLING, H.L., (1974), BARKER, R., (1968) and GIBSONS, J.J., (1966) which provide interesting and representative examples of this type of study.*
9. *Papers concerned with the psychological influences of climate (especially indoor conditions) on human behaviour, appear regularly in international conferences on Architectural Psychology.*
10. *An interesting example is Ryd's approach to climatic comfort. Ryd firmly proposes that comfort climate should be defined by virtue of its capacity, not to cause "stress" and to provide "stimulus" for certain activities. See RYD, (1972).*

and time variables; and "thermal quality" defined by the air temperature, mean radiant temperature, air speed and air humidity. The general character of this type of research has been based primarily on optimization techniques and on cybernetic models which strive to determine certain qualities of life like "well-being" or impaired qualities of life like "disease" or "discomfort".



*Theoretical model of the relationship between well-being and various levels of stimulation. Deprivation of stimuli as well as excess is accompanied by a decrease in well-being. After Levi, L. and Anderson, L.<sup>11</sup>*



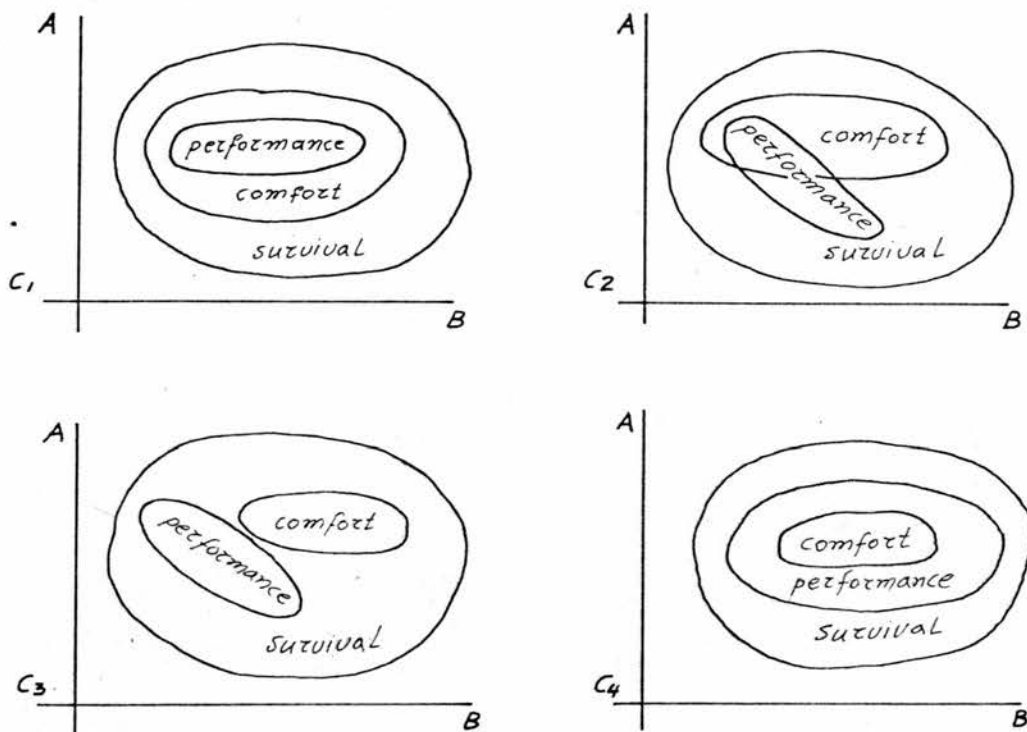
*A theoretical model for the study of population, environment and quality of life. Population structures and processes (1), produce physical and psychosocial stimuli (2). Their interaction with man's psychobiological "program" (3) and with environmental structures and processes not directly dependent on population (7) determines the psychological and physiological reactions (mechanism (4), e.g. stress) of each individual. These may, under certain circumstances, lead to precursors of disease or discomfort (5) or to disease or impaired quality of life (6). The sequence is not a one-way process but constitutes part of a cybernetic system with continuous feedback. After Levi, L. and Anderson, L.<sup>12</sup>*

11. LENNART, O., ANDERSON, L., (1975).

12. *Ibid.*



However, at more integrated levels, optimization has proved inadequate to deal with the complexity of climate and human interaction, especially in establishing environmental criteria for design decisions about the "required" environmental conditions. Wyon<sup>13</sup>, for instance, exploring the thermal environment in buildings, describes this complexity in a model showing the topological relationships among three different kinds of criteria (comfort, performance and survival) which are possible for different climatic elements and different activities:



The topology of environmental criteria in buildings.  
After Wyon, (1974)<sup>14</sup>

Furthermore, Wyon suggests that the principles set out in his model for the systematic optimization of the environment in buildings apply equally to all factors, whether thermal, visual, spatial or acoustic<sup>15</sup>. We can understand the desirability of such a systematic

13. See WYON, D.P., (1974).

14. The fourth configuration which implies that a person could be comfortable only when he is performing optimally is, according to Wyon, so rare that for practical purposes it can be ignored.

15. WYON, D.P., *op.cit.*, p.13.

optimization, but it is hard to imagine its feasibility in practical terms. Integration of the different influences of climatic elements on human biological and psychological behaviour is clearly imperative but I believe that it must derive from hierarchies and predominancies constructed within a "satisficing" framework rather than from analytical and systematic optimization procedures. The construction of hierarchies and predominancies for the climatic elements themselves or for their influences on certain aspects of human behaviour might be possible to evaluate only at a level where physical, socio-economic, technological and cultural considerations are taken into account in terms of both desirability in theory and feasibility in practical applications. This point will be analysed extensively later where an appropriate descriptive framework for the climate-man interaction is investigated<sup>16</sup>.

In this section it is necessary to discuss briefly some interesting psychological theories which may provide bases for second thoughts about the way we deal with the perceptual organization of the built-environment<sup>17</sup>. These are the theory of "perceptual systems" and the theory of "adaptation level" and should be considered within the context in which they are usually applied which is that of environmental psychology.

It is a characteristic of the field of environmental psychology that it has been primarily developed in close relationship to problems formulated on the basis of maximizing the productive efficiency of either industrial or administrative workers. Studies of "lighting levels", "mental performance", "working efficiency", etc., conducted

16. *in Part IV.*

17. *The importance of considering built environment from the point of view of its perceptual organizations has been discussed earlier; see pp. 102-105.*

in laboratory conditions or in the field, constitute the major source of the raw material out of which environmental engineers, architects and planners draw the evidence to support their hypotheses about how the climatic environment should be controlled. However, considering the complexity of the architectural environment, it is not difficult to see that "imported" knowledge of this kind can easily be misleading. Piecemeal approaches which might be of importance in dealing successfully with fractions of environmental variables and human behaviour - at least theoretically - become almost inapplicable in real design situations due to their failure to account for the variety of different environmental settings. These studies also fail in dealing with the variety of spatial and time scales dealt with in the design process. Of course, reduction of this variety is part of the design strategy but it may be achieved either by concentrating on a particular set of variables, or by taking individual environmental settings for examination, or even by concentrating on certain descriptors such as "comfort" or "mental performance". However, this type of reductionism is not without serious methodological problems which themselves suggest a different way of studying architectural phenomena in a more integrated manner by shifting the investigation towards more abstract, but far more meaningful, levels of organization.

The relationship which forms a common theme in environmental psychology is, of course, that between physical environment and behaviour<sup>18</sup>. The major assumption underlying these studies is that behaviour is shaped or modified by the physical environment - the man-built, the man-modified and the natural environment - and that an

18. HEIMSTRA, W.N., McFARLING, H.L., (1974), for instance, in their introductory book *Environmental Psychology defined the field as "the discipline that is concerned with the relationships between human behaviour and man's physical environment"*, p.5.

understanding of these shaping or modifying processes eventually leads to a better explanation of human behaviour and, more interestingly, to more effective design and environmental control of the human habitat. Three types of this relationship are distinguished and studied by environmental psychologists:

- (a) The relationships between what has been called "environmental context" or most commonly "environmental setting" and individual or group patterns of behaviour.
- (b) The relationships between certain "qualities" associated with a particular environment and the biological, psychological or social behaviour of an individual or a social group.
- (c) The relationships between physical environment considered as a "motivating force" and the responses of an individual or a group<sup>19</sup>.

The major ways by which the above relationships can be approached are summarized by D. Canter<sup>20</sup> in three key-processes. The first considers the environment as providing perceptual stimuli which relate to the conceptual structures facilitating human interaction with the environment. The second process considers the built environment as a "filter" in the sense that it restricts, facilitates, or modifies the interaction between environmental fields and living space. This process is more useful in environmental engineering and in building climatological research. The third process considers environment as a factor which encourages or inhibits interaction between individuals. This process belongs mostly to social psychology rather than to environmental psychology.

19. See WOHLWILL's categorization of the physical environment-behaviour relationship, referred to by HEIMSTRA, et al., *op.cit.*, pp. 7-8. See, also, BARKER, R., (1968).

20. D. CANTER, (ed.), (1975), p.9.

What must be added here is that if the physical environment influences behaviour, it is also and more profoundly true that behaviour influences the physical environment. Thus, it is much more productive to study man's capacities and the processes by which he influences the environment rather than the effects of this environment on his behaviour.

The important contribution that environmental psychology might have in the perceptual organization of the built environment through control and design can mostly be seen in Gibson's theory of "perceptual systems" to which, paradoxically enough, very rarely, if at all, books on environmental psychology refer.

Gibson criticizes theories of sense perception in that they have taken for granted that perception totally depends on sensations which are specific to receptors. He argues that "perceptual experiences" dominate perception in the same way that behavioural experiences dominate behaviour:

"... the perceptual systems develop perceptual skills, which, with some analogy to the way in which the behavioural systems develop performatory skills ... The perceptual systems are clearly amenable to learning."<sup>21</sup>

Gibson's information-based perception introduces the important diachronic dimension in the context of which human perception and therefore behaviour, should be studied. For him the maturation of our perceptual systems depends not only on genetic and environmental stimuli of the moment, but also on previous perceptual education coming from the capacity of the environment to act as a source of learning. Information about the world may be obtained by any perceptual systems working together. Gibson, defining the different

21. GIBSON, J.J., (1966), p.51.

basic perceptual systems (orientation, auditory, haptic, taste-smell and visual) emphasizes that the concept of "stimulus equivalence" can be applied to show that even when stimuli are different, stimulus information may be identical in terms of eliciting the same response<sup>22</sup>.

Gibson's theory strongly suggests that if the influences of the perceptual environment on human behaviour are to be considered - especially in introducing particular organizations of the physical environmental elements through design and control - then an integrated level should be established both in terms of the stimuli structure introduced and the behaviour which may be elicited from that structure<sup>23</sup>. This, in turn, implies that the environmental image becomes meaningful (in architectural terms) at an abstract level where such an integration is possible. Designers always operate at this level by externalizing, through the design process, images which are already pre-structured<sup>24</sup>. One of the tasks of environmental psychology, as far as designers are concerned, may be to provide a base on which existing prestructured images can be studied and objectified.

Another effort towards an abstract but more comprehensive description of the dynamics of physical stimuli and behaviour comes from the psychological theory of "adaptation-level". "Homeostasis" as a concept represents the tendency of an organism to maintain a

22. *Ibid.*, p.55.

23. *The extraordinary complexity implicitly involved in analytical investigations of the "stimulus-response" dynamics undoubtedly proves that it is extremely difficult to apply such theories in the design process. For appropriate examples of such analytical studies see, for instance, FISKE, W.D., MADDI, R.S., (1961).*

24. *A successful explanation of the ways in which designers' pre-structured images are involved in the design process has been given by HILLIER, B., MUSGROVE, J., O'SULLIVAN, P., (Dec 1971) and HILLIER, B., LEAMAN, A., (Dec 1972).*



unified physiological behaviour in the presence of changing levels of stimuli that are in some way threatening to an organism. The behavioural analogue of this concept is the theory of adaptation level<sup>25</sup>. The theory asserts that there is a level of psychological equilibrium which may serve as a reference point from which behaviour can be measured and, more importantly, can be predicted. The theory maintains that for each level of behavioural activity there is a corresponding adaptation level and vice-versa. In general terms such a situation can describe the dynamics of behavioural adjustments by simple descriptors like "accepting", "rejecting" or "indifferent to" a given situation, object or event. Thus, every response of the organism may be considered as reflecting a positive, negative or neutral adjustment to a given situation<sup>26</sup>.

I shall close this section by examining briefly the contribution of those studies of experimental psychology, and especially of the Gestalt School, which are significant in organizing a rational method for the study of the perceptual organization of the built environment. The particular reason for doing this is to stress the point that although psychology has developed - with varying degrees of success - a number of different methods and theories to deal with human perception and behaviour in an integrated way, psycho-climatology still uses methods and techniques (such as stimulus-response theory) which have been abandoned by psychology a long time ago. Psycho-climatology, for instance, does not so far seem to have seriously considered the possibility of applying Gestalt theory or even of examining the

25. *For a detailed exposition of this theory see HELSON, H., Adaptation-Level Theory, New York: Harper & Row, 1964; for a summarized version of it refer to CORSO, J.F., The Experimental Psychology of Sensory Behaviour, Holt, Reinhardt & Winston (1967), Ch.13.*

26. *HELSON, H., op.cit., p.37.*

applicability of certain conclusions reached in other fields where the theory has been applied (in visual perception or in art), to the climatic phenomena of the built environment. Neither has psychoclimatology taken advantage of the experimental findings of those studies of experimental psychology which have been concerned with an explanation of the mental processes which govern both the perception of the physical environment and the reaction to it in terms of particular patterns of behaviour such as the theory of schematization of stimulus-response mechanisms.

Gestalt theory has been extensively used not only by experimental psychologists, but also by artists, painters, sculptors and even architects and industrial designers<sup>27</sup>. All of them have used the theory primarily in order to tackle problems concerned with the visual organization and with the evaluation of their artifacts, though the theory extends to other perceptual modalities.

Gestalt theory has introduced a crucial idea to experimental psychology: that certain perceptual structures, certain relations among the elements of a perceived pattern, can be disturbing and can consequently impel changes to restore "equilibrium". Thus, the theory argues that certain combinations of elements contain "conflict", "dissonance", "inconsistency" and therefore, induce "discomfort", "drive", or "arousal" and also that other combinations can be "rewarding" or "reinforcing". Gestalt theorists have also paid attention to those endogenous processes by which unbalanced and unstable structures are replaced by more stable ones by means of

27. *For the most extensive and complete study concerned with the application of the Gestalt theory in Art, see ARNHEIM, R., Art and Visual Perception, Univ. of California Press, Los Angeles, 1954. See also, HESSELGREN, S., The Language of Architecture, II Vol., App.Sc. Publishers Ltd., London, 1972, for the various applications of the Gestalt theory in Architecture. However, for an original expression of the theory itself refer to KOFFKA, K., Principles of Gestalt Psychology, Routledge & Kegan Paul, London, 1935.*

perceptual adjustments, selection of alternative perceptual organizations and so forth.

However, the most significant impact of Gestalt theories as far as the perceptual organization of the built environment is concerned has been on a number of environmentalists from different disciplines who turned their attention to various forms of action by which disturbing patterns of the perceptual environment can be replaced by satisfying ones. This contribution has come long after "optimization" and "good form" were abandoned by Gestalt theorists in favour of the more fruitful adoption of information theory which influenced the development of the concept of "schema".

"Schema", in psychological terms, is defined as the active organization of previous responses or previous experiences which operate in any well structured response of the organism. Others have defined the concept in informational terms speaking about the most "economical" way of informational coding in the human brain. However, the latter definition has been rejected by D.E. Berlyne<sup>28</sup>, a leading psychologist-aesthetician, who does not accept any "optimal" organization of information by the human brain, stressing that variables such as "emotional disturbances" and "inconsistency" are also involved in organizing the perceptual schemata of the individual.

The concept of schema, together with others like it, such as "structured image", "prototype", "mental patterns", have already proved fruitful in their application to architecture and planning (e.g. Lynch, K., (1960), Abercrombie, M.L.J., (1969), Alexander et al., (1967)). It is justifiable, therefore, to expect that within an integrated

28. BERLYNE, D.E., *"Experimental Aesthetics"* in DODWELL, P.C., (ed.), (1972), pp.107-125.

approach to the climatic problems of the built environment, psychoclimatology can play a more productive role by exploiting the advantages of newly developing theories in experimental psychology.

#### 8.4 THE BEHINDS OF COMFORT RESEARCH: TOWARDS A BROADER SOCIO-CULTURAL DEFINITION OF COMFORT

It has been argued in philosophy that scientific method has developed as a form of human mastery over nature which provides the concepts and the tools for a more effective sovereignty of man over man through his control of nature<sup>29</sup>. Accordingly, technology has been considered as the major factor which accounts for the rationalization of "non-freedom". Thus "non-freedom" does not appear as unreasonable or even as political, but simply as submission to the artificial mechanisms which extend the comforts of life and raise the production and efficiency of work<sup>30</sup>.

Marcuse, for instance, argues that technology, due to its methods and concepts, designed and developed a set within which man's sovereignty over nature and over his fellow men remained closely connected, a link which, according to him, may have fatal influences over the whole set. Habermas, on the other hand, explains the evolution of technology as man's attempt at a gradual release from those operations which are necessary for his survival. Within such a context, Habermas recognizes the necessity of technology, especially as it has been formulated today through its immediate relationship with human nature. But he concludes that the problem of

29. *Marxists and Weberians would probably agree with this thesis.*

30. See HABERMAS, J., "Science and Technology as Ideology" in BARNES, B., (ed.), (1971), pp.353-375.



technological sovereignty over nature cannot be solved with better technology, but only through an erasing of the sovereignty in technology-to-man and man-to-man<sup>31</sup>.

A brief consideration of the historical background which lies behind today's environmental technology and even behind its descriptive theories such as that of thermal comfort, may serve to show that at least in this area of human activity both Habermas and Marcuse are correct.

Research on thermal comfort started in the early 19th century. "Discomfort" was attributed to the overheating of the room alone until Lavoisier shifted the focus of attention from the overheating and warmth of rooms to the level of carbon dioxide and to "bad air"<sup>32</sup>. In 1862, Pettenkofer<sup>33</sup> added to these factors the presence of organic material exhaled from the skin and lungs while Hermans, in 1883, attributed discomfort to heat and high humidity. Most interestingly, it was realized, from the early 18th century, that comfort depends not only on the general level of warmth but also on the distribution of warmth throughout the occupied space<sup>34</sup>. By the outbreak of war in 1914 the importance of the four thermal factors - temperature, humidity, air speed and radiation - had been realized<sup>35</sup>.

31. See HABERMAS (1971), *op.cit.*

32. See, for instance, LEBLANC, F., (1842).

33. PETTENKOFER, W., (1862-3).

34. See, for instance, TREDGOLD, T., (1824).

35. For a more detailed account of the historical background on comfort research see BEDFORD, Th., (1961).

Reyner Banham, describing the general atmosphere within which research on environmental technology was conceived and structured during the later years of the 19th century in America, provides a number of examples to illustrate the argument that environmental technology had been motivated by profit rather than by social motives. He maintains that the basic generators behind environmental improvements were profit for the industrialist and gains for the ingenious inventor. This attitude is clearly illustrated by the heating engineer, M.C. Huyett, who, standing below two dramatic photographs of Chicago with the headline "Wastefulness" wreathed in industrial smoke, declared in 1895:

"While looking from a window on the fifteenth floor of the Monadnock building and observing smoking chimneys and escaping steam, the above headline (i.e. Wastefulness) was suggested, because in it was expressed the economic conditions presented to sight. Crossing the Chicago River and seeing hot water and steam from the sewer pipes of individual buildings emptying into the river, and when walking along the streets and seeing steam escaping from manholes, fixed in mind 'Wastefulness' and suggested the thought: 'What does the needless waste from these sources cost Chicago daily - \$50,000 - \$100,000?'"<sup>36</sup>

Another example is Willis Carrier's earliest industrial air-conditioning installation in a tobacco factory developed not so much for comfort or health requirements as for maximizing the efficiency of the workers<sup>37</sup>.

In Britain, the Industrial Fatigue Research Board was formed in 1918. The Board worked mostly on quantitative research which developed measurements and techniques to maximize the efficiency of workers by

36. *Mechanical Heating and Ventilating, Chicago, 2nd ed., 1895, p.76. Quoted by Banham, R., (1969), p.30.*

37. *BANHAM, R., op.cit., pp.30-31.*



optimizing the conditions of their working environment. It is characteristic that most of the work initiated in ergonomics has been orientated exactly towards increasing the efficiency of industrial workers<sup>38</sup>. The ultimate aim of ergonomic research is to provide strategies for optimum design of tools, equipment, environmental conditions and space organization in relation to "operational efficiency" even when it is dealing with household equipment or living-rooms. Human climatology, undoubtedly influenced by the character of ergonomic research, has been primarily orientated towards establishing optimum values for indoor climatic parameters (especially temperature, humidity and air movement) on the basis of maximizing human performance and efficiency and, therefore, the production and profit of industrial capital. The aim of the Climate and Working Efficiency Research Unit of the Medical Research Council, which was: "to survey and solve problems concerned with Anatomical and Physiological problems affecting man in his working environment"<sup>39</sup> indicates a notable aim to study fully all climatic factors affecting human physiology and human productivity within a working environment.

This body of research, firmly orientated towards economic benefits, has created a strong methodological background in the context of which socially produced environmental and architectural problems would undoubtedly remain unsolved. Fortunately, recent work in architectural climatology and of bioclimatology, has realized the inadequacy of some of the established concepts (such as comfort) to deal effectively and comprehensively with the complex nature of ecoclimates and of their polysemic meaning which are dependent on the

38. *For a historical background of this type of research refer to WEINER, J.S., PROVINS, K.A., (1957-58).*

39. *WEINER, J.S., et al., op.cit., p.277.*

socio-cultural context in which they are generated.

Pioneering work on socio-cultural influences on physical descriptors of the man-environment interaction, such as those of E.T. Hall in cultural anthropology and A. Rapoport in architecture, eventually provided the grounds for a broader socio-cultural description of the concept of comfort. Hall, in *"The Silent Language"*, emphasized the cultural variability of the use of space, the scale of space and the needs of privacy<sup>40</sup>, while Rapoport, in his *"House Form and Culture"* and in an earlier paper written with N. Watson on *"Cultural Variability in Physical Standards"*, stressed the socio-cultural input to physically determined descriptors in anthropometrics, ergonomics and comfort<sup>41</sup>. These studies have led to second thoughts in architectural research, especially about the value and applicability of purely physically determined descriptors as these of physiological comfort.

The need to reassess our attitude towards comfort was expressed formally in 1968 by the President of the International Society of Biometeorology, D.K.H. Lee, who pointed out that:

"The hedonistic outlook of an affluent society would be a debilitating luxury for a developing country. Reduction of environmental stress to the *"comfort"* point entirely within the ability of a highly technological culture, is no more than a distant dream to the majority of less endowed people. That reliance upon protection may expose the former to both the disadvantages of a temporary break-down and the superior adaptability of the latter, is beside the point. The aspect of importance to us, as biometeorologists, is that we must take into account the

40. HALL, E.T., (1963, c 1959).

41. RAPOPORT, A., (1969) and RAPOPORT, A., WATSON, N., (1967-68. In this earlier paper Rapoport and Watson argue that "even physical standards which might be regarded as 'hard' and quantifiable data are themselves affected by cultural attitudes and social forces prevailing at the time and place of their inception" (p.64). Their argument is illustrated by anthropological, ergonomic and comfort examples.

impact of climate on both those habituated to comfort conditions and those accustomed to natural ranges, we must bear in mind the different economic feasibilities of climatic protection and we must concern ourselves with the effect upon individuals of translation between the two cultures."<sup>42</sup>

The implications of such socio-cultural attitudes for the description of climate-man relationship and especially of comfort are significant in two ways. First, they provide the opportunity for a comprehensive evaluation of climatic influences on man, and secondly they provide an adequate base for integrating climatic and comfort research into human practices such as architecture. The traditional view of comfort based on the assumption that climate should not cause discomfort or be unpleasant, seems to be utopian when seen in terms of the everyday life experiences and the practical problems met in the design and planning of the built environment. Furthermore, this traditional view of comfort seems to be irrational in terms of overall ecological demands, since its application - even at the small scale of indoor climate - requires types of building technology which are uneconomic in terms of capital investment and running cost, and are destructive in ecological terms (for example, by the production of air pollution and the excessive use of energy).

In 1972, H. Ryd<sup>43</sup> attempted to develop comfort descriptors within a broader socio-cultural framework by defining "comfort climate" as the climate which facilitates human activity. The major assumption behind her work is that climate influences activity patterns, thus it is closely connected with cultural development. This link is

42. LEE, DOUGLAS, H.K., (1968), p.318.

43. RYD, H., "Use of Climatological Data in Building Planning with Respect to Comfort", in *Teaching the Teachers on Building Climatology, CIB Colloquium, Stockholm, 1972.*

explained by the argument that climate provides "stimuli" for certain activities and for certain behaviour and causes "stress" which is compensated by socio-cultural transformations. Accordingly she proposes two basic categories of requirements that a desired climate should satisfy: (a) not to cause stress by causing damage to the human body or to the ecosystem; and (b) to provide stimulus by establishing links between man and his surroundings and by initiating activity<sup>44</sup>.

The "beyonds" of this new conceptual framework for understanding and describing the climate of the built environment have been analysed by Ryd in terms of future research orientations in building climatology. According to her, research is needed:

- (a) "to define a favourable climate by virtue of its capacity for supporting human activity in different situations.
- (b) "to supply development planning procedures with knowledge of the opportunities which there are at every planning level for checking the climatic effect of building development, in order that the climate of the region, urban area and outdoor spaces may be as favourable as possible, with regard to both people's outdoor activities and the climatic stresses imposed on buildings and the landscape."
- (c) "to allocate the cost of climatic modification to the proper quarter."<sup>45</sup>

It is a basic assumption in this thesis that the methodological requirements which any future orientation of research in architectural and building climatology should satisfy, must provide the possibility for an integrated approach not only to the microclimatic environment but also, and most importantly, to the ecoclimatic one. On the one hand, such research should provide an integrated assessment of

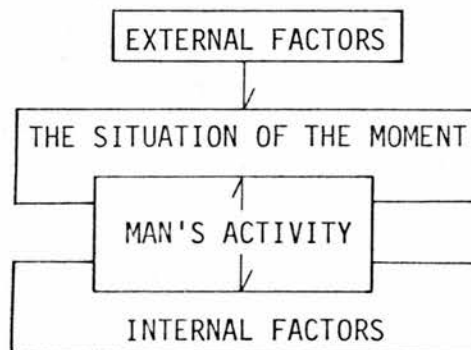
44. *Ibid.*, p.57.

45. *Ibid.*, p.78-79.



climatic elements by constructing predominancies among them according to a system of evaluation which is appropriate to each particular case, and on the other, it should provide a second level of integration at which ecoclimatic descriptors produced at the first level could be coordinated with other descriptors of the built environment which are preferably those commonly used in architectural and planning practice.

The first level of integrated assessment of climatic elements has already been established - though not yet adequately developed - and its importance has been emphasized in relation to the demands of architectural practice<sup>46</sup>. Experimental studies conducted at this level indicate that the impact of one climatic element on man or his buildings may be modified by the impact of another climatic element. Such interactions should be understood and conflicts must be resolved. However, considering that the system within which such a resolution should take place includes influences on man's perception, internal reactions, behaviour and also on the broader ecological and socio-economic environment, it is easy to see that we are dealing with a situation of high complexity. Nevertheless, at deeper levels of consideration, models like those of H. Ryd may provide a base for theoretical formulations of the problem of integration:



47

46. See, for instance, O'SULLIVAN, P.E., (1972).

47. RYD, H., *op.cit.*, p.86.

However, "internal factors" can become operational only after they are methodologically conceptualized and structured as ecoclimatic prototypes because it is only in this way that their links to "man's activity" can be adequately expressed.

There is a great deal of work to be done before such schematic models become operational in building climatological research. Nevertheless, the need for such models should not be underestimated, especially when they can be used to indicate the significance of approaching climatic design problems on anthropocentric bases. The study of the ways in which man structures conceptually ecoclimatic prototypes and of the way that he expresses them in physical terms (for example, in buildings) may well be the most critical factors in establishing such bases.



## CHAPTER 9

## TOWARDS MORE COMPREHENSIVE CONCEPTUAL BASES FOR ECOCLIMATIC RESEARCH

Architectural and planning research, particularly in the last few decades where the strong social character of architectural and planning phenomena has been recognized in these fields, have largely used the concept of "social man" as a starting point. The recognition gradually became an internalized and commonly shared assumption after the establishment and development of fields such as behavioural geography, environmental psychology, ecological psychology and human ecology, where the dialectics between social and physical organization of the environment were established.

Empirical and theoretical work conducted on socially determined conceptual domains has established a variety of architectural and planning processes and methodologies by which the majority of the relevant phenomena can be explained at deeper socio-economic levels. However, in relation to the taxonomic model of empirical research in architecture we may distinguish two major categories of such processes. First, those which, starting from the social totality, try to establish relationships with phenomena of the physical or the artificial environment either in a direct way (S→E)<sup>1</sup> or through manipulation of

1. S: *Social whole*; P: *Process of production of the built environment*; E: *Environmental object with which the study is concerned*. For a further explanation of these symbols refer back to Chapter 5. There for convenience I have used the symbols 1,2 and 3 to indicate respectively social whole, process of production of the built environment and environmental object. However the symbols S, P and E seem to be better memorisable, thus employed here.

the mechanisms of production of the artificial environment (S→P→E). Secondly, those processes which examine the influences of social environment upon the process of production of the artificial environment either by direct relationships (E→S) or through the particular way in which this social environment "tolerates" the artificial object (E→P→S).

The increasing orientation of climatic research towards these conceptual bases have been reinforced, especially in the last decade or so for a number of reasons related to:

- (a) the increasing pollution of man's atmospheric environment;
- (b) the increasing ability of man and his institutions to modify the climatic environment and to forecast weather with greater precision and to exert environmental control in urban areas;
- (c) the increasing ecoclimatic disorientation in urban areas involving all these problems connected with political, legal and planning aspects<sup>2</sup>.

It is interesting to examine both the legal and political dimensions of climate in terms of the general implications which they might have on socially based ecoclimatic research. So far, the legal aspects are restricted to problems related to intentional (rain making) or unintentional (pollution) climate and weather modifications. Political and administrative aspects have similar concerns. In the United States, where these dimensions of climate have been recently emphasized because of their strong economical basis<sup>3</sup>, a number of social groups and organizations have been formed and that reveals a necessity for social science research concerned with the atmospheric

2. According to MAUNDER, W.J. (1970), p.331.

3. For a detailed and comprehensive discussion on the economic basis of climate see MAUNDER, W.J., *op.cit.*

and the ecoclimatic environment<sup>4</sup>.

Sewell suggests that such research programmes should aim first at establishing relationships between the atmospheric environment, the human activity and the biological system and at investigating through them weather variation and production possibilities and, generally, weather variation and human behaviour; and second, at organizing institutional frameworks for a better management of the atmospheric resources which would include processes of decision-making, the roles of the public and private sectors, the identification of damage, the introduction of the relevant laws, and so on<sup>5</sup>.

This type of research opens an entirely new field of ecoclimatic enquiry and a new context for environmental studies in general.

However, as we shall see later, its scope of investigation has been, at least so far, limited to partial assessments and to solutions of

4. *Examples of this increasing social concern for the atmospheric and ecoclimatic environment, found in the developed industrial countries and especially in the United States, can be categorized as follows: First, formations of specific social groups and organizations under the current slogan of "citizen action" formed on the bases of conservation, ecological concern, public health, recreation and natural beauty, etc. Secondly, formations of particular organizations of administrative character such as the Councils on Environmental Quality (CEQ), the Environmental Protection Agencies (EPA), etc. Thirdly, formations of voluntary environmental organizations such as, for instance, in the United States, the "citizen's coalitions", "the environmental law firms", "environmental lobbies", "activist organizations", "specialized voluntary environmental organizations", "youth organizations", and so on. Fourthly, legislation and decision-making through "National Environmental Policy Acts", "Environmental Impact Statements" and "Participatory laws". Especially in the United States, under public pressure, a number of laws have been introduced to secure government's environmental responsibility which are particularly concerned with conservatioal and environmental pollution legislation. For a detailed account of this type of socil mobilization, especially for the United States, see FANNING, O., (1975).*
5. *See SEWELL, D.W.R., "The Human Use of Atmospheric Resources: A Review of Needed Social Science Research", in SEWELL, D.W.R., (ed.), (1968).*

problems which lie at the roots of industrial societies, such as the pollution or the economics of the atmosphere. Furthermore, studies of this kind have been either too abstract or too particular for their results to be taken seriously into consideration in environmental studies pertinent to architecture and planning.

Ecoclimatic phenomena, as they have been defined in this work with particular emphasis to the semantic dimensions of the climatic fields, are directly concerned with attempts to conceptualize the problems of the built environment using frameworks which are predominantly value-dependent. It has been shown earlier, for instance, that all the different kinds of climatic modification processes involve particular problems which require an ecoclimatic conceptualization and that in turn the ecoclimatic descriptors necessary for understanding these processes are generated in all the three levels of logical complexity provided by the ecoclimatic schema. The fact that the social dimensions of climate and weather have been confined by current research to isolated political and legal considerations, in a manner which is inapplicable to planning processes and, even more to architecture, indicates simply that a lot of work is needed before the full socio-cultural character of these phenomena can be internalized in both theoretical and practical terms.

The discussion in Ch. 8 indicated that the interaction between man and climate has been investigated largely with respect to the individual and within a restricted psycho-physiological context. Additionally, it has been suggested that recent attempts to extend this individual basis into a social one have been conducted within broader psycho-physiological, behavioural and cultural frameworks. What I would like to add and stress here are some further common



characteristics of this type of empirical ecoclimatic research.

Examples of ecoclimatic research indicate two different ways of approaching ecoclimatic problems starting from the social totality or the individual. The first way is to "assume" a set of basic human or social needs determined in a rather "ad hoc" manner by some sort of "rational" procedure and then to explore the descriptive or design difficulties emerging in the course of satisfying them. A second way, of much more general concern, is to orientate the scope of inquiry to those procedures by which more comprehensive and objectively defined "basic needs" could be obtained and introduced as design problems.

Sets of assumed basic needs implied by the first way of approaching ecoclimatic problems may be organized from a more general to a more particular level. At a general level commonly accepted needs are, for instance, man's need to conserve resources, or the need to seek more economic ways to achieve the "required" degree of environmental protection, or even the need to be prepared in advance for changes in the supply of materials and in technology and to stimulate growth and more satisfactory new technology<sup>6</sup>. In a particular and more pragmatic way the concept of need may be restricted to those which are basic for survival, propagation and comfort, or for keeping arousal at optimum levels and so forth. The characteristic of this type of approach is that it is extremely difficult for any assumed set of basic requirements to develop an appropriate framework which is adequate for an explanation of the different levels of complexity of the ecoclimatic environment. The major research problem which emerges, therefore, is that of taxonomizing these needs at optimum levels of

6. See, for instance, BUCHBERG, H., NARUISHI, J., (1967).

abstraction which would be analytical enough to explain the different degrees of complexity generated in the observed environment, but at the same time, comprehensive enough to be used in the process of producing or designing this environment.

On a broader social scale, the study of human or social needs presents many descriptive difficulties, both conceptual - in terms of the ambiguity of the concept of need itself - and methodological - in terms of the way in which identified needs might be satisfied. It is precisely these difficulties of the identification and description of unconscious (latent) needs that have turned these studies towards the observation and description of measurable human and social activities. In the most integrated areas (in terms of design) of ecoclimatic research, activity-based ecoclimatic descriptors are the most commonly used.

An additional problem related to the whole framework of the "assumed requirements" base for empirical or theoretical research in both architecture and ecoclimate is connected with the confinement of these studies to the conventional role of the architect or planner as the "specialist of space". Many of the difficulties in providing answers to the social, psychological, economical and technical questions, which undoubtedly arise in the process of producing or modifying the built environment, might be overcome by drawing a less arbitrary line between the "specialist" and the "user" of space. The problem has been approached from many different angles. One of them is to assume a more specialized role for the designer by developing more rigorous rational approaches such as those of "design methods"<sup>7</sup>.

7. See, for instance, BROADBENT, G., WARD, A., (eds.) (1969) and particularly the paper by HANSON, K., "Design from Linked Requirements in a Housing Problem", in BROADBENT, G., et al., *op.cit.*, pp.37-44.



or by accepting the much more questionable attitude of the so-called "behaviour-contingent approach" which rejects the stereotyped list of physical requirements in favour of the detection, isolation and structuring of environmental problems<sup>8</sup>. A different way is to replace the individual specialist by a team which in the best case might include the "world community of specialists" communicating amongst themselves by using specialized pattern languages<sup>9</sup>.

A third approach in architectural theory which has recently been developed to overcome the difficulties imposed both by the assumed list of user's requirements and by the conventional role of the architect specialist, is concerned with user participation in the process of production of the built environment<sup>10</sup>. This approach has been introduced to the field of building climatology by H. Ryd, who suggests that:

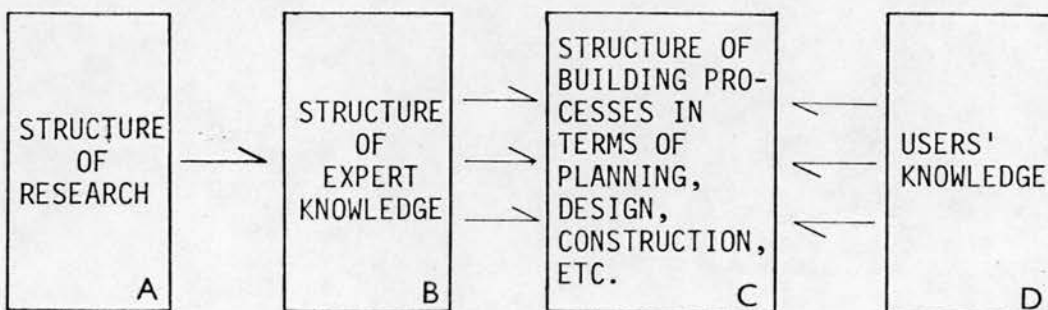
"Building Performance Influences the Quality of Life. I mean that man's chance to make the best of his life requires that his physical environment be designed with respect to his way of using and assessing it. In addition, I mean that man should get more out of his active life by gaining influence over the way in which the physical framework, which entails limitations in his freedom of action, is created."<sup>11</sup>

Ryd transforms the particular problems of assessing user needs at higher levels into the problems of allowing users to take part in important decisions during the planning and design process. This changes the problems but by no means simplifies them. The core

8. See STUDER, G.R., "The Dynamics of Behaviour - Contingent Physical Systems", in BROADBENT, G., et al., *op.cit.* pp.55-70.
9. The work of Chr. ALEXANDER, M. SILVERSTEIN and S. ISHIKAWA at the "Centre for Environmental Structure" presents the most representative and best known example of this attitude. See the proceedings of a seminar held by the above Centre during July, August and September, 1967.
10. For an integrated and comprehensive study on participation in architectural action and processes see KOTSIPOULOS, T., (1975), (in Greek with an extensive summary of the basic thesis in English).
11. RYD, H., (1975), p.19.

difficulty lies in communication and particularly in the codes which should be used between user and designer in both directions. Unfortunately, such a problem calls for a type of research which has not yet been developed in the environmental fields or, indeed, in the whole field of architectural inquiry. Thus, the major target at which research should aim in assessing user needs through participation, is the development of specific methods or codes for either presenting specific design problems and solutions or understanding the user's description of what they consider a desirable environment.

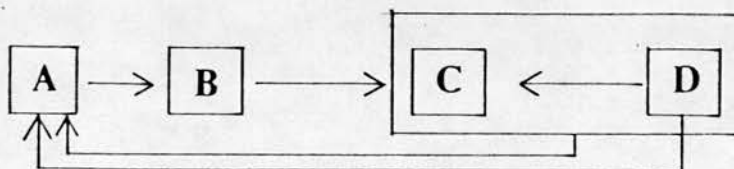
Research of this type, closely related to ecoclimatic studies, is being carried out in the Department of Environmental Design at the Royal Institute of Technology in Stockholm. The major objectives of this programme are reported to be: (a) description of the state of the prevailing physical conditions and the proposed changes in the environment by means of appropriate graphic communication and (b) organization of research dealing with the methodological aspects of the assessment of users' needs and the incorporation of them in the design and planning process. A proposal for this type of research organization is presented in the following diagram:



Adapted from Ryd, H., (1975), p.19.

A major difficulty in accepting Ryd's model concerns the "institutionalization" of the structure of research itself - in terms of important decisions being taken on grounds concerned with its

financial problems and its specific orientation - at levels more or less isolated from users' problems and opinions. To that, one should add the "inertia" of the academic tradition which sometimes indicates research on fruitless topics, ignoring the immediate requirements of new situations. To overcome such difficulties, it would be necessary to break the institutionalization of research by introducing some form of user participation, even in this very specialized stage:



The above problem is discussed extensively in the next part of this work, especially from the point of view of descriptive theories appropriate for a number of architectural descriptors including the ecoclimatic ones. There it becomes obvious that it is both desirable and possible to structure research on a broader user-problem dependent basis, rather than on the current institutionalized one.

Coming back to the question of socially based ecoclimatic research it is worth mentioning that only a few attempts have been made since the early sixties to examine the potential and implication of such work. Within a general context, research has been conducted on "human dimensions" of the atmosphere and of weather modification. In 1964 the National Science Foundation appointed a Special Commission on Weather Modification to examine the physical, biological, legal, social and political aspects of the field and to make recommendations concerning future policies and programmes. The report of this Special Commission which came after one year of inquiry concluded:

"The need is great to assess more fully the social implications of weather and climate modifications"

and recommended a greatly increased research effort on the social, economic and legal dimensions of weather modification. As a result of this recommendation a Task Group on Human Dimensions of the Atmosphere was formed, the extensive research of which led to a symposium on the Economic and Social Aspects of Weather Modification in 1965<sup>12</sup>.

Unfortunately, a review of recent social science literature suggests that no serious research has been aimed at the sociological aspects of the relationship between man and climate. Haas<sup>13</sup> who reviewed this field, has made some recommendations which may be summarized briefly in the following points: (i) Social, political and economic research for planned weather modification should be given priority, (ii) methodological research on the human dimensions of the atmosphere should be conducted on a multidisciplinary base, (iii) the international aspects of man-atmosphere interaction should be recognized for total and comprehensive action on a world-wide scale. Apart from identifying certain aspects of the problem, which are more or less obvious, Haas poses a number of questions which are answerable only within a well-formulated framework derived from climatic descriptors on social bases. Among the topics for research specified by Haas are:

12. *Part of this work has been reported by SEWELL, D.W.R., (ed.), (1966) and (1968). For an extensive bibliography on the human dimensions of the atmosphere see the one by SEWELL, D.W.R. and BROWN, M.J., in SEWELL, D.W.R., (ed.), (1968).*
13. *HAAS, E.J., "Sociological Aspects of Human Dimensions of the Atmosphere" in SEWELL, D.W.R., (ed.), (1968), op.cit.*

- (i) incidence of illness and use of health facilities and personnel,
- (ii) use of educational facilities and student performance,
- (iii) nature of major recreational and leisure time activities,
- (iv) participation in political activity,
- (v) incidence of racial disturbances,
- (vi) incidence of crime and law enforcement efforts.

However, all these are surface questions which have nothing to do directly with the mechanisms of modifying the weather and thus can be considered only as examples showing the lack of theoretical foundation in this field of study.

Fortunately, in respect of those phenomena which in this work have been called ecoclimatic, there have been some suggestions for the type of socially based research which is needed. The work of Bates<sup>14</sup>, for instance, is mostly relevant. Bates, discussing the role of weather in human behaviour, takes the view that it can be best understood not in terms of man-environment relationships but in terms of "human ecosystems". In the study of these ecosystems, Bates gives priority to a component of them which he calls the "conceptual environment". He argues:

"We have lost the rain gods and storm spirits, but I think our conceptual environment still influences the effects weather has on us. This is particularly true in relation to ideas of comfort ..."<sup>15</sup>

and elsewhere:

"A considerable part of our physical environment is shaped by our ideas: the kind of clothes we wear, the buildings we construct, the network of communications, the way we deal with landscape, govern our relations with the biological environment; our attitudes and the ways in which we deal with other animals and with plants. And ideas are obviously important with the weather."<sup>16</sup>

14. BATES, M., *"The Role of Weather in Human Behaviour"*, in SEWELL, D.W.R., (ed.), (1966).

15. *Ibid.*, p.395.

16. *Ibid.*



Since he places the investigation within the sphere of human ecology, Bates argues that efforts to control the weather can be looked at as part of the tendency to restructure complex ecosystems. Of course, the greatest difficulty in doing so arises from the fact that conscious "restructuring" of an ecosystem assumes a clear determination of the appropriate limits to which possible transition and/or transformation of the ecosystem can be extended without unforeseen destructive results. Such limits have not been defined, so far, despite the increasing awareness of ecologists of their necessity<sup>17</sup>. The problem is taken up in Appendix II as the problem of defining the "transformation potential" of a structure and consequently the magnitude of its transformation.

Bates' proposition brings us closer to a basic research problem immediately connected with socially determined ecoclimatic research: the so-called "ecological problem" formulated within the context of contemporary Western philosophy. The ecological movement has lately gained mass popular support, especially in those countries with higher industrial development. It is, therefore, worthwhile to examine the possibility of obtaining answers from ecology itself to some of the questions posed by the ecoclimatic environment. Before doing so it is necessary to look at the "problems" associated with the "ecological problem".

Enzensberger in his "critique of Political Ecology"<sup>18</sup> stresses the reasons why the ecological problem has been disorientated. First, there is the economic and political exploitation of the ecological problem by industrial interests through commercialized publicity which

17. See, for instance, ENZENSBERGER, M.H., GOZZ, A., and MARKOVIC, M., (1975).

18. *Ibid.*, pp.7-58.



has at its disposal the whole set of mass-communication media. Secondly, there are the technocrats who, at every administrative or industrial level, introduce "quick technological fixes" which apart from being only partial solutions are applied only to those situations which do not cause economical or political damage. Thirdly, the so-called movements of "concerned and responsible citizens" which in various ways try to deal with aspects of the ecological problem. The difficulty with these movements - which have a lot of popular support in the developed countries - is that although they are inspired by genuine needs they are limited in what they can do mostly because they adopt "apolitical" targets. Finally, the ecological problem is disorientated by groups which express their dissatisfaction with the present state of society by moving out of cities into a "natural" way of living (e.g. the "eco-freak" groups).

It is quite clear, therefore, that the ecological problem has two major aspects which need careful consideration before one proceeds to define its pragmatic dimensions. On the one hand, the motives of the physical sciences have been confused within the ecological movement with a number of apparent or hidden political motives. Groups such as the "Club of Rome", the "Burgerinitiative" in Germany, or the "concerned and responsible citizens" in the United States, are some examples that may be used to support this argument. On the other hand, there are also groups, many of whose members are involved for sociological or psychological reasons. Such groups are, for instance, those concerned with self-sufficiency, alternative technology, autonomous houses and so on.

Unfortunately, although a considerable number of striking examples exist, ecologists - as is the case with environmentalists

of different disciplines - have not yet taken seriously into account the strong socio-political base of most environmental problems.

P. Samuel and H.M. Enzensberger are among the few ecologists who have tried to stress the socio-political base of the ecological problem by introducing it as a major conceptual domain for comprehensive description<sup>19</sup>.

Enzensberger, whilst realizing both the social indifference of most ecologists and their methodological weaknesses, accepts that many of their descriptions and their predictions of the "ecological crisis" should be taken as valid in order to introduce the social dimensions of these problems. According to him a social definition of the ecological problem should start from the mode of production. Thus, within a mode of production where human products take the form of commodity, social welfare is necessarily accompanied by social scarcity. Furthermore, imposed solutions such as "quick technological fixes" are creating new and more complex ecological crises instead of solving the problem. For instance, the cost of living space, recreation, clear air and clean water, and of energy and primary resources, include the "invisible" costs of these commodities which are compensated by high prices and heavy taxation paid by the mass of the people. Thus, Enzensberger stresses the class character of the ecological problem:

"The physiological and psychological consequences of the environmental crisis, the reduction of life-expectancy, the immediate threat from local catastrophies, may play a decisive role in the life and death of the class in which the individual belongs (provision of possibilities for escaping; second shelter; improved health services, etc.)."<sup>20</sup>

19. SAMUEL, P., (1973) and ENZENSBERGER, H.M., (1975), *op.cit.*

20. ENZENSBERGER, H.M., (1975), *op.cit.*, p.52, (my translation from Greek into English).

The social basis for the explanation of physical phenomena is in fact a philosophy long ago advocated and clarified especially in Marxist thought. Marx in his "Oekonomisch-Philosophische Manuskripte" formulated the argument that:

"The human essence of nature starts only through social man because it is only then that nature operates as his link with man as his existence for the fellowman and the fellowman for him... Thus, society is the integrated unity of man and nature, the true resurrection of nature, the achieved naturalism of man and the achieved humanism of nature."<sup>21</sup>

In viewing the ecoclimatic problems of our cities within established ecological frameworks, we run the risk of assuming a level of physical determinism which, although it is integrated in terms of the physical hardware of the environment, largely fails to account for most of the meaningful software with which architectural and planning processes are concerned<sup>22</sup>. If any ecological level exists, within which ecoclimatic phenomena could be adequately described, this might be found in the fields of social and political ecology. At such a level there are no objective or normative approaches, but a number of conflicts, coming from different values and aspirations held by social classes which are differentiated within the possession of resources, power and status and which should be resolved during the process of organizing the production of the built-environment as a whole.

The major difficulties in organizing a framework on such socio-

21. MARX, K., *Oekonomisch - Philosophische Manuskripte*. MEW, Complementary Vol., Part I, p.537

22. SIMMIE, J.M., (1974), p.26, referring to a critique of theories concerned with the ecological understanding of cities formulated by W. FIREY (1974) in his *Land Use in Central Boston* (Harvard Univ. Press) points out that according to him "... ecological theories assume away the need to explain these problems by implicitly asserting that physical space possesses qualities which are wholly devoid of cultural values and that social systems passively comply with spatial distance."

political ecoclimatic bases are not straightforwardly of a methodological or theoretical nature but of a much broader political and socio-economic character. First of all there are conflicting objectives that a theory or methodology has to assume in order to develop a problem-solving capacity. There are conflicting objectives from different groups in which the conflict is not philosophical but represents purely economic interests. This in turn leads into the second major problem which is related to the nature of the existing professional (or role) paradigm existing in the architectural and planning communities.

This paradigm assumes that disputes over the major objectives of an architectural or planning policy can be resolved within the established professional role of the architect and planner as "space specialists". The paradigm has been well formulated since the Industrial Revolution when economic interests and speculation were heavily involved not in influencing but in determining planning and architectural policies. Further, it has been reinforced through the adoption of deterministic attitudes in planning, early in the 20th century, and the sterile functionalism in architecture during the 50s and 60s. Eventually, both architects and planners have found themselves to be determined by rather than determining the policies which they adopt in order to deal with the organization of the built environment. The paradigm simply states that the professional level at which conflicts in the objectives or in the policy, occurring within the design process, should be resolved is that of "rationality", "political neutrality" and "mono-dimensional

specialization" in architectural and planning professionalism<sup>23</sup>: It is inevitable, therefore, to expect that such a professional approach should be, if not counter-productive, at least very limited in its problem solving capacity.

However, revolutionary approaches in planning and architecture aimed at achieving "social justice" in the organization of the urban environment; with "advocacy" and even "provocacy" planning and, generally, with participatory processes in the design of buildings and the planning of the built environment<sup>24</sup>, have created a climate of opinion within which there is some justification for the belief that a new revolutionary paradigm exists at an early stage of its development<sup>25</sup>. Within this paradigm, which demands socialization of scientific theories rather than scientification of social theories, ecoclimatic problems are to be explained, and most importantly solved, only through a framework comprehensive enough to integrate physical climatic and microclimatic problems with the broader socio-political ones which account for the spatial inequality and the class character of the physical environment.

23. *The general dominance of this paradigm becomes more obvious within the contemporary educational systems for the production of architects and planners, where physical determinism - though not always advocated as such - together with the separation of architectural and planning issues, serves the construction of artificially over-simplified design situations within which major objectives are hardly questioned. It could be argued that such a situation holds true mostly in schools of architecture rather than those of planning, but even so, planning activity isolates itself from the architectural "micro-cosme" where socio-economic conflicts are transferred into a struggling way of living, thus formulating generalised processes without providing means of checking their possible implications for the layman.*
24. *See, for instance, HARVEY, D., (1972); DAVIDOFF, P., (1965); HABRAKEN, N., (1961).*
25. *The next chapter presents a general discussion of this paradigm.*

## PART IV

### TOWARDS A STRUCTURAL METHODOLOGICAL FRAMEWORK FOR ECOCLIMATIC RESEARCH

#### INTRODUCTION

#### CHAPTER 10

DESCRIPTION AND PARADIGM IN ARCHITECTURE - THE ORIGINS OF  
MICROCLIMATIC AND ECOCLIMATIC DESCRIPTORS

#### CHAPTER 11

STRUCTURALISM AND COMPREHENSIVE DESCRIPTION OF ECOCLIMATIC  
PHENOMENA

#### CHAPTER 12

SEMIOLOGICAL ANALYSIS OF ECOCLIMATIC PHENOMENA

#### CHAPTER 13

DEVELOPMENT OF THE SYNTAGMATIC APPROACH TO ECOCLIMATE - THE  
DIALECTICS OF MEANING AND SYNTAX

#### CHAPTER 14

THE SYNTAGMATIC CHARACTER OF ECOCLIMATIC STRUCTURES

#### CHAPTER 15

GENERAL CONCLUSIONS AND ORIENTATIONS FOR FUTURE RESEARCH



## INTRODUCTION

In this work so far, I have examined some theoretical aspects of the nature and the characteristics of the ecoclimatic organization of the built environment. I have repeatedly argued for the importance of studying architecturally related climatic phenomena within the multi-disciplinary domain defined by both the structure of the ecoclimatic phenomena and the nature of architectural empirical research. In doing so, I have stressed a number of terminological, taxonomic and conceptual difficulties, especially those related to a comprehensive description and explanation of the phenomena, which need to be overcome if any integrated approach to the total organization of the ecoclimatic environment is to be achieved. To overcome these difficulties I have proposed the following:

1. I have argued about the necessity of conceptualizing the architecturally related climatic phenomena in ecoclimatic terms and, specifically, for examining the complex ecoclimatic prototypes in the structure of which social, economic, cultural, together with physical aspects of the climate of the built-environment have been integrated. Ecoclimatic prototypes reflect the complex processes by which the climatic conditions of the built environment are internalized and evaluated by people. They are originated and structured not only in terms of the direct climatic influences on man, but also in terms of all these climatic modifications appearing in the environmental, activity and socio-economic images of these prototypes. Moreover, I have argued that the socio-economic image of the ecoclimatic prototype should be considered as the most important one since it appears

to constitute the structuring mechanism of the other two images (see conclusions of Chapter 2, Part I).

2. An appropriate theoretical base on which the study of the ecoclimatic problems may facilitate the identification of ecoclimatic prototypes can be provided only in relation to the broader structure of architectural research. I have proposed, therefore, a taxonomic framework of ecoclimatic research (Part II) which organizes and presents the different images of ecoclimatic phenomena and which, furthermore, establishes "starting points" and "orientations" between these images. Accordingly, it appeared that a methodological shift from a "relational" to a "systemic" and "structural" explanation of the logical complexity introduced by the ecoclimatic environment is inevitable and requires the formulation of architectural disciplinary models at optimum levels of abstraction.
3. I have shown that the climatic phenomena of the built environment acquire their pragmatic meaning and value at synthetic levels, the complexity of which could be approached only within an interdisciplinary conceptual framework. Interdisciplinary considerations of this kind tend to be so complex that they lose their descriptive value by becoming "puzzle-solving" rather than "problem-solving" activities if they do not consider seriously the methodological implications of the increasing conceptual complexity which results from them. Such levels of complexity require proper levels of abstraction in order that they can be simplified without losing their comprehensiveness and in order to acquire the problem-solving capacity which is necessary for effective action upon the ecoclimatic environment.

The major methodological consequence of the above arguments is that a comprehensive and integrated description of the ecoclimatic phenomena, on the one hand, and structuralist methodology on the other, are unavoidably complementary. These methodological requirements are discussed in this part of the thesis and in the appendices.

However, there is an additional point which, though only briefly discussed in the previous chapters, is significantly related to any methodological discussion concerned with description in architecture. This is concerned with the manifested conflict between the normative prescriptions, of how design "should be done", and the actual ways in which design "is commonly done". Explanatory theories concerned with the organization of the climatic elements of the built environment and design methods formulated on their basis tend to forget the synthetic level in which design action occurs in practice. The general methodology dealing with the physical organization of the built environment (including the climatic one) assumes most of the time a rationalization of design action which in many respects conflicts with the prestructuring of the design problem and the intuitive use of prototypes by architects. It appears that this conflict, which partly generates the so-called "applicability gap", reaches its maximum at the higher synthetic levels which are appropriate for design action. Accordingly, the materialization of the design solution has to follow its own practical procedure which usually deviates considerably from the prescribed intentions and models of the theory.

Architecture as a science has a responsibility to explain the products and the processes of practice. As far as design is concerned, rationalized methodologies have repeatedly failed to comply with this

requirement. However, it seems that in the broader methodological framework of structuralism the theoretical method could be equipped with the necessary links to practice, not by attempting to "scientific" practice, as the present epistemology of architecture assumes, but by shifting the theoretical method closer to practice. This general method of "theoretical-practice" has been already proved useful in other fields of social sciences where their general epistemology is dominated by social rather than scientific paradigms.

The discussion which follows in this Part of the thesis starts with a consideration of the methodological implications which the adoption of a social paradigm brings to the origin of architectural descriptors in general, and the microclimatic and ecoclimatic ones in particular. In Chapter 10, I will discuss some aspects of the epistemology behind the social paradigm and its descriptive methodological beyonds which are assumed in this thesis. It is, however, in Chapter 11 that these methodological implications are incorporated within a broader strategy and where the complementarity between comprehensive description and structural methodology becomes apparent. Here the discussion is further developed in order to examine and evaluate, on the basis of the nature of architectural phenomena, the two mainly different structuralist approaches (genetic structuralism and semiological structuralism). Chapters 12, 13 and 14 elaborate on the applicability of different structuralist methodologies to architecture and especially to ecoclimate and, in addition, on the terminology concerned with these approaches, through particular microclimatic and ecoclimatic examples.

Chapter 12 examines and evaluates the application of a purely semiological approach to ecoclimate by which appropriate levels of

meaning can be identified. Chapter 13 deals with a syntactic approach to microclimatic and ecoclimatic structures and examines the limitations of purely abstract descriptive bases for these phenomena. Chapter 14, based on the methodological conclusions reached in Chapters 12 and 13, develops an appropriate structural framework for ecoclimatic studies, which in this work is called syntagmatic. Chapter 15 summarizes the conclusions of this thesis and indicates directions for future research.

The discussion in this Part is supplemented by two more papers which have been produced collectively by the author and his colleagues, Awadalla, A., and Kotsiopoulos, T. These papers were published in two separate articles:

- (i) "Description and Descriptors in Architecture", Edinburgh Architectural Research, Vol.3 (E.A.R./3), 1976, and
- (ii) "Description and Descriptive Theories in Architecture", E.A.R./4, 1977.

They are included in this thesis as Appendix I and Appendix II respectively. In particular, Appendix I presents the core arguments and the methodological philosophy on the basis of which this part of the thesis has been originated. Some of the arguments in that paper, which are specifically concerned with microclimatic and ecoclimatic descriptors, have been included in the main text in the way that they have appeared in the original, while others have been further examined and developed. Appendix II, originated during the last stage of the development of this thesis, supplements both Appendix I and the methodological framework which is developed for ecoclimate in Chapter 14.

## CHAPTER 10

DESCRIPTION AND PARADIGM IN ARCHITECTURE - THE ORIGINS  
OF MICROCLIMATIC AND ECOCLIMATIC DESCRIPTORS

The question of whether or not descriptive paradigms are commonly recognized in the general field of man-environment theoretical or empirical studies and, particularly in architecture, has been answered in both ways.

A. Rapoport, reviewing a considerable number of studies concerned with the man-environment relationships and structures<sup>1</sup> concludes that these studies are characterized by a "pre-paradigmatic" stage and suggests that it is too early to accept any paradigm in this field of enquiry. On the other hand, Hillier and Leaman take the view that man-environment paradigms existed in the past and that they have been transformed into a new form today. They write:

"The meeting of these three lines of thought: the organism-environment concept in biology; the subject-object interdependence in Kant; and the resultant concept of man as the object of science constitutes the man-environment paradigm of science and meta-science pervasive in nineteenth century thinking and less so in the twentieth.... In many scientific fields today the man-environment paradigm is not so much a general theoretical idea, or even a meta-theory, but part of the mechanism of perception and understanding itself."<sup>2</sup>

1. *RAPOPORT, A., (1971), p.4.*

2. *HILLIER, B., LEAMAN, A., (1973a), p.508.*



Rapoport's concept of paradigm has been directly derived from T. Kuhn's<sup>3</sup> original concept the applicability of which to social sciences and, therefore, to architecture I shall question in a number of points. This will be discussed later in this chapter<sup>4</sup>. Hillier and Leaman's concept of paradigm goes beyond that of Kuhn and is closely related, in my view, with Foucault's<sup>5</sup> notion of "episteme". It might be useful from an abstract epistemological point of view to identify the paradoxes of this contemporary episteme but it does not give any answer to the question of the structure of the contemporary architectural descriptive paradigm.

To illustrate the above argument and to extend the discussion to cover the nature and the characteristics of a descriptive paradigm appropriate to architecture it is necessary to examine briefly Kuhn's "scientific paradigms", Foucault's "episteme" (which might be termed "epistemological paradigm") and Harvey's "social paradigm".

For Kuhn a paradigm is a set of

"universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners."<sup>6</sup>

Here the paradigm is considered as a form of maturity in the development of any given scientific field governing not only the descriptive tools themselves by which phenomena are analysed and explained, but also their problem solving capacity. This becomes obvious by considering the concept of "normal science" which is defined by Kuhn as:

3. KUHN, *Th. S.*, (1970).

4. See p. 250

5. FOUCAULT, *M.*, (1970). Refer to the discussion in p.248 of this Chapter.

6. KUHN, *Th. S.*, *op.cit.*, p.viii.

"research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the formation for its further practice."<sup>7</sup>

But the most important characteristic of Kuhn's notion of paradigm is that it describes science as a "puzzle-solving" rather than "problem-solving" activity. "Puzzles" are seen within this context as a special category of problems which serve to test ingenuity and skill in solution without questioning their social relevance or their lack of immediacy in solving practical problem situations. Kuhn emphatically stresses that:

"a paradigm can even insulate the community from those socially important problems that are not reducible to the puzzle form, because they cannot be stated in terms of the conceptual and instrumental tools the paradigm supplies."<sup>8,9</sup>

A similar attempt to Kuhn's to explain the evolution of scientific knowledge, though from a much different viewpoint, is the work of M. Foucault. Foucault's inquiry according to his own words aims,

"to rediscover on what basis knowledge and theory became possible; within what space of order knowledge was constituted; on the basis of what historical *a priori* and in the elements of what positivity, ideas could appear, sciences be established, experience be reflected in philosophies, rationalities be formed, only, perhaps to dissolve and vanish soon afterwards."<sup>10</sup>

The basic tool that Foucault employs for his analysis is the concept of "episteme" which largely but not totally corresponds to Kuhn's notion of paradigm. "Episteme" is for Foucault the epistemological field within which:

7. *Ibid.*, p.10. Here, "achievement" is used as an alternative term for "paradigm".
8. KUHN, Th. S., *op.cit.*, p.37.
9. For an extensive criticism and evaluation of Kuhn's philosophy of science, refer to LAKATOS, I., MUSGRAVE, A., (eds.), (1970). For an analysis of the nature of paradigm within Kuhn's philosophical context see MASTERMAN, M., 'The Nature of a Paradigm' in LAKATOS, I., et al., (eds.), *ibid.*, pp.59-89.
10. FOUCAULT, M., (1970), *op.cit.*, p.xxii.

"Knowledge, envisaged apart from all criteria having reference to its rational value or to its objective forms, grounds its positivity and thereby manifests a history which is not that of its growing perfection, but rather that of its conditions of possibility; in this account, what should appear are those configurations with the "space" of knowledge which have given rise to the diverse forms of empirical science."<sup>11</sup>

In his later book *'The Archaeology of Knowledge'*<sup>12</sup> Foucault gives a rather more comprehensive formulation of his concept of "episteme" by redefining it as:

"the total set of relations that unite, at a given period the discursive practices that give rise to epistemological figures, sciences, and possibly formalized systems; the way in which, in each of these discursive formations, the transitions to epistemologization, scientificity, and formalization are situated and operate; the distribution of these thresholds, which may coincide, be subordinated to one another, or be separated by shifts in time; the lateral relations that may exist between epistemological figures or sciences in so far as they belong to neighbouring, but distinct, discursive practices. The episteme is not a form of knowledge or type of rationality which, crossing the boundaries of the most varied sciences, manifests the sovereign unity of a subject, a spirit, or a period, between the sciences when one analyses them at the level of discursive regularities."<sup>13</sup>

Obviously an evaluation of the usefulness of such general concepts as "paradigm" and "episteme" within the framework of architectural and environmental sciences, to the degree that such evaluation is possible, needs to be conducted within the broader domain of facts specifically related to the construction of general theories or epistemologies of descriptive or explanatory character. Undoubtedly, the first thing that the theories of "paradigm" and "episteme" suggest

11. *Ibid.*, p. *xxii*

12. *FOUCAULT, M.*, (1972).

13. *Ibid.*, p. 191.

for theoretical architectural research is that such theories, irrespective of the degree of their rationality, are equipped with "behinds" which dominate not only their constructional phase, but also their origin itself, and that they are equipped with "beyonds", especially in terms of their problem solving capacity, which are again dominated by their paradigmatically accepted "behinds".

Within such a framework, there is, at first sight, a striking similarity between Foucault's "epistemes" and Kuhn's "paradigm" since both point out clearly that theoretical or empirical research is governed by fundamental principles in terms of its evolution and, most importantly, in terms of its practical applications. However, while Kuhn's analysis remains descriptive at the level of analysing dominant intellectual formations and intellectual crises which result in transformations from one paradigm into another, Foucault's programme, because of its structuralist ambition and if it is applied to the scale of sciences describing human practices, such as architecture, may provide methodological procedures for the evaluation of the origin of an "architectural episteme" over design and may even provide criteria for judging the validity of alternative problem situations.

Nevertheless, I do not share the view that it is productive to extend the analysis of the possibilities of applying descriptive tools like those of "scientific paradigms" and "episteme" into architectural sciences beyond the point defined by the above general remarks. Rather, I agree with Harvey's<sup>14</sup> criticism of Kuhn's theory and especially with his argument that Kuhn has abstracted scientific knowledge from its materialistic base.

14. HARVEY, D., (1975). *See, in particular, Ch.4, pp.120-128.*

According to Harvey, Kuhn provides an idealist's interpretation of scientific advancement while he (Harvey) suggests that scientific thought is fundamentally geared to material activities. A by-product of this formulation is, of course, Kuhn's concept of social sciences as being in a "pre-scientific" stage in the sense that no social science has yet established that corpus of generally accepted concepts, categories, relations and methods that form a "paradigm". Harvey's counter-argument is that the social sciences formulate concepts, categories, relationships and methods and, therefore, form paradigms which reflect the nature of science as being still in a "pre-social" stage. In this way Harvey concludes that:

"Contrary to popular opinion, therefore, it seem appropriate to conclude that the philosophy of social science is potentially much superior to that of natural science and that the eventual fusion of the two fields of study will come not through attempts to scientize social science but instead by the socialization of natural science."<sup>15</sup>

This concept of what we may call "social paradigm" as opposed to Kuhn's scientific paradigm and to Foucault's "epistemological paradigm" is much more relevant for architectural research within the broader social context of architecture. For instance, within the conceptual framework defined by this notion of "social paradigm" the open question in architecture as to whether there exists a distinction between social and institutional processes, on the one hand, and spatial or environmental form, on the other, should be regarded as an artificial one. This becomes obvious if the behinds of architectural descriptive theories and descriptors, in terms of their social and ideological input, are considered, and even more so through the criterion of "comprehensiveness" required by any descriptive theory in architecture which aims at maximizing its problem-solving capacity.

15. *Ibid.*, p.128.

Within this context the environmental images of the built environment are not just inanimate objects within which the social process unfolds: they are socio-historical objects, that is, they contain social processes in the same manner that social processes are necessarily historico-spatial. This argument may be understood better if we consider that even the most spatial architectural descriptors, for instance microclimatic, become architecturally meaningful only within a broader socio-economic and cultural context defined in this case by the ecoclimatic conceptual framework. This "socio-spatial unity" of the architectural environment has been recognized and to some degree explained in recent architectural and planning theories. The series of papers by Hillier and Leaman (1972, 1973a, 1973b, 1974a, 1974b, 1974c) form an interesting example of the theoretical and methodological work carried out at such a socio-spatial understanding of the built environment.

Similarly, Harvey's work defines social evaluation as the only comprehensive evaluation of spatial forms. He writes that:

"... the shaping of space which goes on in architecture and, therefore, in the city is symbolic of our culture, symbolic of the existing social order, symbolic of our aspirations, our needs and our fears. If, therefore, we are to evaluate the spatial form of the city we must, somehow or other, understand its creative meaning as well as its mere physical dimensions."<sup>16</sup>

Within the context of the social paradigm, description is necessarily used in its broader sense of "explanation" and in this way it is clearly distinguished from terms like predictive, prescriptive, nomothetic, or normative, in that it implies automatically both "behinds" and "beyonds" in terms of its historical evolution and its practical application. I intend to explain this general

16. *Ibid.*, p.31.



assumption by considering some epistemological positions concerned with the "observer-object" bipolar in relation to the context of design process and also in relation to architectural empirical and theoretical research. In doing so, we may understand better the nature of the ecoclimatic and the microclimatic descriptors of the built environment.

In the social sciences and the sciences of the artificial, which above all describe human practices, it is extremely difficult for the observer to consider himself excluded from the reality he investigates. The real insight of the Marxian concept of "praxis" or of Piaget's "reflective abstraction" is that the act of observing *is* the act of evaluating and to separate them is to force a distinction on human practice that does not really exist. Wiener<sup>17</sup> also, in an important effort to examine the possibilities of extending the mathematical methods of prediction to social sciences, concludes that in these sciences the coupling of the observer with the observed phenomenon is so strong that it is inevitable to consider the object as necessarily affected by the intervention of the observer<sup>18</sup>. It is easy, therefore, to imagine that even the most rational descriptive theories in social sciences are unavoidably rooted in some ideological framework<sup>19</sup> which influences both the objectives of the investigator

17. See WIENER, N., (1948).

18. *There are some serious objections to this thesis as far as comprehensive social phenomena, such as language, are concerned, especially when they are studied in the light of structural linguistics. See Lévi-Strauss' objections to Wiener's assumptions above, in: LÉVI-STRAUSS, C., (1972) (c.1958), p.56.*

19. *The term "ideology" is used, here, in the sense defined by Althusser as the "lived" relationships between man and his world where these relationships are reflected in a conscious way. Thus, "ideology" implies a particular philosophy, and it is considered, by Althusser, together with science as an "essential element of every social formation". See ALTHUSSER, L., p.252.*

and the characteristics of the phenomena being investigated. It is exactly this that makes Harvey admit the impossibility of overcoming the difficulty of constructing a general urban theory:

"There are, it seems, far too many ideological positions to be defended, too many intriguing speculations to be followed up, too many investigators, and too many contexts in which urban phenomena may be encountered, for a general theory of urbanism to emerge easily."<sup>20</sup>

In this context descriptive theories concerned with comprehensive description of human practices, such as architecture, are characteristically concerned with some form of "theoretical-practice"<sup>21</sup> within which dualisms such as "man-nature", "fact-value", "subject-object", "mind-body", "thought-action" can be resolved in a productive manner. And it is especially in this framework of "theoretical-practice" that descriptive theories are equipped with "behinds" and "beyonds" in a dynamic manner described by A. Gramsci. He writes:

"The discovery that the relations between the social and the natural orders are mediated by work, by man's theoretical and practical activity, creates the first elements of an intuition of the world free from all magic and superstition. It provides a basis for the subsequent development of an historical, dialectical conception of the world, which understands movement and change, which appreciates the sum of effort and sacrifice which the present has cost the past and which the future is costing the present, and which conceives the contemporary world as a synthesis of the past, of all past generations, which projects itself into the future."<sup>22</sup>

20. HARVEY, D., *op.cit.*, p.196.

21. The term "theoretical-practice" has been introduced by Althusser in an attempt to stress the distinction between science and ideology. Althusser insists that, beyond economic, political and ideological practices, theory constitutes a fourth practice which he calls "theoretical-practice", and which transforms ideology into knowledge with theory. See ALTHUSSER, L., *op.cit.*, pp.164-175. For an application of this concept to the construction of a methodological framework for the explanation of multi-disciplinary environmental structures, such as cities, see: HARVEY, D., *op.cit.*, and particularly p.12.

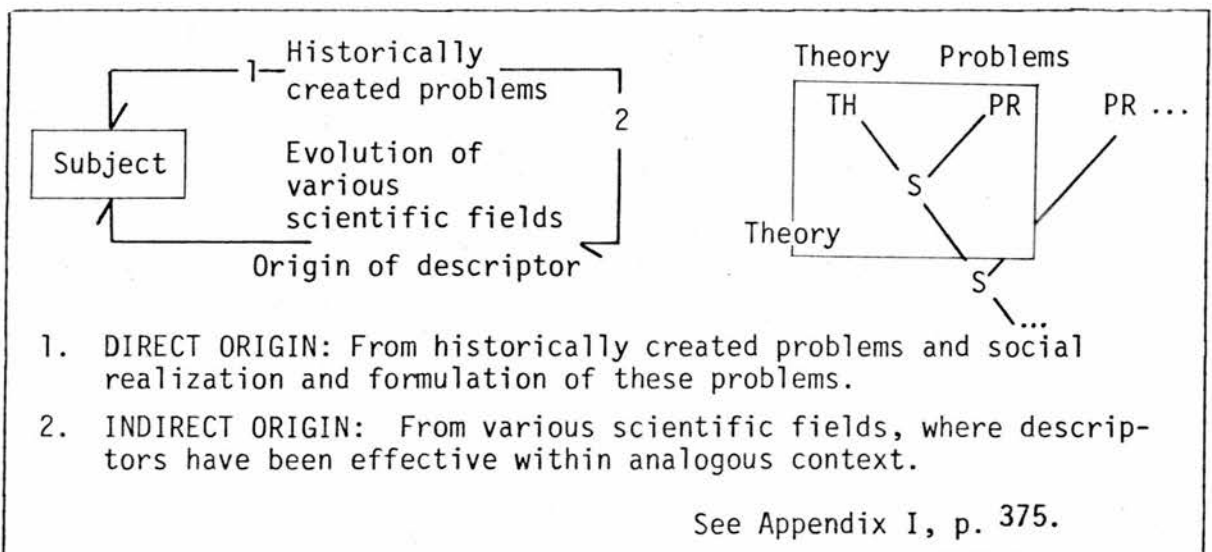
22. GRAMSCI, A., (1971).

Within the field of environmental studies there is much evidence that the cultural and mental set of the observer affects to a great extent the construction of prototypes through perception, archetypes and schemata<sup>23</sup>. Such pre-structured behinds necessarily govern both research and design in architecture though most of the time unconsciously. Thus, it has been argued that:

"unless research can influence designers at the stage of pre-structuring the problem in order to understand it, then its influence on design will remain limited."<sup>24</sup>

What I should add to the above remark is that it is on a descriptive basis that research could restructure the behinds of its own methodologies and of the design process, especially when the concept of description takes the dynamic form of explanation.

Within the framework defined by the epistemological context of the social paradigm, which was discussed above, and the dialectics between research and design, the origin of architectural descriptors, in general, and microclimatic and ecoclimatic ones, in particular, are derived historically according to the following general model:



23. For a general formulation of this argument see ABERCROMBIE, M.L.J., 'Perception and Construction', in BROADBENT G., WARD, A., (eds.), (1969), pp.118-127. See also by the same author, *The Anatomy of Judgement*, Penguin, 1960, for a more thorough investigation of the concept of "schema".

24. See HILLIER, B., MUSGROVE, J., O'SULLIVAN, P., (1971), p.18.

The historical origin of microclimatic and ecolimatic descriptors has been explained in detail in Ch.2, where I discussed the ecoclimatic conceptualization of the built-environment in a historical perspective. A major conclusion there was that man in history has always conceived and described the influences of the physical environment on him and his structures in ecoclimatic terms, that is, by internalizing complex prototypes in the structure of which social, economic, religious and physical (together with climatic) aspects have been integrated and, furthermore, that this internalization of ecoclimatic prototypes has been reflected clearly in both the descriptors and the processes by which man organized his habitat<sup>25</sup>. An additional conclusion of that chapter was that these ecoclimatic prototypes have been generated and transformed, not only in respect to the particular climatic or microclimatic conditions and the changes produced by them in the development and evolution of human settlements, but also in respect to the general socio-economic problem-situations which have affected man's attitudes towards nature and towards his fellow-men.

By considering additionally the behinds of comfort research it became obvious that the Industrial Revolution constitutes the background within which descriptors of comfort have emerged and have gradually been emphasized. But it also became obvious that what led to the emphasis of microclimatic and ecoclimatic descriptors - apart from the obvious effects of urbanization and industrialization, such as pollution and energy conservation, was the formalization of "comfort" as a commodity<sup>26</sup>. In order to explain the reasons for such a formalization, we have argued in Appendix I that:

25. See Conclusion in Chapter 2, Part I, of this thesis.

26. Refer to the "behinds" of comfort research in Part III, pp.214-219.

"What happened, however, after the Industrial Revolution and the technological advance of systems by which comfort may be achieved, is that comfort has been included in the course that Mandel described as 'a system for constantly extending needs'. He wrote: 'The system must provoke continued artificial dissatisfaction in human beings because without that dissatisfaction the sales of new gadgets which are more and more divorced from genuine human needs cannot be increased.'<sup>27</sup> It is very characteristic that P. O'Sullivan proposed the term 'lack of discomfort'<sup>28</sup> in order to identify the subjectivity of the concept. This subjectivity is not only due to the inadequacies of psychological or other scientific tools to identify it, but is also due to the recent function of comfort as something which one could buy and sell and which is consequently subject to the unstable character of market forces."<sup>29</sup>

The indirect reasons for the origin of the microclimatic and ecoclimatic descriptors which are presently used and which originated primarily in other scientific fields, have been discussed in the first chapter of this thesis and they are briefly summarized here.

The establishment of microclimatology by Geiger in the mid-20s, the development of climatology especially in the period after World War II, beyond its purely descriptive base, and the emphasis attached to problems like adaptation, acclimatization, etc. in both man and machine, constitute probably the most basic influences upon the establishment and development of other scientific fields which have more directly influenced microclimatic and ecoclimatic descriptors in architecture. Such sciences are, for instance, bioclimatology - developed particularly by Tromp in Holland since 1956; forecasting climatology - especially developed in the 60s; economic climatology - developed in the 60s but more importantly by Maunder in 1970 who brought together economic, social and atmospheric considerations in an attempt to put an economic value on climate and on weather; and psycho-climatology - developed in the 60s but particularly for

27. MANDEL, E., (1974), p.25.

28. O'SULLIVAN, P.E., (1972).

29. See Appendix I, pp. 375-76.

architecture in the early 70s.

Microclimatic and ecoclimatic descriptors, therefore, due to the historical character of their origin, are equipped with "behinds". But in order to understand their "beyonds" it is necessary to consider the relationship between "descriptor" and "descriptive theory". Again, in Appendix I we have argued that:

"Descriptors are the components of descriptive theories. In other words constitute the basis according to which a description may be implemented. A descriptive theory may consist of either one predominant descriptor which is being considered as the most predominant one, or a set of descriptors which supplement each other in a structural way within the framework of a descriptive theory. Comprehensiveness, therefore, emerges as one basic property of descriptive theories. However, comprehensiveness is not a property that a descriptive theory may technically acquire only by combining descriptors in isolation from both its historical and its structural context."<sup>30</sup>

Within this context it is obvious that a descriptive theory for microclimate and ecoclimate has to consider very carefully the methodological implications which derive from their basic property of comprehensiveness. The discussion which follows deals with these implications from both methodological and terminological point of view, and suggests that the "beyonds" of descriptive theories are evaluated through the problem solving capacity of description determined by systems of social evaluation.

30. *Ibid.*, p. 373



## CHAPTER 11

## STRUCTURALISM AND COMPREHENSIVE DESCRIPTION OF ECOCLIMATIC PHENOMENA

This chapter describes the search for a general methodological strategy on the basis of which the development of a comprehensive descriptive approach to the ecoclimatic problems of the built environment could be carried out. A conceptual base appropriate for the present discussion has already been established in the collective paper appearing in this thesis as Appendix I. There the starting point of our discussion has been a preliminary definition of the concepts of "environment", "built environment" and "comprehensiveness". In particular, we have argued:

1. "Environment" has been considered, especially in ecological terms, as the aggregate of external conditions that influence the life of an individual or of a population of organisms. "Built environment", on the other hand, implies the particular impact of man on modifying the natural environment of a specific place and producing what is generally known as "human settlement". In this sense then, built environment might be defined either as a totality of natural and artificial components or as a set of elementary actions consisting of modifications of natural space transformed into logically higher forms. Accordingly, "ecoclimate" and "microclimate" being components of the built environment, can similarly be defined in either way.

2. These two different ways of defining the environmental object introduce two distinct approaches to the characteristic of wholeness which has been attributed to the built environment or to certain components of it, in current descriptive theories in architecture. The first approach reflects the trend in architectural theories which is borrowed from a general tendency in modern sciences and well developed by Bertalanffy<sup>1</sup>; that is, to approach the notion of wholeness and consequently comprehensiveness from a "systemic" view. Here, comprehensiveness is inevitably accompanied by continuously increasing complexity which places limits on the degree of wholeness which might be achieved. The second approach reflects the present "structuralist" thinking which is also an approach to problems of wholes. However, it does so by trying at the same time to reduce complexity by using the most elementary operations, together with transformational rules which lead to higher structures in order to attain comprehensiveness with simplicity.

The notion of wholeness, that both systems theory and structuralism are aiming at, refers not only to the notion of totality but most significantly to the bridging of the gap between physical sciences and social sciences. Laszlo, for instance, has argued that:

"... there have been methodological and conceptual developments in the sciences in the last two decades which permit a bridging of the gap between nature and society without either reducing the one to the other, or infusing it with characteristics foreign to itself. I am referring to the concepts and methods of *systems theory* in America and *structuralism* on the Continent. These are sophisticated theoretical frameworks which do not pretend to simply describe observable phenomena and to penetrate their essence. Rather, they build models of certain perspectival forces of phenomena and hold up the models for investigation and comparison. They seek the unity of science, and by implication of nature, in the isomorphism, or structural analogies, of the models themselves."<sup>2</sup> (my emphasis)

1. BERTALANFFY, L., -von, (1973)
2. LASZLO, E., (1971).

The work of von Bertalanffy<sup>3</sup> in system analysis and of Wiener<sup>4</sup> in cybernetics has pointed to the idea that, in very complex organizations like those appearing in the built environment, the investigator needs a holistic methodological tool which can be provided by the general systems theory. General systems theory, then, is an attempt to formulate a set of concepts, mathematical or cybernetical, through which the behaviour of a given reality can be holistically described and predicted. A major assumption behind this theory is that from the identification of the parts of a system and the relations among them, the identification of the behaviour of the total system is possible. According to von-Bertalanffy:

"If, however, we know the total of parts contained in a system and the relations between them, the behaviour of the system may be derived from the behaviour of the parts."<sup>5</sup>

Thus, Bertalanffy defines mathematically the concept of system as follows:

$$\frac{dQ_1}{dt} = f_1 (Q_1, Q_2 \dots Q_n)$$

$$\frac{dQ_2}{dt} = f_2 (Q_1, Q_2 \dots Q_n)$$

$$\frac{dQ_n}{dt} = f_n (Q_1, Q_2 \dots Q_n) \quad ^6$$

so that change of any measure  $Q_i$  is a function of all  $Q$ 's and, conversely, change in any  $Q_i$  entails change of all other measures and of the system as a whole.

3. BERTALANFFY, *op.cit.*

4. WIENER, N., (1948).

5. BERTALANFFY, *op.cit.*, p.54.

6. *Ibid.*, p.55.

In many cases, where comprehensiveness can be attained by an analytical examination of a small number of parameters, the systemic approach is a useful methodological tool, and sometimes an inevitable one. However, at higher levels of complexity, such as those defined by the descriptive domain of comprehensive architectural phenomena, wholeness can only be attained through appropriate abstraction, as we have already noticed in the case of ecoclimatic phenomena (Part II). Moreover, the type of abstraction required is not the one provided by the systemic mode of thinking.

According to Piaget, wholeness can be attained genetically by "reflective abstraction". In the systemic mode of thought a property can be derived by being drawn out of things through abstraction. In the structural mode of thought properties are derived from the way in which we act on things (reflective abstraction)<sup>7</sup>. It is quite natural to expect description in architecture - dealing particularly as other sciences of the artificial do, with the results of human actions - to be more amenable to reflective abstraction than to the systemic way of thinking.

I have already argued<sup>8</sup> that the study of "climate-architecture" interaction - and in extension of "physical environment-architecture" interaction - can only be studied adequately in a general methodological framework within which integrated "anthropocentric" approaches to the various climatic problems of the built environment can be organized. One of the major reasons why structuralism becomes an appropriate methodological framework for describing comprehensively architectural phenomena is that through reflective

7. *PIAGET, J., (1971), p.19.*

8. *See Introduction, p. 6.*

abstraction description becomes anthropocentric and consequently historically created. It is this point which has made many authors, including Piaget, to conceive reflective abstraction in close connection with the Marxian concept of "praxis"<sup>9</sup>. This reciprocity between structuralism and historical explanation, that is history explained structurally - as Marx did - and structuralism explained historically - as Piaget points out - reflects the methodological coherence of the proposed model of the origin of architectural and ecoclimatic descriptors presented earlier in p. 255

Furthermore, as it is argued in Appendix I, this reciprocity between structuralism and historical explanation accounts for the way in which elementary structures may be formed, and implies that abstraction is without any importance if it is not to solve the problems that have produced it.

Let us now turn into the discussion of the concept of structure. The argument in Appendix II has been that:

1. The term 'structure' has been defined and used in different disciplines in a variety of different ways, thus one could hardly expect any common interpretation of what this term is supposed to represent. The ambiguity of the term is evident in the method of structuralism, in spite of the efforts of well-known structuralists<sup>10</sup> to define it. Furthermore, in architecture, the term structure has gradually acquired a polysemic meaning, the complexity of which makes its use quite ambiguous. The traditional meaning and use of the term associates the concept of structure
9. Refer to footnote (9) in Appendix I, p. 379.
10. For instance, PIAGET, J., (1971), *op.cit.*, and in his *Main Trends in Interdisciplinary Research*, (1973), and also, LÉVI-STRAUSS, C., (1972).

either with the loadbearing parts of a building or, in a more general sense, with anything built by man from a house to a pyramid<sup>11</sup>. An "imported" use of the term structure, influenced by the development of structuralist thinking in other conceptual domains, associates structure with a number of other concepts like "system", "whole" and "coherence".

2. As it is the case with the general epistemological use of the term structure<sup>12</sup>, its imported use in architecture is not clear, and consequently the conditions of its application to a given reality are not well understood. The multiplicity of connotations attributed to it sheds doubt on both the existence of a single definition and a single methodological orientation which could be termed "structuralist". This leads to the conceptual confusion surrounding the use of the term in general epistemology and in architecture.
3. The differentiations in the use of the term might be considered as taking place by the different values applied to it according to two major semantic bases: (i) The conditions under which a structure can be applied as such. For Piaget, for instance, conditions of 'wholeness', 'transformation' and 'self-regulation' are applied to define 'structure' as a system of transformations under some well defined transformational rules<sup>13</sup>. Two extreme examples according to this basis may be given; the mathematical group which Piaget considers as the finest prototype of his

11. See, *The Dictionary of Building*, Penguin, 1964.

12. For an extensive discussion on the definition of "Structure" see BOUDON, R., (1971). See, also, PETTIT, Ph., (1975).

13. PIAGET (1971), *op.cit.*, p.5 and (1973), *op.cit.*, p.8.



definition of structure and, a concept in general use, the "social structure" where no such formal conditions may necessarily be applied<sup>15</sup>. (ii) The degree of abstraction applied to a certain reality which is necessary in order to understand a structure. This basis leads automatically to the syntactic components of the "deep structure" and it is identical in its practical application to the Chomskian linguistic model of grammar<sup>16</sup>. According to this basis, structures are to be identified either at the abstract level of deep structure<sup>17</sup> or, alternatively, at a surface level of the observable reality. One attitude identifies a structure at a surface level under the conditions that there is a deep level which itself only is the structure, while a second attitude accepts the deep level analysis as inevitable without imposing conditions to identify the structure at a surface level.

4. It will gradually become apparent that there is no objective way of imposing any conditions upon the definition of the concept of structure in explaining a particular set of architectural realities. The structural identity of a set of architectural phenomena cannot derive from any predefined set of conditions but it is strongly implied in some cases by the environmental image of the reality under investigation (e.g. a neighbourhood as a structure), and in others by the institutional image (e.g.
15. *"Social Structure" even considered in its broader sense may well depend upon higher structures, for instance, like those of "roles" and "character structure". For an explanation of this dependence see GERTH, H., MILLS, C.W., (1954).*
  16. *See Appendix I, pp. 393-94.*
  17. *Compare with the concept of "space syntax" in, HILLIER, B., LEAMAN, A., STANSALL, P., BEDFORD, M., (1976).*

a hospital as a structure) and by more complex images (e.g. ecoclimatic environment as a structure)<sup>18</sup>.

Before we start to examine the conditions and the particular structural framework within which microclimatic and ecoclimatic structures can be identified and described comprehensively, it is necessary to consider some well-developed structuralistic movements and, in doing so, to introduce the basic terminology which they use. These terminologies and the conceptual frameworks underlying them will be explained and further developed through microclimatic, ecoclimatic and other architectural examples, in an effort to evaluate the applicability of structuralism in the study of the ecoclimatic problems of the built environment. This explanation is mainly given in the last four Chapters of this Part, supplemented by Appendices I and II.

#### Genetic and semiological structuralism

Piaget's "Genetic Structuralism" is a method of inquiry based on the concepts of wholeness, self-regulation and transformation, common not only to linguistics and anthropology where it has been developed primarily, but also to mathematics, physics, biology, philosophy, the social sciences and so forth. Piaget defines structure as a system of transformations. He argues:

"Inasmuch as it (the structure) is a system and not a mere collection of elements and their properties, these transformations involve laws: the structure is preserved or enriched by the interplay of its transformation laws which never yield results external to the system nor employ elements that are external to it. In short, the notion of structure is comprised of three key ideas: the idea of wholeness, the idea of transformation, and the idea of self-regulation."<sup>19</sup>

18. *For an extensive discussion of the descriptive importance of the different images of an environmental structure refer to the discussion in Appendix II.*
19. *PIAGET (1971), op.cit. p.5.*

The "wholeness" of the structure appears to be due to the fact that the structural laws are referred to the total structure and that they, therefore, add to the structure properties which are different from the properties of its elements. The "transformability" of the structure is supported by evidence that all the known general structures are systems of transformations, either synchronic (e.g. logical and mathematical structures) or diachronic (e.g. linguistic, psychological, sociological structures). Finally, the "self-regulating" characteristic of a structure means the maintenance of the structure inside certain limits. Transformations never move out of these limits but they produce elements which belong to the structure and which are, therefore, subordinated to the same structural laws by which they have been produced. In this way the structural stability of the structure is maintained while it is transformed to higher levels of logical complexity.

"Semiological Structuralism" is another type of structuralism developed especially in Saussurian linguistics and in the anthropology of Lévi-Strauss. Its development has followed very closely the assumption that theories of structural linguistics are directly or indirectly applicable to all aspects of human culture insofar as all of these may be interpreted, like language, as systems of signs<sup>20</sup>. This way of thinking, in turn, presupposes the adoption of semiotic dimensions in these systems of human culture. This type of structuralism adopts a quite distinct body of thought but accepts all the principles of Piaget's genetic structuralism. Piaget's later work<sup>21</sup>, however, has also been expanded to this type of structuralism

20. See ROBEY, D., (ed.), 1973.

21. PIAGET (1973), *op.cit.*

which can investigate interdisciplinary problems of the broadest kind.

A detailed discussion of some terminological and methodological aspects concerned with a semiological analysis of ecoclimate is given in the following chapters. There, both the advantages and the limitations of purely semiological analysis are examined as far as complex architectural and ecoclimatic phenomena are considered although emphasis has been given in the terminology concerned.

At present there is a tendency to formulate descriptive theories in architecture using semiological structuralism as a methodological background<sup>22</sup>. Chapters 12 and 13 argue for the acceptance of this approach, not because architecture or even ecoclimate can be described and explained comprehensively by semiology, but because of the following reasons which were the major conclusions to these chapters. First, because semiological structuralism makes possible the generation of the notion of meaning which is crucial to ecoclimatic description, particularly in its higher form of "social" evaluation. Secondly, because semiological structuralism indicates the levels of complexity at which the ecoclimatic organization of the built environment forms structural solidarities where social evaluation is generated. Thirdly, because there is a level at which the methodological advantages of both genetic (general and abstract) and semiological (analytical but socially meaningful) approaches may be obtained. We have called this level syntagmatic. The main aim of the following chapters in this part of the work, supplemented by the two appendices, is to show how this level is generated in architecture and particularly in ecoclimate. This necessitates a much closer investigation of both semiological and genetic (or syntactic) structuralism to describe comprehensively the ecoclimatic phenomena of the built environment.

22. See, for example, JENCKS, C., BAIRD, G., (eds.), (1969).

## CHAPTER 12

## SEMIOLOGICAL ANALYSIS OF ECOCLIMATIC PHENOMENA

The general importance of considering the built environment as a "source of learning" has already been stressed earlier in this work, together with the general implications of doing so, which are concerned with the perceptual organization of this environment especially from the point of view of its production. Similarly, we have also considered the significance of studying the ecoclimatic environment within the conceptual domain suggested by the notion of built environment as a "source of learning" by considering it as a major component of this source.

A proper methodological framework in which such "sources of learning" can be analysed is provided by the semiology which originated in Saussurian linguistics<sup>1</sup> and in the philosophy of Peirce<sup>2</sup> and was further developed in the anthropology of Lévi-Strauss<sup>3</sup> and E. Leach<sup>4</sup>.

1. SAUSSURE, F.de, (1974).
2. See PEIRCE, C.S., (1940). A good summary and a further development of Peirce philosophy is presented by MORRIS, C.W., in his famous "Signs, Language and Behavior", (1946). See also MORRIS, C.W., (1970).
3. LÉVI-STRAUSS, C., (1972, c.1962). See, especially, Chapter II, IV and XI.
4. LEACH, E., (1976). See also his paper, "Structuralism in Social Anthropology", in ROBEY, D., (ed.), (1973), pp.37-56.

Within this semiological framework ecoclimate can be defined as a system of "signs" on the assumption that ecoclimate includes the "signified" aspects of some "signifiers". In other words the ecoclimatic phenomena have a communicative function (as one might have already expected from the way in which these phenomena have been described in this work). On p. 52 I argued:

"Ecoclimatic phenomena, on the other hand, are considered to be those concerned with the semantics of the physical fields of climate and microclimate, that is, with the human perception, understanding and evaluation of the climatic conditions of the built environment. These phenomena, therefore, cannot be defined by their microclimatic characteristics alone and they are not describable in a purely climatological and meteorological language, but only *within a much broader conceptual framework* where the processes of producing the architectural environment together with the semantic dimensions of the climate of the built environment are taken into account."

In this discussion I shall introduce some basic terminology concerned with a semiological interpretation of ecoclimatic phenomena and, also, evaluate the applicability of a purely semiological language to the explanation of the ecoclimatic organization of the built environment. However, it is inevitable that this discussion should start by introducing some semiological concepts originated in linguistics and anthropology upon both of which all known semiological systems have been based.

In general, semiology defines "sign" as a stimulus (or perceptible substance) the mental image of which is associated with that of another stimulus, with a view to communication. According to Saussure, the linguistic sign links a concept and a sound-image where the concept corresponds to the signified [*signifié*] aspect of the sign and the sound-image to the signifier [*signifiant*] aspect of it<sup>5</sup>.

5. SAUSSURE, *op.cit.*, p.67.



Signs have also been defined outside language (non-linguistic signs), the linguistic signs being only part of the total sign-system existing in society<sup>6</sup>. According to Lévi-Strauss:

"Signs can be defined as a link between images and concepts where images and concepts play the part of the signifying and the signified respectively."

Signs for Lévi-Strauss resemble images in being concrete entities, but they also resemble concepts in their power of reference<sup>7</sup>. An even more general definition of sign is given by C.S. Peirce who points out that a sign can be defined:

"as anything which determines something else (its interpretant) to refer to an object to which itself refers ... in the same way, the interpretant becoming in turn a sign, and so on ad infinitum."<sup>8</sup>

The "interpretant" as Eco suggests, plays the role of the sign again in order to make the world of unlimited semiosis progress in a sort of "spiral movement" by which actual objects are understood after being transformed into significant forms<sup>9</sup>.

This unlimited permutability of signs proposed by Peirce and Eco has been questioned. Lévi-Strauss, for instance, although he accepts the permutation function of signs, establishes certain operational limits beyond which signs are not permutable. In doing so, he suggests that signs are capable of standing in successive relations with other entities of a limited number and only under the condition that they always form a system in which an alteration which affects one element automatically affects all the others<sup>10</sup>.

6. See for instance, ROBEY, *op.cit.*, and GUIRAUD, P., (1975).

7. LÉVI-STRAUSS, C., (1972, c.1962).

8. Referred to by ECO, U., 'Social Life as a Sign System', in ROBEY, (ed.), *op.cit.*, p.71.

9. *Ibid.*

10. LÉVI STRAUSS, 1972b., p.20.

Permutability is the specific characteristic which differentiates signs from signals and symbols and by which the sign acquires its "connotative" meaning. This does not prevent the sign from performing a signalling function, but this happens only at the level of denotation, where signals can be conceived as signs. Relations, therefore, of the type "signifier-signified" are also introduced by signals and these represent, according to Piaget, the type of meaning which is observable in children around the age of twelve to sixteen months old (Piaget's sensory motor level), but which also accompanies man throughout his life-time. Piaget further suggests that the transformation of signal-to-sign is possible *only when social significance* is attached to its signified aspect and he, therefore, defines the semiotic function as that function of signs by which the signified is evoked in the absence of any immediate perceptive stimulus<sup>11</sup>. Thus, the evolution of signs from denotative to connotative levels of meaning is the most significant characteristic of the semiotic function because it suggests that in sign-systems of higher complexity (e.g. architectural or ecoclimatic), meaning is involved in the form of "social evaluation".

The ecoclimatic sign, like the linguistic one, consists of a signifier and a signified aspect, both of which have their own substance and form. The substance of the ecoclimatic signifier is always material (e.g. microclimatic physical fields or a given space with familiar climatic conditions) while the substance of the signified may be a concept or an idea or a particular sensation (e.g. fear of catching a cold, comfort, a particular activity for compensation of unfavourable microclimatic conditions, a particular strategy physiological, psychological or behavioural to counter-

11. PIAGET, J., (1973).

balance the climatic situation at hand. The form of the ecoclimatic sign, on the other hand, is defined by the way in which it participates in a defined ecoclimatic semiological system. I will return later to this question of the form of the ecoclimatic sign after examining in more detail the nature of the ecoclimatic semiological system as a whole.

Semiological analyses based on realities of the artificial environment or components of it (e.g. built environment or ecoclimatic environment) which have the particular objective of describing the processes by which these realities are produced, have to be carried out at two levels: (i) a conceptual level and (ii) a design orientated level.

The "conceptual level" presupposes the existence of a physical space together with the participating activities and the social space it contains. This realization gives rise to the emergence of particular sets of signs the evolution of which, from denotative to connotative signifieds, forms the major objective at this level of analysis which is, obviously, of a descriptive character. In the case of ecoclimatic semiological systems, the question of the different levels in which the evolutionary chains of ecoclimatic signs may be studied is of utmost significance, especially from a descriptive point of view. As far as the signified aspect of the ecoclimatic sign is concerned, evolutionary chains can be performed at physiological, psychological and behavioural or activity levels. For instance, a microclimatic signifier could induce a physiological readjustment, a psychological reaction, or an activity; in each case a stimulus-response fashion.

However, it is the permutability of ecoclimatic signs which gives rise to the different forms which may be identified in an ecoclimatic system. Ecoclimatic signs may be transformed from an environmental image to an activity one or even at higher levels of organization to a social or an institutional image. For instance, a set of microclimatic conditions may correspond semiologically to a particular organization of activity and this correspondence may give rise to particular cultural or social arrangements which articulate further this correspondence. In this way the ecoclimatic semiotic function acquires its "social signification" and transfers the purely communicative meaning of ecoclimatic signs (observed at the lower physiological and psychological levels) into the more pragmatic meaning which in this work has been called "social evaluation".

The second level which a semiological analysis of an artificial system has to consider is what it has been called above, "design-orientated level". Here, the analysis is concerned with the physical space itself, from the point of view of its production through the preconceptions of its designers. I have already argued that the ecoclimatic conceptualization of the built environment means the internalization of complex prototypes in the structure of which climatic, physical, socio-economic and cultural aspects have been integrated. In this way ecoclimatic prototypes reflect the complex processes by which the climatic environment of the habitat is internalized by the individual or the social group<sup>12</sup>. These arguments, reached earlier through a historical study presented in the first part of this thesis, can be supported by the present semiological

12. Refer to the conclusions of Ch.2, Part I.

analysis of ecoclimate. It is quite obvious that since the production of an artifact of high complexity, such as the human habitat, takes place in a historically created process, the ecoclimatic signs participate in this process by means of totalities which are already structured at the higher levels of their evolution. Thus, the ecoclimatic prototypes always include not only the environmental and the activity image of the ecoclimatic phenomena, but most importantly their socio-cultural and economic images. The last are undoubtedly the structuring mechanism of the other two, since they include the social signification of these prototypes.

Although the "design orientated level" is unquestionably interesting from a semiological point of view, it is at the "conceptual level" that the descriptive and explanatory capacity of the semiological method can be examined and evaluated, because it includes the study of the methodological mechanisms which may be adopted for design-orientated studies. This study, therefore, with its interest in the descriptive and terminological characteristics of these semiological mechanisms, confines itself to the "conceptual level". The design-orientated level is only studied in terms of its methodological implication to the present semiological analysis of ecoclimate.

The form of the ecoclimatic sign is generated by two different relationships. First the relationship between the signifier and the signified which is called "mode of modification", and second, the relationship of the sign itself to its meaning which is called "mode of signification".

The ecoclimatic mode of modification can be either motivated or

conventional (arbitrary). Motivation<sup>13</sup> is a natural relation between signifier and signified, such as those, for instance, between temperature fluctuations and thermoregulatory responses. Motivation does not exclude convention but the more motivated a sign is the less conventional and vice-versa. For instance, physiological reactions to climate are much more motivational and less conventional, while psychological reactions are more conventional and less motivated. On the same basis Piaget distinguishes between "biological signalling" and "semeiotic function"<sup>14</sup>, but he goes further to distinguish between two different levels in which the semiotic function operates. The level in which a motivated relationship exists between signifier and signified and which is of symbolic nature and of individual character, and the level in which signs are highly conventional and are dependent on social or educational transmission and thus depend upon the whole society rather than upon individual reaction. We may understand here that it is at this level that ecoclimatic meaning acquires its broader value of social evaluation just as the linguistic meaning, as Piaget argues, acquires its broader communicative evaluation which is to be found at the level of the articulated language<sup>15</sup>.

The mode of signification distinguishes ecoclimatic signs in terms of those which are of a predominantly denotative meaning and those of a predominantly connotative meaning. The bipolar connotation-denotation is the semiological expression of

13. *The term "motivation" has strong psychological connotations. However, the term has been introduced to semiology by Saussure to denote signs which are not absolutely arbitrary. See SAUSSURE, F.de., op.cit. pp.131-134 and GUIRAUD, P., op.cit., pp.25-*
14. *The term "semiosis" is spelled by some writers as "semeiosis".*
15. *PIAGET, J., (1973), op.cit., pp.53-54.*



the fundamental bipolarity of subjectivity-objectivity, the importance of which in describing architectural phenomena has already been stressed in Part II of this thesis. Furthermore, it appears that motivated ecoclimatic signs acquire predominantly denotative meaning (e.g. in the case of biological signalling) while conventional ecoclimatic signs, due to the social character of semiotic function and the subjective values attached to the different systems of social evaluation, acquire strong connotations.

So far I have tried to present some terminological issues of a semiological interpretation of ecoclimate and to examine the nature and the characteristics of the ecoclimatic sign through "imported" knowledge from other semiological systems, predominantly, but not entirely, of linguistic origin. Apart from discussing terminology I have attempted to define the methodological requirements which are necessary in the study of ecoclimate from a semiological point of view. A first requirement is the study of the ecoclimatic semiological system at the descriptive "conceptual level". There, semantic considerations have revealed the different types of meaning which are generated in the different levels of analysis of this system. A second and probably more important requirement is the study of ecoclimatic semantics at the higher level of social evaluation which, in turn, requires the study of the ecoclimatic sign at the higher levels of its semiological evolution where it acquires its social signification and, thereby, its structural identity.

It is the questions of structural identity of the ecoclimatic organization of the built environment which, in particular, are of greatest significance for describing ecoclimatic phenomena and - at

a design level - for their participation in the general processes of the production of the built environment. However, as might have become apparent, the semiological method is too analytical to deal with complexities defined at the higher levels of ecoclimatic organization. I have already argued<sup>16</sup> that appropriate levels of abstraction are necessary for any comprehensive description concerned with the identification and the dynamics of structured ecoclimatic realities like those, for instance, of the ecoclimatic prototypes. Nevertheless, what seems to be possible is to show, even using an analytical semiological language, that social evaluation is attached to ecoclimatic signs after they have been transformed into what might be called "structural solidarities". The discussion which follows deals precisely with questions of ecoclimatic structural solidarities and formulates a first step towards the structural identity of ecoclimatic structures.

Semiological structuralism predominantly assumes that meaning requires structure and:

"claims to provide a framework for organizing any 'semiological' study, any study concerned with the production and perception of 'meaning'. It derives the framework from linguistics, the primary semiological discipline, and extends it to the analysis of the literary arts, the analysis of the non-literary arts and the analysis, in social psychology and social anthropology, of 'customary arts'."<sup>17</sup>

De Saussure defines the linguistic sign at the level of word but accepts that the minimum viable meaning generated in language is to be found in the combinations of these signs (words) which form sentences. These combinations are for Saussure systematic and at proper levels of abstraction (the level of "langue" for Saussure and

16. See pp. 262-

17. PETTIT, Ph., (1975), *preface*.

the level of linguistic "competence" for Chomsky) constitute the raw material out of which the linguistic structure is identified and acquires its communicative value. Thus, for Saussure, the linguistic sign is transformed to higher levels of structural solidarity in which meaning becomes possible through two primarily different sets of relationships by which it is associated with other linguistic signs. These are the 'paradigmatic' and the 'syntagmatic' relationships by which the linguistic sign acquires its form when participating in a linguistic system of signs<sup>18</sup>.

The syntagmatic relationships of a word are those it has with words which can occur in its neighbourhood in a sentence. Saussure argues that words connected with syntagmatic relationships form "syntagms" the structure of which is essential to understand and define the meaning of the words which occur in them<sup>19</sup>. The paradigmatic relationships of a word are less clearly defined by Saussure than the syntagmatic. These are relationships that a word has with other words which may replace it in some sentence without making the sentence syntagmatically unacceptable. J. Lyons has expressed the syntagmatic and paradigmatic relationships in a more generalized form arguing that the syntagmatic relations which an "element" contracts (to use Lyons' term) are those which derive from its combination with preceding and following elements of the same level, while paradigmatic relations contracted by an element are those which hold between the actually occurring element and other elements of the same level which might have occurred in its place<sup>20</sup>.

18. SAUSSURE, F., *de, op.cit.*, pp.123-34.

19. *Ibid.*, p.23.

20. LYONS, J., 'Structuralism and Linguistics', in ROBEY, D., (ed.), *op.cit.*, p.12.

Meaning, therefore, is generated in the linguistic system only at the level of its syntagmatic formulation, that is, in structural solidarities formed by signs through a set of systemic relationships. However, the distinction between "syntagm" and "sentence" should be clarified if the importance and the generality of the concept of syntagm is to be understood. Syntagm is defined by Saussure as the combination of consecutive units supported by linearity<sup>21</sup>. Thus, syntagmatic formations, though predominantly found at the level of sentence, also apply to compounds, derivatives, phrases and even to combinations of sentences, that is to combinations of words of any degree of complexity. Accordingly, the most important feature of the Saussurian notion of syntagm is that the whole system of signs has a value only through its parts and the particular relationships they hold to each other and, moreover, these parts acquire their value by virtue of their places in the whole system. Thus, syntagms form what Saussure called "syntagmatic solidarities" in the linguistic system, by which the communicative value of language is generated:

"Language is a system of interdependent terms in which the value of each term results solely from the simultaneous presence of the others."<sup>22</sup>

Pettit argues that the study of language can follow two distinct approaches; the paradigmatic approach and the syntagmatic approach<sup>23</sup>. The syntagmatic approach which involves the idea of "syntax" is the approach adopted by Chomsky in developing his generative grammar. The assumption behind this approach is that it is possible to formulate recursive rules which would constitute a

21. SAUSSURE, F., *de, op.cit.*, p.123.

22. *Ibid.*, p.114.

23. PETTIT, Ph., *op.cit.*, p.11.

"generative grammar" or "syntax" by means of which any sentence of the language - and only a sentence of the language - can be given an abstract structural description<sup>24</sup>.

Chomsky's linguistic model based on the syntagmatic strategy is discussed later in this thesis and also in Appendix I (p.393). There, I have also discussed the major question of how semantics are related to syntax and I have referred to the importance of generative semantics in identifying levels of abstraction where the "deep structure" is defined both syntactically and semantically<sup>25</sup>. However, it would be more productive here to proceed with a discussion of what the syntagmatic strategy might mean for the semiological study of architectural phenomena and particularly of the ecoclimatic organizations of the built environment.

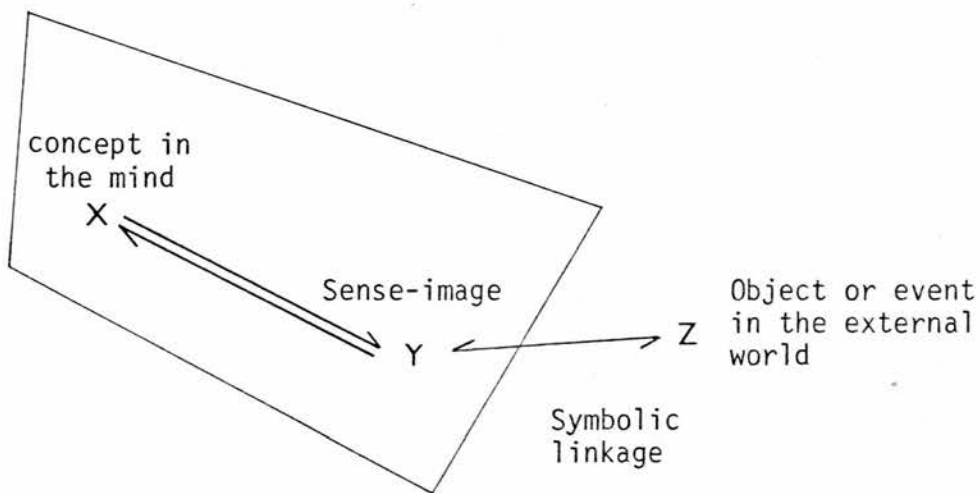
The linguistic sign associates a sound image and a concept. However, the application of the linguistic model to non-literary expressions of society assumes a much broader conception of the semiological sign. A semiological sign, thus, associates patterns of information received in different modes (e.g. through touch, sight, hearing or smell) into patterns of behaviour manifested mainly in three interconnected levels: (i) the level of natural biological activities of the human body (breathing, metabolic process, etc.), (ii) the level of technical actions (which alter the physical state of the environment) and (iii) the level of expressive actions (gestures, verbal evaluation of the environment, etc.). Semiologists, therefore, assume that:

24. *Ibid.*, pp.13-29.

25. See Ch. 13. For a more extensive discussion on this controversy refer to: SEUREN, P., (ed.), (1974); PETTIT, Ph., *op.cit.*, pp.25-29 and particularly to a footnote in p.18.

"... all the various non-verbal dimensions of culture, such as style in clothing, village lay-out, architecture, furniture, food, cooking, music, physical gestures, postural attitudes and so on are organized in patterned sets so as to incorporate coded information in a manner analogous to the sounds and words and sentences of a natural language. I assume therefore it is just as meaningful to talk about the grammatical rules which govern the wearing of clothes as it is to talk about the grammatical rules which govern speech utterances."<sup>26</sup>

In this way, the strict application of the linguistic model to non-linguistic signs has been originated from models similar to the following one proposed by E. Leach:



E. LEACH, (1976), p.19.

Pettit, discussing the various ways in which an application of the linguistic model to non-literary or to customary arts might be made, points to two different approaches. These are straight analysis and systematic analysis<sup>27</sup>.

Straight analysis is usually applied to isolated products of a non-literary work, (e.g. a piece of music, sculpture, architecture or painting). It is an intuitive approach aimed at explaining how certain effects are produced through particular devices and patterns of articulation.

26. LEACH, E., (1976), *op.cit.*, p.10.

27. PETTIT, Ph., *op.cit.*, p.56.



The systematic analysis, according to Pettit, can be performed either at the level of generative theory or at the level of descriptive theory. On the generative level, he argues that the analyst draws a parallel between "genre" in architecture, painting or music, and "grammar" in Chomsky's sense. He suggests that:

"There is some parallel but it can scarcely be pressed for theoretical purposes. The structure which I put on a piece of music, a work of architecture or a painting - the outline order within which I place and value this or that element of the work - is not a structure assignable by a set of recursive rules."<sup>28</sup>

For Pettit, it appears that the subject assigns a structure or form to a work of art on a "gestalt" basis rather than by a generative procedure. I will come back to this discussion after presenting Pettit's views on the second level of systematic analysis, that is of descriptive theory. He states:

"Descriptive theory is a more realistic option than generative but, ... is not a very interesting one. Norberg-Schulz, again in architecture, points to the possibility of such a theory when he tries to define the elements which any work of architecture would combine in a more or less distinctive way: 'the elements may be defined as "space-cells", "mass-forms" and "bounding-surfaces". Or the element can be a *gestalt* combining these aspects' (Norberg-Schulz 105). Definition of these elements suggests that the way is open for a 'poetic' of architecture in Todorov's sense of the term, a poetic which would 'derive' actual buildings and kinds of buildings as possible architectural combinations among others. It is significant that Norberg-Schulz does not explore the possibility of such a descriptive theory. The terms of the theory would be too abstract for it to link up tightly with actual works of architecture. The theory might be an enjoyable game but would have little explanatory interest."<sup>29</sup>

Thus, Pettit suggests that the systematic analysis of non-literary works would be promising and interesting only if it were performed on

28. *Ibid.*, p. 57.

29. *Ibid.*, pp. 57-58. Pettit refers in this quotation to : NORBERG-SCHULZ, C., *Intentions in Architecture*, Allan & Unwin, 1966.

a "gestalt" basis<sup>30</sup>.

I find myself in disagreement with Pettit's view on the application of the linguistic model to architecture, even if I were to reduce architecture to the level of pure art which, in any case, I am not prepared to do. Considering that architecture is, above all, a social science responsible for explaining not only its isolated products, but mostly the various processes by which they have been produced, there is a social level of equal importance to the aesthetic one in which architectural systems of evaluation are originated and operate. I am not going to repeat here the arguments which were presented in the last two Chapters as to the importance of a generative or, even more so, a descriptive approach to architecture or to ecoclimate. I wish only to stress the fact that the way in which the linguistic model and semiological structuralism have been applied to the investigation of the built environment so far cannot be used as a basis for refuting these methods, although even in this context some significant works, for instance Hillier and Leaman's on space syntax<sup>31</sup> or that of Lagopoulos on a semiological analysis of town planning<sup>32</sup> prove that both the generative and the descriptive implications are, as opposed to Pettit's view, very important and useful.

Nevertheless, I have to admit the limitations of analytic semiology as a descriptive methodological tool in examining architectural structures which are of much higher complexity than those assumed by Pettit in the above discussion, and which are of interest in the

30. Refer to Pettit's discussion, *Ibid.*, pp.58-71.

31. Refer to the series of papers by Hillier, B. and Leaman, A., concerned with a syntactic interpretation of architectural structures (see Bibliography).

32. LAGOPOULOS, Ph., *Structural City-Planning, Tech. Ch. of Greece, Athens, 1973, (in Greek)*. For a number of different applications of the linguistic model on the "non-literary" and the "customary" arts, refer to ROBEY, D., (ed.), *op.cit.*

present work. I have already mentioned both the potential and the limitations of purely semiological methods and those of the linguistic model earlier in the discussion. I argued about the generation of structural solidarities where meaning gets its pragmatic value (and in this respect the semiological method is really valuable). I also argued about the structural identity of these structures and their prototypic manifestation (where the semiological method falls short due to its analytical scope). The methodology developed in this thesis for studying the ecoclimate of the built environment (and which is expanded further in Appendix II to deal with a number of other architectural phenomena) points to the limitations of a purely semiological or a purely syntactic approach to architecture, deriving from an isomorphic application of the linguistic model and at the same time it suggests a structural approach based on the notion of prototype which is derived directly from the notion of syntagm in linguistics, though not in an isomorphic sense<sup>33</sup>.

From the analysis of the ecoclimatic sign we have carried out so far, and in connection with the model (ecoclimatic schema) developed earlier in Part II, we might agree that the basic structure of the elementary ecoclimatic sign could be represented schematically in the following way:

Domain of signifiers:	Climate (C) ↔ Building (B) interaction. (formulation of microclimates)
	↑↓
Domain of signifieds:	Man (M) in his totality (in all physiological, cultural and sociological manifestations)
Elementary ecoclimatic sign:	<u>(C-B): signifier aspect</u> (M) : signified aspect

33. ... for instance, we accepted the syntagmatic character of architectural structures as far as meaning and evaluation are concerned, but at the same time we rejected a linear formation of architectural signs deviating from what the linguistic model clearly suggests for the linguistic signs.

However, due to the permutation function of semiological signs, it is important to examine the behinds and the beyonds of the eco-climatic sign within the context of its semiotic evolution and to relate the different ranges in this evolution to the different types of meanings which are generated in them. This is done schematically in the following figure:

LEVEL OF STRUCTURE	METHODOLOGICAL FRAMEWORKS	TYPE OF MEANING
Range of physical stimuli originated either in the domain of (C) or in the domain of (B) - range of physiological and psychological signs. $\left[ \frac{C}{P} \right]$ or $\left[ \frac{B}{P} \right]$	Physiological and psychological studies on the S-R PARADIGM  I	Purely communicative meaning
Range of the ecoclimatic signs  $\left[ \frac{C-B}{P} \right]$	SEMIOLOGICAL ANALYSIS  II	Meaning beyond the communicative level but not yet of social character
Range of the ecoclimatic syntagms, Prototype formulations of sets of ecoclimatic signs	(a) Structural solidarities (b) Structural identity of the ecoclimatic prototype.  SYNTAGMATIC STRUCTURALISM  III	Meaning in its broader sense of social evaluation

The diagram summarises schematically some of the arguments discussed in this chapter. No claim is made that this discussion

represents a complete semiological analysis of the ecoclimatic environment nor that it covers fully the methodological side of such an analysis. The main objective was to introduce the basic terminology concerned with a semiological explanation of ecoclimate and to suggest some of the advantages and the limitations of purely semiological methods in describing phenomena of the built environment of such a structure and complexity as the ecoclimatic ones.

The methodological conclusions reached here are considered and further developed in Chapter 14, where an appropriate methodological framework is formulated for ecoclimate within the context of a syntagmatic structuralism which generates social evaluation as its particular domain of meaning. Furthermore, in the next Chapter, which supplements the present one, the significance of social evaluation in identifying architectural and ecoclimatic structures at the level of design action becomes obvious, and this justifies the utility of the semiological method to develop structural solidarities which permit the generation of meaning at the higher level of social evaluation.

## CHAPTER 13

### DEVELOPMENT OF THE SYNTAGMATIC APPROACH TO ECOCLIMATE - THE DIALECTICS OF MEANING AND SYNTAX

#### 13.1 INTRODUCTION

In the previous chapter I introduced the basic terminology of a semiological approach to ecoclimate and I indicated the significance of a conceptual and methodological shift from the notion of ecoclimatic "sign" into those of ecoclimatic "syntagm" and ecoclimatic "prototype"; a shift necessitated by the requirement of adopting a semantic domain dominated by systems of social evaluation in order to explain ecoclimatic phenomena adequately.

However, a further development of the semiological analysis of ecoclimate is required, particularly in terms of achieving a more precise identification of its methodological potentials and limitations which are necessary in order to define the characteristics of the syntagmatic approach. This chapter undertakes the task of examining these methodological aspects by looking at the general nature of semiological analyses in architecture which have already been developed and by considering the way in which genetic structuralism (which deals primarily with the crucial concept of "syntax")<sup>1</sup> becomes a supplementary methodological framework to which

1. Refer to the discussion in Ch.11, pp.266-267.



semiological analyses in architecture and ecoclimate should be extended. The discussion is presented in three sections:

- 13.2 Semiology and architecture; a critical discussion.
- 13.3 Ecoclimate as a second- and third-order semiological system.
- 13.4 A syntactic analysis of ecoclimate

### 13.2 SEMIOLOGY AND ARCHITECTURE; A CRITICAL DISCUSSION

Semiology<sup>2</sup> has always been considered as an appropriate theoretical framework within which "meaning" would be demystified, understood and, thus, consciously expressed in the production of social objects, such as language, myth, art, architecture and science. However, the interest of the present study in semiology does not mean that ecoclimate can only be explained semiologically but rather it arises from the fact that both semiological methodology and the ecoclimatic approach share, in different ways perhaps, a similar emphasis on the crucial concept of meaning.

Before I proceed to develop further the semiological analysis of ecoclimate, presented in the previous chapter, it is essential to establish a critical view of the potentials and the limitations of analytic semiology in providing an adequate theoretical framework for the study of architectural phenomena, similar in nature to the ecoclimatic ones.

2. *The terms 'semiology', 'semiotics' and 'semiotic' appear interchangeably in the relevant literature to the extent that one may consider them as synonyms. It should be mentioned, however, that although these terms derive etymologically from the same root (the Greek semeion 'sign') their epistemological origin is quite distinct. 'Semiology' was introduced by Saussure as the future science which would relate the conceptual and methodological aspects of linguistics to non-linguistic systems. 'Semiology' in these terms refers to the study of sign-systems with reference to linguistic laws. The term 'semiotic' was first introduced*

Recently, much concern has been paid to the role of semiological analysis in architecture<sup>3</sup>. It is precisely the claim that semiology can offer an adequate base for a systematic exploration of architectural meaning, that seems to have generated both positive and hostile reactions within the architectural community. However, to understand the intentions of the architectural semiologists one has to accept that the relationship of architecture to art is not simply a lively tradition, but (despite the current dogma of sophisticated functionalism) the most critical element of architectural expression<sup>4</sup>.

*in the philosophy of Peirce and Morris and refers to the study of sign-systems in a mode independent of linguistics. Finally, the term 'semiotics' was introduced by Margaret Mead as the interdisciplinary study of all the different modes of communication. The term 'semiotics', especially since 1969 when the International Association for Semiotic Studies came into existence, is the one which prevails in architectural studies. However, I have decided to use the term 'semiology' throughout this work - without paying much attention to the current terminological controversy, for the following reasons: first, whatever the claims are, there is not sufficient evidence to support the argument that 'semiotics' could be developed independently from the linguistic paradigm; after all language is and will always be the finest prototype of any mode of communication. Second, and more significantly, the linguistic model if properly used within an appropriate architectural framework, would offer a lot of insight to the study of architecture.*

3. *This concern has been growing, particularly in Britain, together with the search for an alternative theory to the current architectural dogma of 'functionalism'. In a recent paper, G. Broadbent suggests that: "It is perfectly possible now for people like the Venturis, Charles Moore, Brent Brolin, Charles Jencks and many others, to suggest that architecture designed with deliberate meaning is taking over from functionalism". See, BROADBENT, G., (1977).*
4. *For an appropriate discussion which illustrates this point, see: MAXWELL, R., The Venturi Effect in Venturi and Rauch, Architectural Monographs 1, Academy Editions, London, 1978, pp.7-28.*

Semiological analysis in architecture, applied either to the products of the design process<sup>5</sup> or to the media used in the design process<sup>6</sup>, is generally justified as an attempt to understand the ways in which architectural products carry meaning, as well as the mental processes which underlie architectural production and expression in general. Thus, a semiological explanation of architecture could be identified as a conscious attempt to give meaning to buildings and this attitude reveals the primary objective of the architectural semiologists:

"If all buildings inevitably carry meaning, then we should do well to see how they do it. At the very least, that will help us to understand all buildings better. And if our buildings are going to symbolise anyway - despite our best (or worst) intentions - then an understanding of how they do so *may* help us design them to do it better. The most promising way of looking at these things seems to be the Theory of Signs which has been developing from the work of Ferdinand de Saussure, ..., and Charles Sanders Peirce, ..." <sup>7</sup> (author's emphasis).

The major characteristic underlying the earliest attempts of Italian theorists to introduce semiology into architecture, was the *a priori* assumption that semiology provides the comprehensive methodological framework capable by itself of identifying architectural

5. ..., for instance; building elements such as, staircases, windows, columns and so forth (see: ECO, U., *Function and Sign: Semiotics of Architecture*, in BRYAN, J., and SAUER, R., (eds.), *Structures Implicit and Explicit*, in VIA-Publications of the Graduate School of Fine Arts, Vol. 2, University of Pennsylvania, 1973); buildings (see: JENCKS, C. and BAIRD, G., (eds.), *Meaning in Architecture*, Barrie & Rockliff: The Cresset Press, 1969; NORBERG-SCHULZ, C., *Intentions in Architecture*, M.I.T. Press, Cambridge, Mass., 1968, (c.1963); urban elements (see: LAGOPOULOS, A., Ph., *Structural Town Planning*, Technical Chamber of Greece, Athens, 1973, (in Greek)).
6. ..., for instance, architectural descriptions of various kinds, such as, designs, models and other means of graphic or verbal representation, accessible to symbol analysis. See ECO, U., *Introduction to a Semiotics of Iconic Signs*, in VERSUS 2 1972, and KRAMPEN, M., *Iconic Signs, Supersigns and Models*, in VERSUS 4, 1973.
7. BROADBENT, G., *op.cit.*, p.475.

meaning<sup>8</sup>. This architectural belief in the methodological superiority of semiological theory has been reinforced by its remarkable successes in linguistics and anthropology<sup>9</sup>. The point, however, that has escaped serious attention in the recent developments of architectural semiology<sup>10</sup> is that in both the linguistic and the anthropological areas the semiological model has been "contextually" redefined on the basis of the empirical realities associated with these areas. And, moreover, that it is precisely this contextual use of the model that led to the methodological successes in these areas, such as those encountered in the works of Lévi-Strauss, Barthes and others.<sup>11</sup>

8. For instance, the works of: RAGGHIANI, *Saggio, di Analisi Linguistica del Architettura Moderna*, in Casabella, No.116, 1937; PANE, R., *Architettura e Letteratura*, in *Architettura e Arti Figurative*, Venice, 1948; and BETTINI, S., *Critica Semantica e Continuità Storica dell' Architettura Europea*, in *Zodiac* 2, 1958, reflect the strong influence of the pioneering works of SAUSSURE, F., *de, Cours de linguistique générale*, Payot, Paris, 1916 and PEIRCE, C.S., *Collected Papers*, Harvard University Press, 1931-1958.
9. I am referring here to the pioneering works of R. Jakobson on phonology, N. Chomsky on syntactic structures and, later on, generative grammar, R. Barthes on the study of myth, C. Lévi-Strauss on structural anthropology and so forth.
10. ... such as those by: ECO, U., in his *La Struttura Assente*, Bompiani, Milano, 1968 and the later version of his theory recently published as: *A Theory of Semiotics*, The Macmillan Press Ltd., 1977 (c.1976); the French School of Architectural Semiologists; and, more recently, by British architectural semiologists.
11. For the range and the value of the linguistic and the semiological models in their application to non-literary arts and to architecture, see: PETTIT, Ph., *The Concept of Structuralism: A Critical Analysis*, Gill and Macmillan, 1975, particularly Chapter II. Furthermore, the work of R. Boudon has made clear that the operational character of structural models and methodologies depends primarily on the characteristics of the object-system to which it applies, the degree of operationality required and the methodological objectives (e.g. descriptive, systematic, analytic, synthetic) underlying its application. All these constitute a context within which the potentials and the limitations of the structural model (in our case the semiological model) could be identified. See: BOUDON, R.,

In the same manner, the semiological model could be systematically explored by "endogenous" approaches (contextually developed within the framework of architectural reality), rather than by "importation" of semiological concepts, categories, and techniques, the architectural significance of which remains necessarily questionable. It could be argued that it is due to this importation that semiological analyses in architecture suffer enormous difficulties, the most important of which are summarized below:

First, there is the notorious and, in architectural terms, confusing complex terminology imported directly into architecture from semiology and its application to linguistics and anthropology<sup>12</sup>.

The Uses of Structuralism, Heinemann, London, 1971, (c.1968). We may realise what a "contextual" use of the linguistic version of the semiological model means, in the work of R. Barthes. He writes: "Semiology, once its limits are settled, is not a metaphysical trap: it is a science among others, necessary but not sufficient. The important thing is to see that the unity of explanation cannot be based on the amputation of one or other of its approaches, but, as Engels said, on the dialectical co-ordination of the particular sciences it makes use of. This is the case of mythology: it is a part both of semiology inasmuch as it is a formal science, and of ideology inasmuch as it is an historical science: it studies ideas-in-form." BARTHES, R., *Mythologies*, Paladin, 1973, (c.1957), p.112.

12. Broadbent, for instance, writes that: "Unfortunately, the profusion and conflict of terminology within this field has probably proved the greatest stumbling block ... Many people indeed have made the point that the word 'semiotic' reminds them of - is itself a sign for - 'idiotic'." BROADBENT, G., *op.cit.*, p.475. It is more common than not in architectural semiological writings to find the apparently different semiological concepts, such as sign, syntagm, context, etc., to be used both as synonyms and as homonyms.



Second, there are difficulties associated with the weak operational character of the conceptual structures proposed to explain analytically highly synthetic architectural phenomena and processes<sup>13</sup>. Third, there are methodological difficulties generated by the analytic and taxonomic character of the semiological method. Analytic semiology, though useful in investigating the semantic context of isolated architectural products, is inadequate to provide explanations at higher degrees of complexity generated by architectural design where the identification of the design requirements, the description, the production and the evaluation of architectural products should be studied within a unified conceptual and methodological whole<sup>14</sup>. Finally, the importation of certain characteristics of the linguistic system, such as, for instance, the principle of linearity in combining

13. *For instance, the concept of "architectural sign", used by all architectural semiologists as the basic unit for the generation of architectural meaning, has very little operational significance in architecture. Since 1976 the author, together with A. Awadalla and T. Kotsiopoulos have argued that it is at the level of "architectural syntagm" - not of "sign" - that elementary units of architectural meaning are generated. (See: AWADALLA, A., KOTSIPOULOS, T., MARAVELIAS, T., Description and Descriptors in Architecture, in Edinburgh Architectural Research Journal, 1976, pp.37-75; refer, in particular to section 5). It is very characteristic that the leading architectural semiologist Umberto Eco, has recently come to realise the weak operational character of the concept of architectural sign. Referring to his earlier work in architectural semiology and particularly to his: La Struttura Assente, Bompiani, Milano; and "A Componential Analysis of the Architectural Sign/Column/", Semiotica V/2, he suggests that: "Both Eco (1968) and Eco (1972c) were still linked to the notion of signs criticized in the present book. One should now read them by substituting for the notion of 'architectural sign' that of 'architectural text' in which many modes of sign production are simultaneously at work." See ECO, U., (1977), op.cit., p.308.*
14. *Refer to PETTIT, Ph., op.cit., pp.55-64.*



linguistic signs or the predominance of communicative values, implies the development of a semiology in architecture which does not take into account basic structural differences between the linguistic and the architectural system<sup>15</sup>. The over-emphasized communicative character of architecture, which is forcefully advocated by most architectural semiologists, could only be explained in terms of a "homeomorphic adoption" rather than a "paramorphic adaptation"<sup>16</sup> of readily available and, in their own context, successful linguistic models. The straight application of linguistic models to an assumed "langue" level of architecture can be nothing else but a misused and a misleading metaphor, if this langue level does not derive out of an identification process organized within the totality of architectural reality.

Within the broad area of application of the semiological method to the study of non-linguistic systems (which provide an appropriate context for developing semiology in architecture) the predominant values applied to these systems are transformed beyond the purely communicative ones<sup>17</sup>. Beside the striking similarities between

15. *For a brief comparison of four systems of human practice (language, music, painting and architecture) in terms of their 'structural complexity' and the properties of their 'super-surface structures', see: AWADALLA, A., KOTSIPOULOS, T., MARAVELIAS, T., (1976), op.cit., pp.59-61.*
16. *For the distinction between the 'homeomorphic' and the 'paramorphic' use of the linguistic model see PETTIT, Ph., op.cit., pp.39- . Refer also to his discussion on p.36 on the non-communicative character of those semiological acts which involve cultural construction.*
17. *For a brief discussion on the transformation of "communicative value" to "social value" and its importance to architectural descriptions, see: AWADALLA, KOTSIPOULOS, MARAVELIAS, (1976), op.cit., sec.4. It is also significant to see how this transformation permits a semiological explanation of the institutional image of architecture. An interesting discussion, which attempts an extension of architectural semiology into the study of the ideological and political nature of certain architectural codes, is given by LASARIDIS, P., The Communication with Architecture, Posseidonas, Salonica, 1976 (in Greek).*

linguistic and architectural systems there are crucial differences which are equally significant for the development of semiology in architecture. It is through a clear identification of the limits, within which one could maintain homological relationships between linguistic and anthropological systems on the one hand and architectural system on the other, that the methodological advantages (e.g. conceptual, descriptive, explanatory) of semiology would be utilized in the study of architectural phenomena.

This argument relates to the common assumption underlying semiological analysis in architecture which is that architecture could be adequately explained only semiologically. The view that semiology offers today a sufficient framework of models, concepts and categories which, if properly understood, could provide a set of procedures for the construction of an adequate methodology of architecture, capable of explaining both architectural products and the processes by which they are produced, has to be abandoned. No methodology can be assumed in an *ad-hoc* manner as an architectural methodology. Such a methodology cannot be induced from other spheres of application and development, but only deduced from the empirical domain of facts related to the totality of architectural reality. Architectural methodology can become effective in design only when it is "contextually" defined and developed.

In summary, semiological analyses as they are usually applied in architecture, do not offer an adequate methodological framework within which architectural meaning can be comprehensively identified and operationally transformed into the design process. What is required primarily is that semiological analysis needs to be transformed from the stage of being an exogenous theory in architecture into the stage of being an endogenous methodology for it.

by re-examining in a contextual manner its conceptual and terminological tools and by defining its methodological potentials and limitations more precisely. The following section attempts to develop further the semiological analysis of ecoclimate, presented in the previous chapter, and to define some of the problems concerned with such a development when it is carried out in contextual terms.

### 13.3 ECOCLIMATE AS A SECOND- AND THIRD-ORDER SEMIOLOGICAL SYSTEM

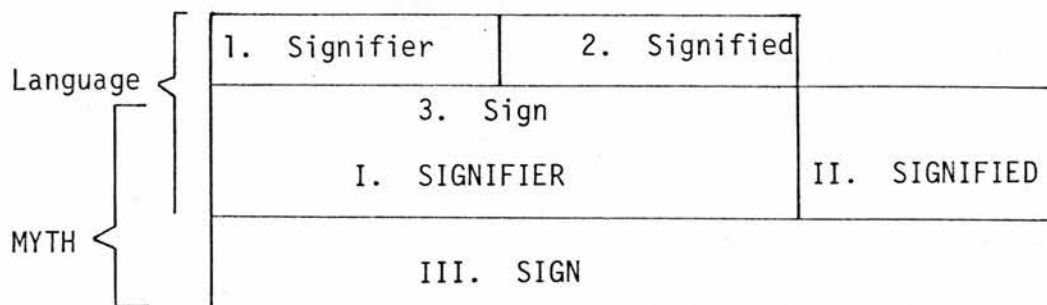
I argued earlier<sup>18</sup> that a comprehensive methodological framework for ecoclimate can be developed within the epistemological context of the structuralist paradigm. By the term "structuralist paradigm" I referred to both "semiological structuralism" (a body of knowledge which accepts that the linguistic model, as originally developed by F. de Saussure, is applicable to the analysis of systems of human action, insofar as all these, like language, may be interpreted as systems of signs) and to "genetic structuralism" (developed by J. Piaget as a method of enquiry based on the concept of totality, self-regulation and transformation). In this section, I will try to show that an appropriate semiological study of architecture and particularly of ecoclimate should recognize that the meeting of these two lines of thought (that is, of semiological and genetic structuralism) is not only epistemologically possible but, most significantly, architecturally necessary.

The work of R. Barthes in *Mythologies*<sup>19</sup> seems to be the best starting point for this discussion. He suggests that

18. ... particularly in Ch. 11.

19. BARTHES, R., 1973, *op.cit.*

"myth"<sup>20</sup>, semiologically speaking, is not constructed on the basic notion of 'sign' but from a semiological chain of signs. In other words, myth, like ecoclimate, is semiologically interpreted in syntagmatic terms. And although Barthes does not use the term "syntagm" to describe the system of myth, he does, however, suggest that myth is a "second-order" semiological system<sup>21</sup>:

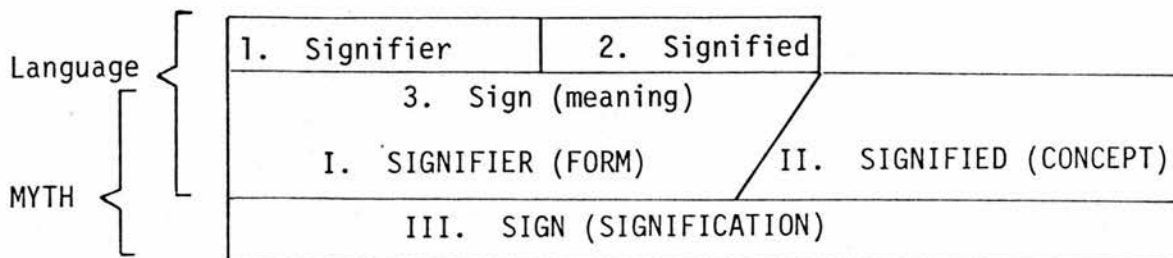


BARTHES, R., (1973), p.115

What Barthes indicates in the model above is that the concept of 'sign', which in Saussurean linguistics becomes the elementary unit for the generation of the system of language, constitutes simply an element of a second-order elementary unit which generates the system of myth. Part of Barthes' effort to develop a semiological interpretation of myth (in a manner which we call here contextual) is to

20. *In semiological terms "myth" is a system of communication. In Barthes' terms it is "a type of speech" generated at a level higher than that of language. The significance of this concept - at least for semiology - lies in its generality; "everything can be a myth provided it is conveyed by a discourse". According to Barthes: "Every object in the world can pass from a closed, silent existence to an oral state, open to appropriation by society, for there is no law, whether natural or not, which forbids talking about things". See BARTHES, R., *ibid.*, p.109.*
21. *"In myth, we find again the tri-dimensional pattern which I have just described: the signifier, the signified and the sign. But myth is a peculiar system in that it is constructed from a semiological chain which existed before it: it is 'a second-order semiological system'. That which is a sign (namely the associative total of a concept and an image) in the first system, becomes a mere signifier in the second." *Ibid.*, p.114.*

avoid a terminological confusion which may arise by the use of the same terms in two different structural levels. Thus, he transforms the linguistic pattern signifier, signified and sign into *form*, *concept* and *signification* correspondingly:



The interesting point for our discussion is the relationship of sign to form. Form is a sum of signs, a global sign, the final term of a first semiological chain. Barthes has chosen this term in order to give emphasis to the fact that in a second-order semiological system one is not interested in the analytical meaning of the sign, but rather in a more synthetic and complete value which he calls 'signification'<sup>22</sup>. Unlike the 'form', however, the 'concept' is not abstract. The synthetic meaning, which the form is deprived of, is transferred to the concept. But the meaning of the concept is totally new and does not derive from the sum of meanings of the original signs that have constituted the form.

Having dealt briefly with the necessary terminology and concepts we can now turn to the discussion of what Barthes' analysis of myth may suggest for a semiological analysis of ecoclimate. The ecoclimate system, like that of myth, can be seen as a "second-order" semiological system since it is generated by elementary units, the

22. An illustrative discussion concerned with the transformation of the linguistic 'sign' into the mythical 'form' is given by Barthes, *ibid.*, p.117- .

syntagms, which are of higher complexity than that of the linguistic sign. The concept of 'syntagm' in these terms becomes synonymous with Barthes' concept of 'form' because it similarly indicates that an ecoclimatic signifier consists of a structured totality made up of a set of lower level elements which in themselves may be realised as signs. Let me illustrate this argument by the following example:

Consider a common climatic design problem, for instance, the design of a physical setting where both natural and artificial elements (e.g. trees and buildings) should interact with climatic fields in such a way as to produce a desired microclimate within which people could perform certain activities. The setting, after being designed and built, will become meaningful to its users through a number of different processes. The general semiological explanation of these processes would be that the setting contains a number of signs which associate visual images or other stimuli patterns with certain physiological sensations, psychological reactions or activity patterns. The ecoclimatic meaning that may be attributed to the setting by a user does not derive from the associative total of all the possible signs which may be recognized by the same user at different times or by other users of this setting. The ecoclimatic meaning varies both synchronically (in terms of different people experiencing the setting at the same time) and diachronically (in terms of varying, even for the same people, on different occasions) although in the case of strongly motivated significations a substantial number of group-signs may be observed.

However, the point to be made with this example is that the meaning the designer associates with a future setting is quite



different from the type of meaning generated by its users. The designers' meaning is generated at a level beyond the physical actuality of the setting. It is a meaning which has a very different history from that associated with the signs of the user, its own conditions of construction, based largely on the designer's experience as a designer, and which is dominated not only by physio-psychological values but mostly by socio-economic and cultural ones. The total sum of ecoclimatic signs experienced in such a setting is transformed into an ecoclimatic syntagm which generates its own comprehensive syntagmatic meaning.

The ecoclimatic syntagm, like the 'form' of the myth, has no particular meaning in the sense that the signifier of a sign has. The ecoclimatic syntagm simply indicates a particular arrangement of built forms, natural elements and people's activities more or less articulated by certain relationships. However, as soon as a syntagmatic arrangement is associated with a specific semantic context an ecoclimatic "prototype" derives from this marriage. In other words, the ecoclimatic prototype is a double entity in the sense that it is the associative total of an ecoclimatic syntagmatic arrangement and a specific semantic context. Thus, the triadic pattern [signifier-signified: sign] which describes an ecoclimatic system as a "first-order" semiological system, may be transformed into the pattern [syntax of a set of signs - syntagmatic meaning : syntagm] which describes an ecoclimatic system as a "second order" semiological system, and this may be further transformed into the pattern[syntagmatic syntax - architectural semantic context : ecoclimatic prototype] which describes - at a design orientated level - an ecoclimatic system as a "third-order" semiological system. (See following table).

STRUCTURAL LEVELS AND METHODOLOGICAL ISOMORPHISMS OF ECOCLIMATIC SEMIOLOGICAL ANALYSES										
	STRUCTURAL LEVELS OF ECOCLIMATIC SEMIOLOGICAL ANALYSES	METHODOLOGICAL ISOMORPHISMS TO ALREADY DEVELOPED SEMIOLOGICAL SYSTEMS								
1st ORDER SEMIOLOGICAL SYSTEM The S-R paradigm may be interpreted semiologically	<p>STUDY OF ISOLATED ECOCLIMATIC EVENTS WITHIN THE FRAMEWORK OF THE S-R PARADIGM</p> <table border="1"> <tr> <td> <p>ECOCLIMATIC SIGNIFIER:</p> <p>Sense-image of an object or event in the of (C) or (B)</p> </td> <td> <p>ECOCLIMATIC SIGNIFIED:</p> <p>Physiological readjustment, psychological or activity reaction in the domain (M)</p> </td> </tr> <tr> <td colspan="2"> <p>ECOCLIMATIC SIGN</p> <p>Predominantly motivated</p> <p>Predominantly denotative meaning</p> </td> </tr> </table>	<p>ECOCLIMATIC SIGNIFIER:</p> <p>Sense-image of an object or event in the of (C) or (B)</p>	<p>ECOCLIMATIC SIGNIFIED:</p> <p>Physiological readjustment, psychological or activity reaction in the domain (M)</p>	<p>ECOCLIMATIC SIGN</p> <p>Predominantly motivated</p> <p>Predominantly denotative meaning</p>		<p>SAUSSUREAN MODEL OF LANGUAGE</p> <table border="1"> <tr> <td> <p>SIGNIFIER</p> <p>[sound-image]</p> </td> <td> <p>SIGNIFIED</p> <p>[concept]</p> </td> </tr> <tr> <td colspan="2"> <p>LINGUISTIC SIGN</p> <p>Predominantly arbitrary</p> </td> </tr> </table>	<p>SIGNIFIER</p> <p>[sound-image]</p>	<p>SIGNIFIED</p> <p>[concept]</p>	<p>LINGUISTIC SIGN</p> <p>Predominantly arbitrary</p>	
	<p>ECOCLIMATIC SIGNIFIER:</p> <p>Sense-image of an object or event in the of (C) or (B)</p>	<p>ECOCLIMATIC SIGNIFIED:</p> <p>Physiological readjustment, psychological or activity reaction in the domain (M)</p>								
<p>ECOCLIMATIC SIGN</p> <p>Predominantly motivated</p> <p>Predominantly denotative meaning</p>										
<p>SIGNIFIER</p> <p>[sound-image]</p>	<p>SIGNIFIED</p> <p>[concept]</p>									
<p>LINGUISTIC SIGN</p> <p>Predominantly arbitrary</p>										
2nd ORDER CONVENTIONAL SEMIOLOGICAL ANALYSIS	<p>STUDY OF THE ECOCLIMATIC ORGANIZATION OF THE BUILT ENVIRONMENT</p> <table border="1"> <tr> <td> <p>ECOCLIMATIC SIGNIFIER:</p> <p>Syntax of a set of ecoclimatic signs</p> <p>[(C) - (B)]</p> <p>[M]</p> <p>(sign-syntax)</p> </td> <td> <p>ECOCLIMATIC SIGNIFIED</p> <p>Subjective eco-climatic concepts, e.g. comfortable or uncomfortable environments. Meaning in the form of social evaluation</p> </td> </tr> <tr> <td colspan="2"> <p>ECOCLIMATIC SYNTAGMS</p> <p>Motivated - arbitrary</p> <p>Predominantly connotative meaning</p> </td> </tr> </table>	<p>ECOCLIMATIC SIGNIFIER:</p> <p>Syntax of a set of ecoclimatic signs</p> <p>[(C) - (B)]</p> <p>[M]</p> <p>(sign-syntax)</p>	<p>ECOCLIMATIC SIGNIFIED</p> <p>Subjective eco-climatic concepts, e.g. comfortable or uncomfortable environments. Meaning in the form of social evaluation</p>	<p>ECOCLIMATIC SYNTAGMS</p> <p>Motivated - arbitrary</p> <p>Predominantly connotative meaning</p>		<p>BARTHES' MODEL OF MYTH (culture as a language)</p> <table border="1"> <tr> <td> <p>SIGNIFIER</p> <p>Set of linguistic and non-linguistic signs. Emphasis on their structure:</p> <p>FORM</p> </td> <td> <p>SIGNIFIED</p> <p>CONCEPT</p> </td> </tr> <tr> <td colspan="2"> <p>MYTHOLOGICAL SIGNIFICATION</p> </td> </tr> </table>	<p>SIGNIFIER</p> <p>Set of linguistic and non-linguistic signs. Emphasis on their structure:</p> <p>FORM</p>	<p>SIGNIFIED</p> <p>CONCEPT</p>	<p>MYTHOLOGICAL SIGNIFICATION</p>	
<p>ECOCLIMATIC SIGNIFIER:</p> <p>Syntax of a set of ecoclimatic signs</p> <p>[(C) - (B)]</p> <p>[M]</p> <p>(sign-syntax)</p>	<p>ECOCLIMATIC SIGNIFIED</p> <p>Subjective eco-climatic concepts, e.g. comfortable or uncomfortable environments. Meaning in the form of social evaluation</p>									
<p>ECOCLIMATIC SYNTAGMS</p> <p>Motivated - arbitrary</p> <p>Predominantly connotative meaning</p>										
<p>SIGNIFIER</p> <p>Set of linguistic and non-linguistic signs. Emphasis on their structure:</p> <p>FORM</p>	<p>SIGNIFIED</p> <p>CONCEPT</p>									
<p>MYTHOLOGICAL SIGNIFICATION</p>										

(continued)

	STUDY OF ECOCLIMATE AT A DESIGN-ORIENTATED LEVEL		
3rd ORDER SEMIOLOGICAL SYSTEM Proposed: SYNTAGMATIC STRUCTURALISM	ECOCLIMATIC SIGNIFIER:  Syntax of a set of ecoclimatic syntagms (syntagmatic syntax)	ECOCLIMATIC SIGNIFIED:  Meaning in the broader sense of social evaluation and pragmatic architectural meaning	Non-isomorphic to semiological systems which do not include the crucial concept of "design".
	ECOCLIMATIC DESIGN PROTOTYPE  Predominantly arbitrary. A metalanguage for the 2nd order ecoclimatic semiological system.		

The table suggests, among other things, that the semantic context of an ecoclimatic prototype does not derive from the particular meaning that the constitutive elements of the prototype may carry with them, but from the particular relationships which the elements hold among themselves to produce the prototype. At this level ecoclimatic meaning derives out of the structural solidarity that the ecoclimatic syntagms should reach before these syntagms acquire a prototypic manifestation, that is, before they become operational in the design process.

Among the many questions that may arise by the present semiological interpretation of ecoclimatic prototypes there are two which can be considered as the most critical and which are chosen here for further analysis. The first is concerned with the concept of "syntax" and the second concerns the nature of the "semantic context" and the way in which it is associated with a given syntagmatic arrangement.

In respect of this second question the argument in the previous Chapter has been that the semantic context of an ecoclimatic prototype is dominated by systems of social evaluation which are historically produced<sup>23</sup>. In these systems the predominant values are social rather than physio-psychological, although the latter are significant when systems of evaluation are identified at a 'first-order' semiological level.

To illustrate this argument consider once again the distinction between the concepts of 'ecoclimatic sign' and 'ecoclimatic prototype' but this time from a semantic viewpoint. The signified aspect of the ecoclimatic sign (say a physiological readjustment or a psychological reaction) is dominated by a type of meaning which is loaded by the whole history of experiencing what constitutes the signifier of this sign (say a particular microclimatic arrangement). This type of meaning is closely related to the linguistic meaning which is similarly constructed through a history of learning experiences. The only difference might be that while the ecoclimatic meaning is, at this level, predominantly motivated, the linguistic meaning is conventional or, in Saussurean terms, arbitrary. On the other hand, the signified aspect of the ecoclimatic prototype derives its semantic value not by reference to any particular signifier (in our terms ecoclimatic syntagm) but with reference to a wider context of already structured cultural and socio-economic values associated with architecture as a whole. Obviously, in doing so the semantic value

23. *The term 'system of social evaluation' is used here in its broader sense to refer to a system of evaluation which includes cultural, social and ideological values that for a given period represent the cultural, social and ideological superstructures of a community. Within such a system we can assign to prototypes, historical limits, conditions of use and generally we can re-introduce architecture through them.*

of the prototype becomes associated with a number of different eco-climatic syntagms in the same manner as a given syntagm is capable of being associated with different semantic values. This explains why prototypes usually present themselves as loose images which destroy both the actuality of the physical setting to which they refer and the precise meaning of the individual ecoclimatic sign. They do so in order to re-introduce a new semantic context, a new interpretation of the physical setting, on the basis of a higher order meaning; that of social evaluation.

Thus as myth "corrupts" language by destroying its conventional meaning<sup>24</sup> so the prototype corrupts physical actuality in order to re-introduce it within a different semantic context. The prototype does so by achieving a necessary abstraction of its original meaning at a level which permits the designer to re-introduce the prototype enriched by a new set of values which may be required by the design situation at hand. The discussion which follows investigates the nature of this abstraction and the particular forms it may take within the framework of syntagmatic structuralism which this thesis proposes as an appropriate descriptive methodology for the study of ecoclimatic phenomena and, more generally, of architecture.

#### 13.4 A SYNTACTIC ANALYSIS OF ECOCLIMATE

The aim of this section is to examine the question, posed in the previous section, concerned with the concept of "syntax" which was used in order to argue that ecoclimate should be studied both as a "second-order" and as a "third-order" semiological system (see

24. See BARTHES, R., *op.cit.*, p.131- .



table on pp 302-303). The concept of syntax is the key-concept for investigating appropriate levels of abstraction at which ecoclimatic structures either in a syntagmatic or in a prototypic form can be identified and described.

A syntactic investigation of ecoclimatic structures requires the adoption of a body of knowledge called "genetic structuralism" and the development of its terminology for the study of the specific object of this thesis: ecoclimate. It also requires a treatment of the concept of "syntax" on the basis of the methodological conclusions reached in the previous sections of this Chapter and in Chapter 12<sup>25</sup>, a requirement which implies a totally different approach to those followed by the current applications of semiological structuralism to architecture. The discussion is divided into two sub-sections:

13.4.1 The concept of syntax in linguistics and architecture.

13.4.2 Notes on the terminology concerned with a syntactic analysis of ecoclimate

#### 13.4.1 The concept of syntax in linguistics and architecture

In linguistics, "syntax" is a traditional term which refers to the study of the rules governing the way words are combined to form sentences in a language. An alternative definition of syntax refers to it as the study of the interrelationships between elements of sentence structure, and of the rules governing the arrangement of

25. *A major conclusion was that the study of architecture and of ecoclimate from a structuralist viewpoint requires an approach (we called it the syntagmatic approach) which includes both the idea of meaning and the idea of syntax. The general structuralist trends in architecture, however, have so far isolated themselves either upon purely semiological analyses dealing exclusively with 'meaning', or upon abstract, syntactic analyses dealing only with 'syntax' without systematic reference to the dialectics between meaning and syntax.*



sentences in sequences<sup>26</sup>.

In architecture and in all the areas to which a structuralist methodology tries to extend the linguistic model (either in a semiological version or in a genetic one) it has been assumed that these are areas in which meaning is produced and some mechanism like the linguistic syntax operates. In other words, the basic postulate of structuralist methodology as applied to both linguistic and non-linguistic areas is that meaning is the product of rule-governed mechanisms or structures.

There have been a number of different attempts to transfer the concept of syntax into architecture. C. Jencks, for instance, suggests:

"Another aspect architecture shares with language is more mundane than metaphors and words. A building has to stand up and be put together according to certain rules, or methods of joinery. The laws of gravity and geometry dictate such things as an up and down, a roof and floor and various storeys inbetween, just as the laws of sound and speech formation dictate certain vowels, consonants and ways of speaking them. These compelling forces create what could be called a syntax of architecture - that is the rules for combining the various words of door, window, wall, and so forth."<sup>27</sup>

26. See *'The Fontana Dictionary of Modern Thought'*, p.620. Even in linguistics, however, there is no common agreement about the definition of syntax. The different definitions range from the most autonomous and abstract formulations demonstrated by N. Chomsky (1965) to the most generative and semantic ones advocated by generative semanticists: J.R. Ross and G. Lacoff (1967), J.D. McCawley (1968), P.A.M. Seuren (1974) and others. The linguistic controversy generated between "autonomous syntax" and "semantic syntax" is an argument about the relation between the syntactic structure and the semantic representation of a sentence, a problem which is becoming more and more central in theoretical linguistic discussions. A similar problem also becomes central in architecture and particularly in developing the syntagmatic approach.

27. JENCKS, C., (1977), p.72.

Apart from using the concept of syntax in the above rather loose sense and by the straight importation of linguistic analogies, there have been attempts to introduce a more rigorous syntactic terminology into architecture. A notable example of such an attempt is the work of Hillier and Leaman on "space syntax". They suggest that architecture can be described in terms of an architectural syntax made of functional variables such as contiguity, differentiation, boundaries, and permeability, and operational rules aiming at transforming simpler architectural structures into more complex ones<sup>28</sup>.

To understand the importance of Hillier and Leaman's work in applying a syntactic logic to architecture we should consider first the way in which the involvement of meaning in a linguistic structure has been related to syntax. In linguistics this relationship takes the form of a chain which connects "deep" and "surface" linguistic structures. The surface structure of a sentence is the string of sounds or words that we articulate and hear. A deep structure of a sentence is a level of structural organization in which all the factors determining structural interpretation are defined and inter-related. Syntax in this sense operates by generating a set of deep structures and conveying these into surface structures by applying a set of transformational rules. Hillier and Leaman have shown that in architecture the 'deepness chain' is inadequate to define an architectural syntax and that architectural structures have to be explained at a level where the complex architectural structures we observe are produced by the transformation of 'elementary' ones. Thus, they

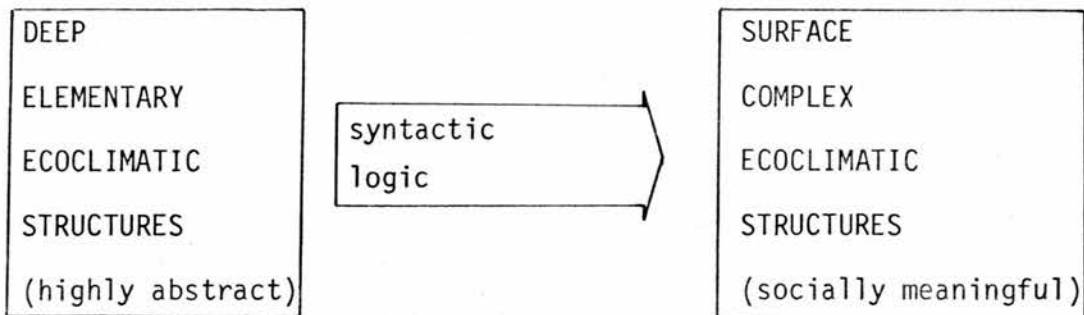
28. See HILLIER, B. and LEAMAN, A., *The Architecture of Architecture*, RIBA Intelligence Unit, November 1973 (unpublished paper) and *Space Syntax: A Formal Sketch*, March 1975 (unpublished).

suggest that an architectural syntax has to deal simultaneously with both a deepness and a complexity chain and this can be done using a "commutative square" logic of the kind demonstrated by them<sup>29</sup>. In the following section it is shown how a similar logic may be used in an approach to developing what may be called an ecoclimatic syntax.

#### 13.4.2 Notes on the terminology concerned with a syntactic analysis of ecoclimate

Most of the arguments in this section originate in the collective work of Appendix I and Appendix II both of which are concerned with the problem of description in architecture. In particular, I present here those arguments which are related to the terminology of a syntactic approach to microclimatic and ecoclimatic structures; a task which is necessary to elaborate further the syntagmatic approach to ecoclimate developed in this thesis.

To study ecoclimatic structures from a syntactic point of view means to study the formal logic by which deep-elementary ecoclimatic structures are transformed into the complex-surface ones at which social signification is achieved:

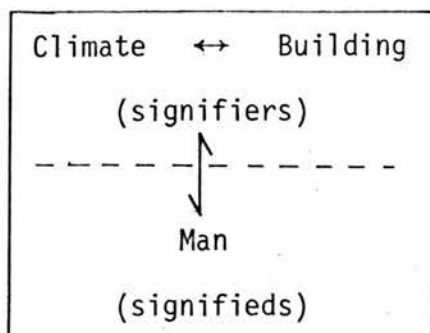


Using the structure of the elementary ecoclimatic sign presented in the previous chapter<sup>30</sup> the figure above can be changed into the following one which is ecoclimatically more meaningful:

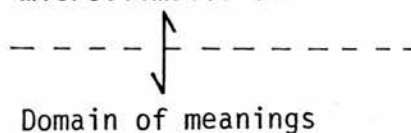
29. HILLIER, B. and LEAMAN, A., (January 1974).

30. See p.285.

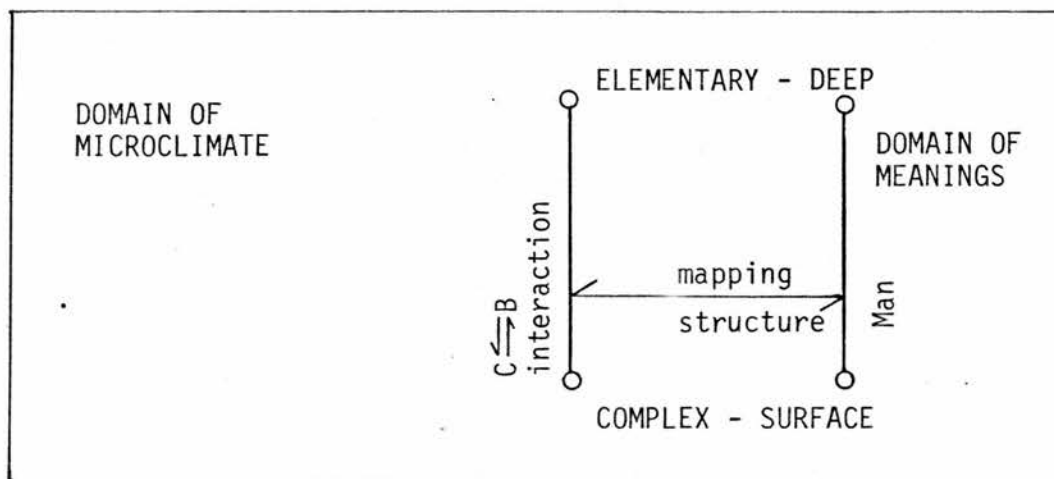
## The elementary ecoclimatic sign



Domain of objects:  
formation of elementary  
microclimatic structures



thus:



The dialectics between climate and buildings as physical objects produce the domain of physical realities in which the ecoclimatic signifiers originate through elementary structural formations. In studying these dialectics we have accepted that:

- (i) The elementary operation of modifying climate - when it is considered achronically and on a statistical basis - is "barrierization" of physical climate.
- (ii) The outcome of barrierizations are differentiations in the climatic fields which produce the microclimate of the built environment.
- (iii) The differentiations of climatic fields may be identified by physical and/or "semantic boundaries" of the type indicated in the figure below.

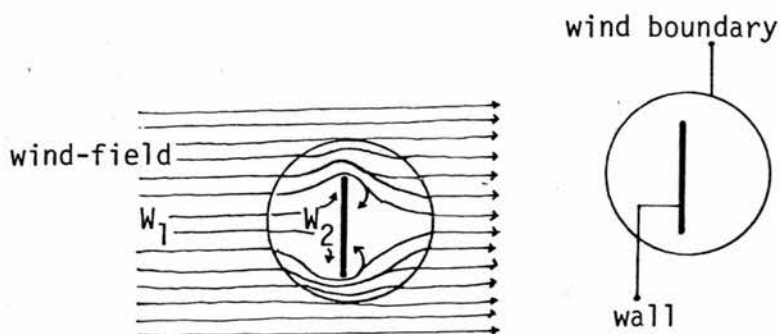
TYPES OF ECOCLIMATIC BOUNDARIES					
SEMANTIC		PHYSICAL			
cold	(warm)	rain	(absence of rain)	10°C	(25°C)
cheap	(expensive)	comfort	(dis-comfort)	10° Hum.	(60° Hum.)
outdoor	(indoor)	...	...	...	...
...	etc.	...	etc.	...	etc.
Boundaries described by applying different semantic values to the same properties		Boundaries described in negational terms (absence-presence) of a property		Boundaries described through quantitative differentiations of set of properties.	

The analysis which follows deals with the dialectics of the concepts of "barrier" and "boundary" and the way in which they produce elementary ecoclimatic structures which are equipped with complexity and deepness chains and transformational rules, in order to form an abstract ecoclimatic syntax. It should be pointed out, however, that this analysis is carried out at an environmental level which is one among other possible levels (e.g. activity and institutional levels) at which ecoclimatic structures may be identified. The interest therefore of this discussion is not to present a comprehensive ecoclimatic syntax which would be used to explain all the possible images in which an ecoclimatic prototype manifests itself (e.g. environmental, activity, institutional) although some suggestions as to how such a syntax may be achieved are given later in this discussion. In simplifying the situation by isolating ecoclimate at

an environmental level the primary aim is to discuss the logic by which a syntactic analysis of ecoclimate can be developed and the terminology concerned with it.

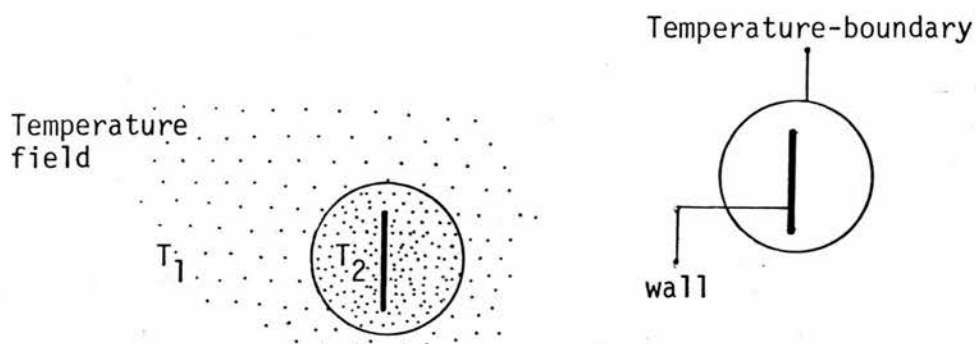
The notion of "barrierization" in modifying climate implies that building elements acquire a barrier function which operates in such a way that elementary microclimatic boundary structures are produced. Consider a building element, for instance a wall. By creating a wall we modify the various climatic fields such as wind, temperature, radiation, humidity, precipitation. The result is that different boundaries are produced, attributing to the specific operation of barrierization a multifunctional character, and at the same time these boundaries indicate the particular differentiations which occur in each climatic field.

Take the example of a wall immersed into a wind-field. In relation to the wind-field the wall constitutes a wind-barrier and, introduces through differentiation a wind-boundary as indicated below:

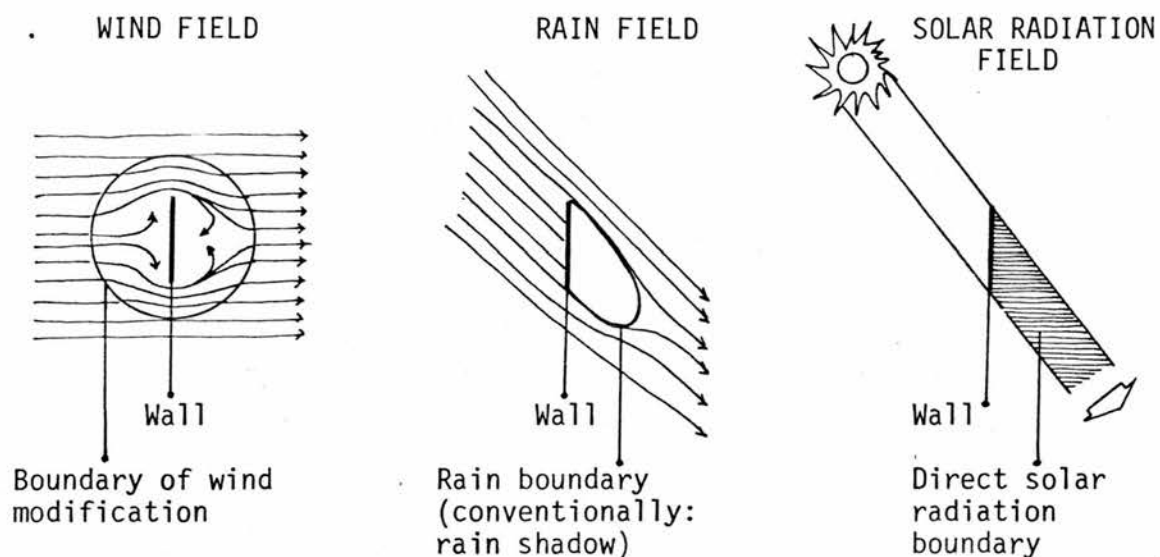


A similar pattern may be produced if we consider the wall immersed in a temperature-field. The wall becomes a temperature-barrier and introduces, eventually, a temperature boundary:

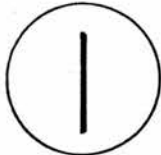
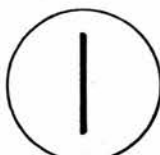






So it is easy to imagine that for each climatic field the wall (or any other building element) operates as a field-barrier producing differentiations in these fields which result in the production of field boundaries:

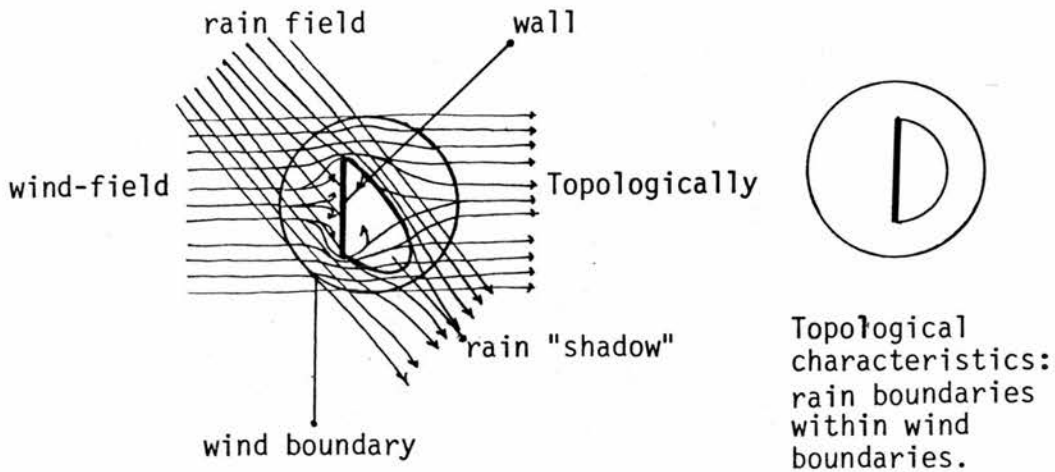


The physical properties which interconnect these fields in the classical theory of physics, imply some fundamental characteristics of the elementary microclimatic deep structure which are analogous, for instance, to the rule of linearity in language. The topological characteristics of elementary microclimatic barrier structures are shown below:

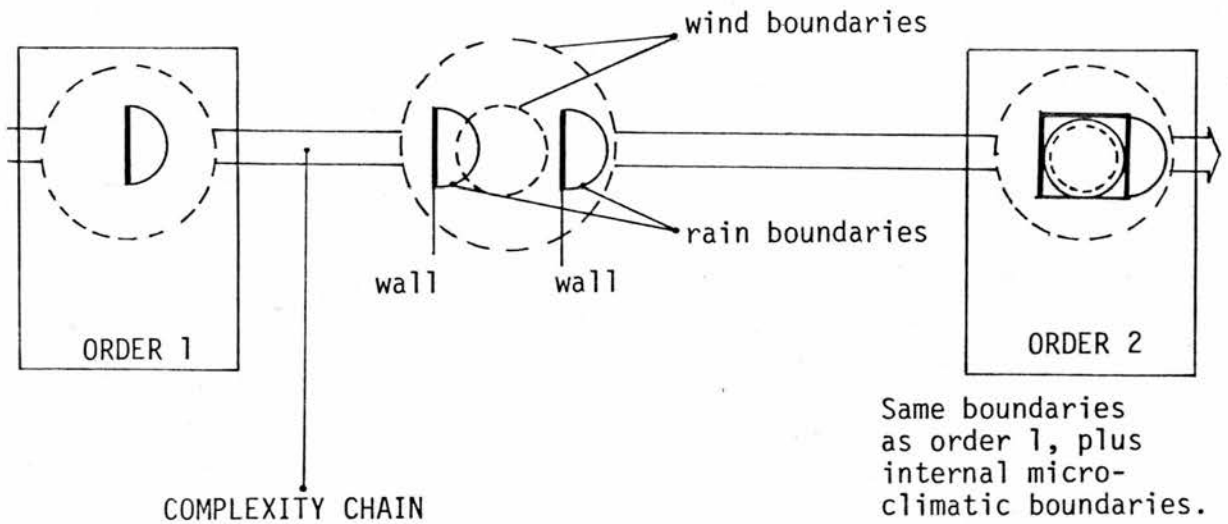
			
Wind modification boundary: Always on both sides of the barrier	Temperature modification boundary: Always on both sides of the barrier	Rain boundary: Always on the one side of the barrier.	Direct solar radiation boundary: Always on the one side of the barrier.
Boundaries formed through modification		Boundaries formed through negational differentiation.	

Obviously, these images have been derived from the involvement of a semantic dimension rather than from a pure physical actuality. Of course, in a strictly physical sense, rain and solar radiation boundaries can be thought of as modificational boundaries, thus becoming identical with the wind and temperature boundaries. However, we have considered them in the way shown in the diagram above - taking "modification" in terms of wind and temperature but "presence-absence" for rain and direct solar radiation - because, in architectural thinking, even abstract elementary structures cannot be isolated from a certain semantic context.

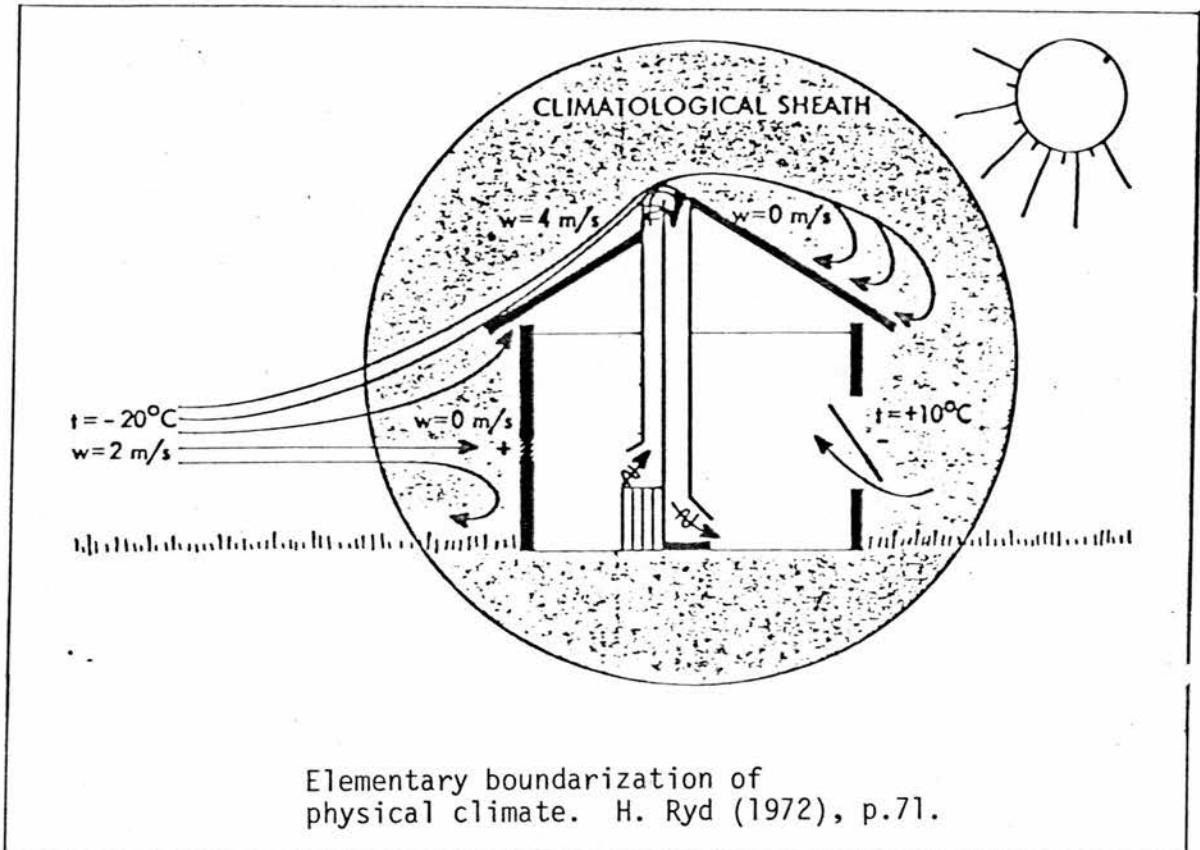
In order to examine how complexity chains are formed which account for the transformations of elementary microclimatic structures into complex ecoclimatic structures at higher levels, we must examine first how integrated elementary structures arise within climatic fields defined by more than one climatic parameter. Consider, for instance, a wind and rain climatic field:



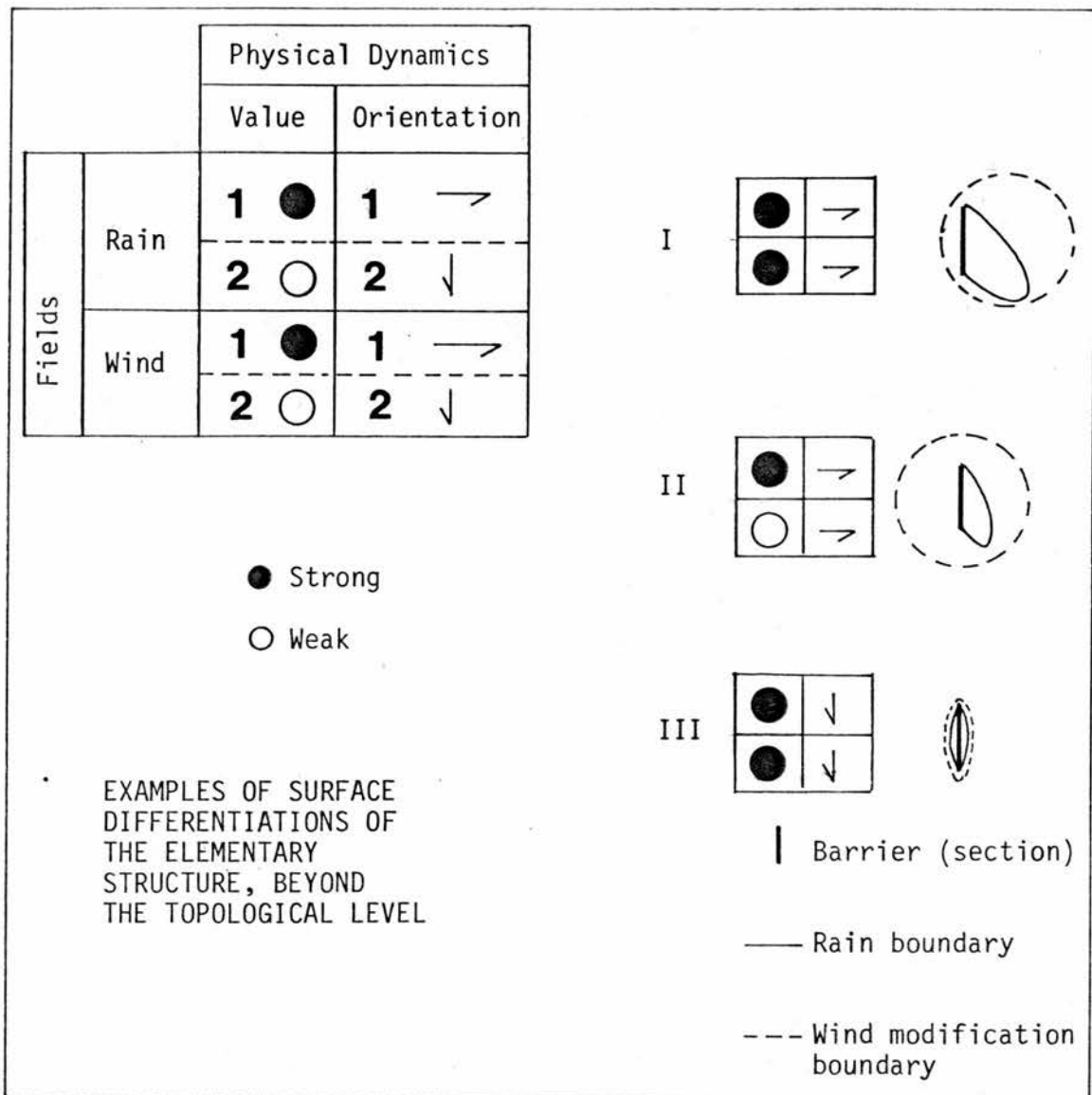
These structures are transformed through an aggregation function of the barrier into more complex organizations. An example is the microclimatic enclosure:



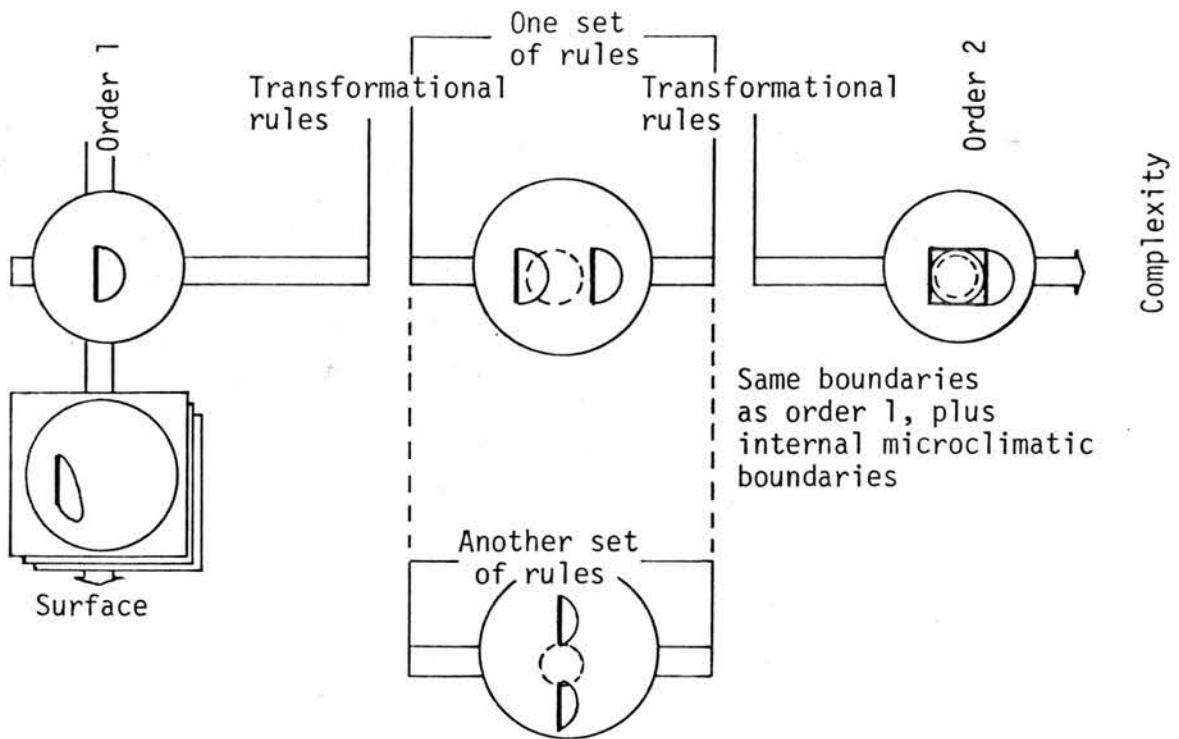
Building climatology has already realized the significance of conceptualizing microclimate in terms of abstract formulations of the elementary boundarization of physical climate. An interesting example is H. Ryd's concept of the "climatological sheath".



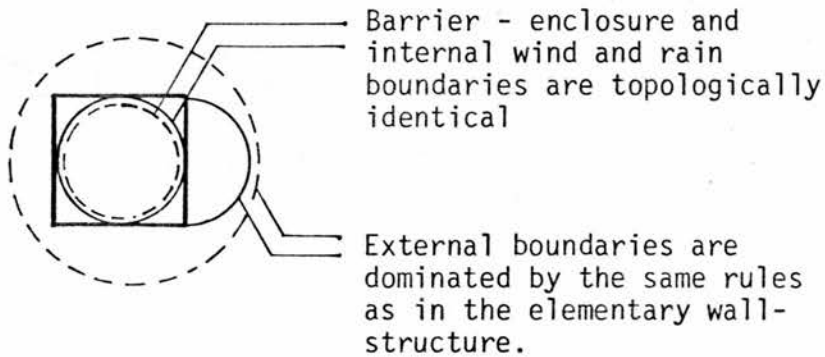
So far, we have discussed how microclimatic structures are transformed from an elementary into a complex level. However, according to the initial model on p.310 ecoclimatic structures are also transformed from a deep-abstract level into surface-meaningful one. The path from deep structures to the surface ones may only be understood through the dialectics between abstract syntactic microclimatic structures and the semantic context associated with them. The figure below indicates schematically how a semantic context consisting of some physical variables of the climatic fields produces surface differentiations of the elementary microclimatic structures discussed earlier:



What has been suggested so far by our analysis of the ecoclimatic syntax - when this syntax is considered only at an environmental level - is that in order to identify an ecoclimatic structure at a level of syntactic abstraction we must identify the rules by which elementary ecoclimatic structures are transformed into the higher complex levels at which they are commonly understood. The argument has been that these transformational rules are to be found in two evolutionary chains: the complexity chain (from elementary-to-complex realities) and the deepness chain (from dee-abstract-to-surface-meaningful realities):

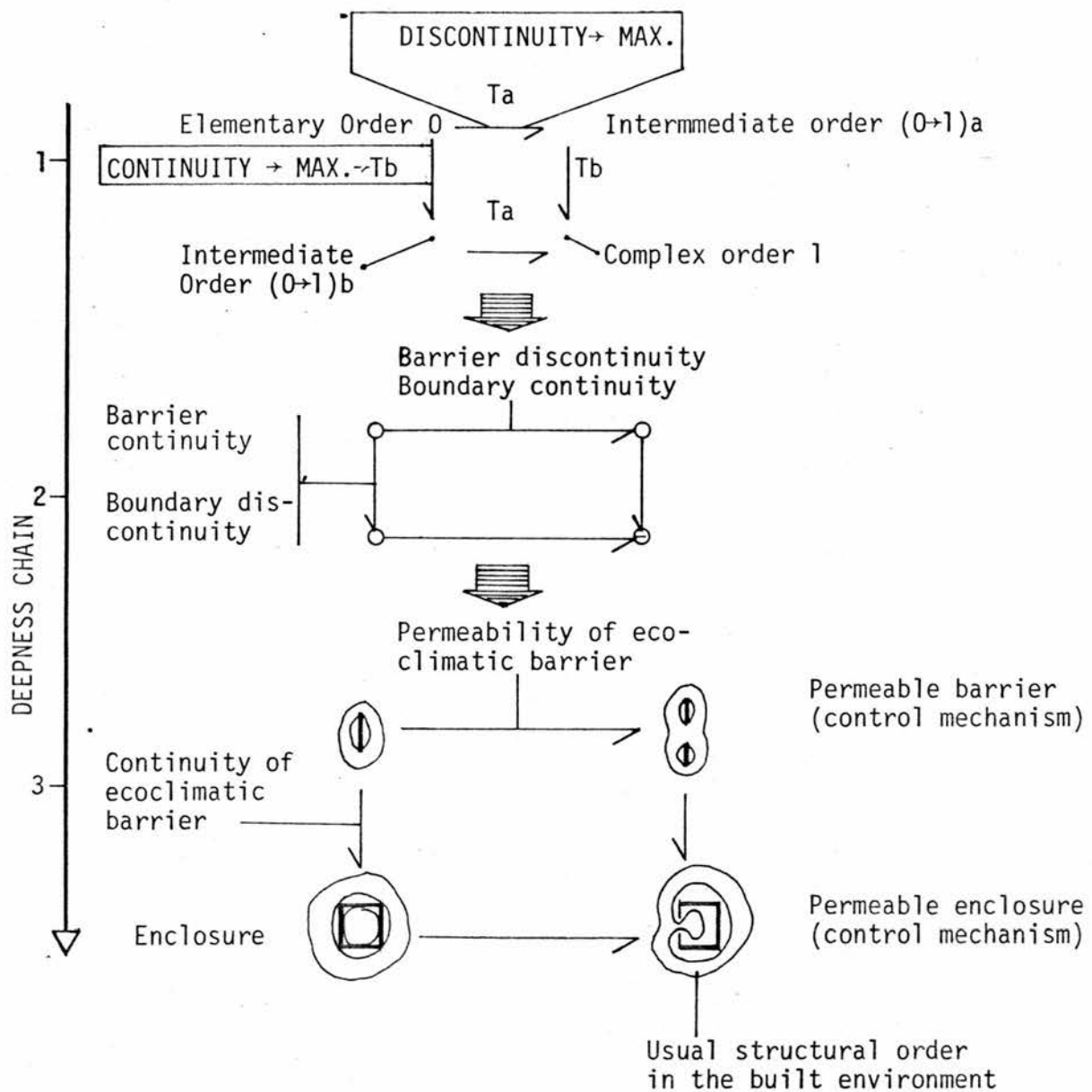


Again, the physical properties that interconnect the microclimatic fields imply fundamental characteristics of a "higher complexity deep structure", such as:



To illustrate the way in which transformational rules work within a syntactic chain, in order to transform the elementary-deep ecoclimatic structures into the surface-complex ones, consider once again the dialectics between "barrier" and "boundary" enriched with functional variables such as "continuity", "discontinuity" and "permeability" structured by an abstract commutative square logic:





A further development of an ecoclimatic syntax beyond the level of the environmental representation of the ecoclimatic structures has to consider what in Appendix II we called the "descriptive dimension of architectural structures". According to our analysis given there:

- (i) Complexity chains are to be identified in the decision-making process but each one of them is necessarily developed within the framework of a given substance (for instance, a complexity chain may refer to microclimatic organization in one case or to activity organization in another case, and so on, that is to group of signs or syntagms of the same substance).
- (ii) The deepness chain is a semantic chain which connects deep

ecoclimatic structures with observable surface ones by assigning to them a certain semantic context. However, in the case of multidisciplinary structures, such as the ecoclimatic ones, the semantic context assigned to a deepness chain is dominated not only by environmental values but also by activity, organizational and institutional values. This explains why an ecoclimatic prototype can be recognized at an environmental, an activity and an institutional level. The following table shows how the descriptive dimension may provide a variety of different semantic contexts organized in three deepness chains.

Both the deepness chain and the descriptive dimension, which are involved in a syntactic approach to ecoclimate, suggest that such an approach cannot be formulated outside the semantic domain associated with these phenomena. In fact, I have suggested that the semantic domain of ecoclimate plays a critical structural role in the formulation of its syntax, particularly in terms of defining appropriate levels of optimum abstraction at which the complexity, deepness and descriptive dimensions of such a syntax are to be identified. Further, I have suggested that within a structural approach to ecoclimate (as opposed to language) even the most abstract formulations cannot be separated from their semantic context through mapping structures or projectional rules. It is through a careful investigation of the plurality of meanings of the ecoclimatic phenomena as this plurality is expressed in environmental, activity and institutional terms, that the ecoclimatic system can be studied at the level of 'sign' (1st order semiological system), at the level of 'syntagm' (2nd order semiological system) and at the level of 'prototype' (3rd order semiological system). See table pp. 302-3.

In closing this section and the discussion of this Chapter, let me stress the point that the analysis of ecoclimate presented here is not intended to provide a syntactic explanation of the phenomena

		DESCRIPTIVE DIMENSION →		
		EKOCLIMATIC IMAGES		
		ENVIRONMENTAL	ACTIVITY	INSTITUTIONAL
Super-Surface Structure		Ecoclimatic environment as seen and experienced by the layman	Performance of activities allowed by a real ecoclimatic setting	Common behaviour patterns organized within an institutionalized eco-climatic setting
Surface Structure		Ecoclimatic compartmentalization of the environment: syntagms, prototypes, etc.	Organization of activities within accepted eco-climatic syntagms, prototypes etc.	Historical process of social internalization of eco-climatic prototypes
Deep Structure		Predominant micro-climatic structures dependent on location, geography climate, etc.	Basic activity pattern allowed by the micro-climatic structure: indoor, outdoor activities, movement, etc.	Factors affecting the production of the ecoclimatic environment such as professional structure, building regulations, etc.
Underlying Strings		Building physics, thermodynamics, laws of atmospheric motion, radiation, etc.	Psycho-physiological functioning of the human body: thermal balance, metabolic rate, etc.	Socio-economic and political framework: mode of production, division of labour, etc.
Chosen Elements		Resources, materials, climatic fields, etc.	Who, when, from where, to where, etc.	Societal form: egalitarian, industrialized, etc. and factors such as urbanization, centralization, etc.

dealt with in this work. What I have tried to indicate is an approach by which genetic structuralism could be developed into a supplementary methodological framework to which the semiological analysis of ecoclimate could be extended.

## CHAPTER 14

## THE SYNTAGMATIC CHARACTER OF ECOCLIMATIC STRUCTURES

## 14.1 INTRODUCTION

In this chapter, the discussion elaborates the methodological conclusions reached in the previous chapters, particularly in the last two, and develops through them an appropriate structural framework for the study of the ecoclimate of the built environment.

In Chapter 11 I argued that:

"... there is a level at which the methodological advantages of both the genetic (general and abstract) and the semiological (analytical, but socially meaningful) approaches may be obtained."<sup>1</sup>

This level has been called "syntagmatic", and the methodology concerned with it, "syntagmatic structuralism"<sup>2</sup>. The major attributes which characterize syntagmatic structuralism are: First, that meaning is not external to the elementary structural formations nor to the syntactic evolution of the structure and its logical tools (e.g. complexity and deepness chains, transformational rules), but that meaning has to play an "internal" structural role. Second, that meaning is included in the structure in its higher form of social evaluation. The term "syntagmatic structuralism" may be compared to Pettit's "syntagmatic approach"<sup>3</sup>. The syntagmatic approach is, for

1. See Ch.11, p. 268.
2. Refer to the discussion in the previous 2 chapters dealing with the concepts of "syntagm", "syntagmatic level" and "syntagmatic structuralism".
3. PETTIT, P., (1975), pp.11-15, 16-17,29.

him, the one which leads into a "generative syntax" like that put forward by Chomsky. However, Pettit does not exclude the idea that the syntagmatic strategy is closer to generative semantics (Pettit's term "differential semantics")<sup>4</sup>, as it is argued in Appendix II. My position here is that as far as the application of the linguistic model is concerned to the non-literary arts (like architecture) the "syntagmatic approach" differs from the Chomskian one in that it excludes the possibility of structural evolution through "mapping mechanisms" relating deep structures to their semantic representations.

The major objective in this chapter is to show that architectural and ecoclimatic phenomena demand a descriptive methodology developed within the framework of syntagmatic structuralism. The argument is presented in the following three sections:

1. Architectural structures and social evaluation.
2. The syntagmatic character of architectural and ecoclimatic structures.
3. The study of ecoclimatic prototypes within the framework of syntagmatic structuralism.

The whole of the discussion in this chapter is supplemented by the two Appendices which examine in more detail some theoretical and terminological aspects concerned with a syntagmatic interpretation of architectural and ecoclimatic structures. In particular, Appendix II discusses some problems related to the "identity" and "dynamics" of descriptive theories which deal with multi-disciplinary architectural structures, such as the ecoclimatic ones. Further, it develops a syntagmatic language - on the basis of a "contradictional logic" -

4. *Ibid.*, pp. 27-29.

by which the transformational potential of architectural and eco-climatic structures can be studied.

#### 14.2 ARCHITECTURAL STRUCTURES AND SOCIAL EVALUATION

The significance of social evaluation in structuring methodological tools for dealing comprehensively with architectural phenomena is presented in detail in section 4 of the collective paper which appears in this thesis as Appendix I. In addition to that, Chapter 12 presented a detailed discussion of the generation of meaning into the higher form of social evaluation within a purely semiological framework<sup>5</sup>. Here I will bring together the points made in the above discussions and elaborate further on the structural role played by the system of social evaluation in the study of multi-disciplinary architectural structures.

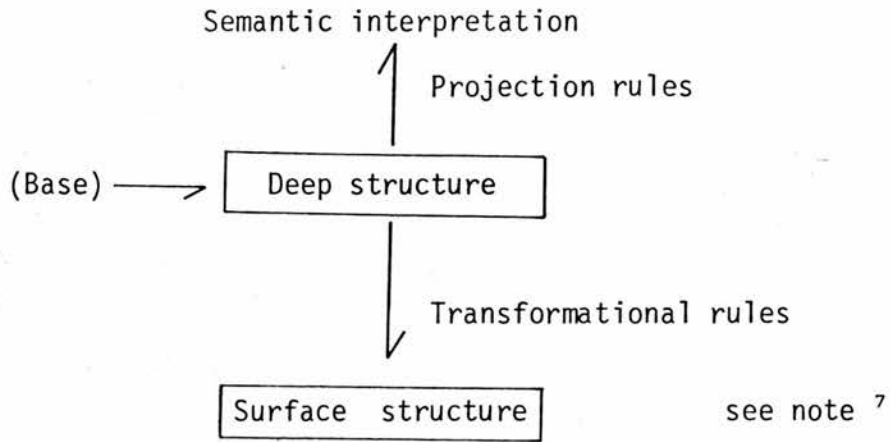
The problem of how meaning is related to structure is pertinent not only to linguistic structures but also to any type of structure where meaning is involved. The controversy over the use of "interpretive" and "generative" approaches to semantics in linguistics may serve as a starting point for this discussion. In Appendix I the argument is presented in the following manner:

"According to the initial model by Chomsky<sup>6</sup> semantics in linguistics are derived from the syntactic deep structure as follows:

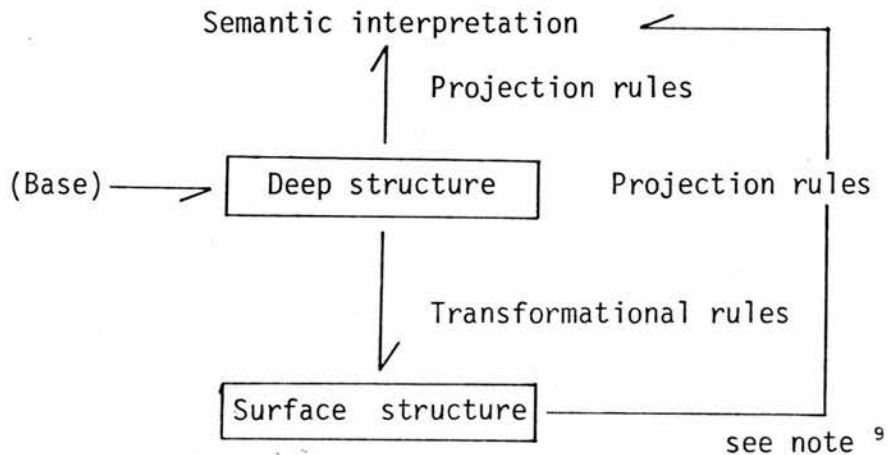
5. See Ch.12, pp. 272, 274, 276, 286.

6. CHOMSKY, N., (1965).





By 1970, Chomsky revised this model<sup>8</sup> to the following one:



Both Chomskian versions constitute what has been called the 'interpretive approach' to semantics and, thus, have been distinguished from a more recent approach called 'generative'<sup>10</sup>. According to the generative approach, semantic interpretation is no longer derived from the purely syntactic deep structure, but the structure is so deep (this is what is called the 'base' in the Chomskian versions) as to be identical with semantic interpretation. In this manner projection rules disappear and the model becomes simpler as follows<sup>11</sup>:

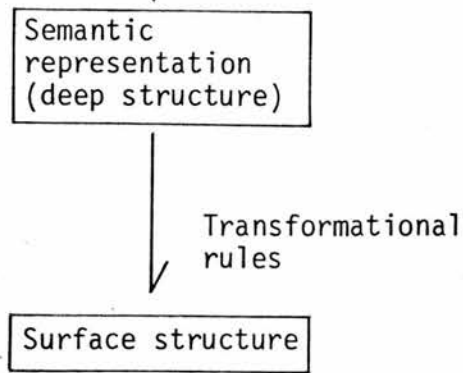
7. After LEECH, G., (1974).

8. CHOMSKY, N., *Deep Structure, Surface Structure and Semantic Interpretation*, in: JAKOBSON, R., KAWANOTO, S., (eds.), *Studies in General and Oriental Linguistics*, Tokyo, T.E.C. Company, 1970.

9. After LEECH, G., 1974, *op.cit.*, p.329.

10. *Ibid.*, p.324 ff.

11. *We are not dealing here with phonology.*



see note <sup>12</sup>

Traditionally, semantics deal predominantly with the concept of 'meaning'. C.K. Ogden and I.A. Richard wrote on what they called 'the meaning of meaning'<sup>13</sup>. The important point made by Ogden and Richard (1923), later by Bloomfield in 'Language' (1933) and quite recently by Leech in 'Semantics' (1974) is that meaning may best be studied as a purely linguistic phenomenon in its own right. Leech, however, proposed instead of meaning the concept of 'communicative value'<sup>14</sup>. Value in semantics explains the way in which the meaning of a semantic unit is developing from the total set of semantic units. In this way, value introduces the notion of 'system of evaluation' which in the case of language is, of course, one aspect of the system of communication. This means that, apart from the system of verbal communication - with which language is concerned - we can refer to a broader semiotic framework which extends the dimension of communicative value beyond language."

In Chapters 12 and 13 I discussed the process by which meaning is attached to non-linguistic signs, such as ecoclimatic ones, and by which it incorporates the social and historical character of these signs, and allow us to introduce the broader concept of "social evaluation". So, as we argue in Appendix I, the simple concept of meaning, appropriate for linguistics, is replaced by the concept of "historically created social evaluation" which allows us, even starting from a purely semiological base, to enlarge its context in order to include the broader social character of systems like architecture.

12. After LEECH, G., 1974, *op.cit.*, p.330.

13. OGDEN, C.K., RICHARD, I.A., (1946).

14. LEECH, G., 1974, *op.cit.*, p.27.

Accepting the historical evolution of the social evaluation of architectural products means to accept also that each particular historical period is characterized by a particular balance of systems of evaluation. The history of architecture suggests that aesthetics and symbolism, as communicative values, have dominated the production of official or religious architecture. This weighting was shifted onto economic grounds during the twentieth century and this economic predominance in the system of social evaluation became the basis of our contemporary "symbolism"<sup>15</sup>.

However, official and religious buildings have never been the only forms of architecture and it can be argued that vernacular architecture has been the real expression of the needs and values of a culture, and that this has always been dominated by ecological and economic values rather than by symbolic and aesthetic in its system of social evaluation<sup>16</sup>.

In summary, the main characteristics of the relationship between architectural structures and social evaluation are as follows:

15. *The argument for economically based social evaluation of architecture is presented in Appendix I, pp. 399-401. A further development of this argument does not constitute an objective of this chapter. Although it might appear that the proposed economic predominance in the system of social evaluation is an oversimplification, I am adopting it as an assumption in order to illustrate the development of the syntagmatic model.*
16. *See Rapoport's differentiation between "grand design tradition" and "folk tradition" in architecture. Buildings of the grand design tradition, represented by the official and religious architecture of the past were, according to Rapoport, "built to impress either the populace with the power of the patron, or the peer group of designers and Cognoscenti with the cleverness of the designer and good taste of the patron". On the other hand, Rapoport argues that the folk tradition, represented by vernacular buildings, "... is the direct and unselfconscious translation into physical form of a culture, its needs and values - as well as the desires, dreams, and passions of a people... . The folk tradition is much more closely related to the culture of the majority and life as it is really lived than is the grand design tradition, which represents the culture of the elite. The folk tradition also represents the bulk of the built environment". RAPOPORT, Amos, (1969), p. 2.*

First, the semantic domain of architectural structures is dominated by systems of social evaluation which are historically produced. The system of social evaluation operating in contemporary architecture is dominated by economic values expressed either in the form of land use and economic exchanges or, indirectly, through a transformation of the economic order to aesthetic and symbolic languages.

Second, the system of social evaluation, being historically produced, is not external to the production of architectural artefacts, but plays a structural role, not only in terms of their production but also in terms of the methodological tools employed in their study. A major methodological argument is that architectural structures - being socially and historically evaluated - cannot be studied at abstract syntactic structural levels (as can, for instance, linguistic structures) but only at levels where the generation of architectural structures can be socially evaluated. Another methodological argument is that architectural structures cannot fruitfully be studied only synchronically and employ rational procedures in their investigation, but that they demand diachronic consideration which enables their historical character to define the system of social evaluation which operates in their production.

Third, the balance of different values in the system of social evaluation of architectural structures depends both on the socio-historical conjuncture in which they are produced and on the syntactic properties of architectural products (e.g. being of static and unique character, commodities of high economic cost, non-reproducible).

The notion of "syntagmatic structure", as defined in Chapter 12 and Chapter 13 in relation to social evaluation, is an inevitable

consequence of the high complexity of multi-disciplinary architectural structures when they are considered within the context of their social evaluation. This eventually leads us to examine in detail the syntagmatic character of architectural and of ecoclimatic structures.

#### 14.3 THE SYNTAGMATIC CHARACTER OF ARCHITECTURAL AND ECOCLIMATIC STRUCTURES

The term "syntagmatic structure" refers to a type of structure produced in a "generative"<sup>17</sup> manner, that is, by simultaneous reference to both syntactic and semantic levels. Thus, the syntagmatic approach to a structure includes the social evaluation of even the elementary deep structures.

It is interesting to examine further the similarities between the notion of "syntagmatic structure" and that of the "prototype" in architecture. In Appendix I we expressed the relationship between these notions as follows:

"The function of prototypes in architectural practice has characterized its whole history both at a "language" level by producing different styles and at a "speech" level by influencing the individual way in which architectural surface structures have always been produced. What we propose here is that prototypes do not constitute anything but syntagms in which the semantic component cannot be isolated from the syntactic one. Particularly in architecture prototypes have played the role of "already structured" elementary units which always carried a special meaning. Apart from this obvious way in which every-day architecture has been practiced, even revolutionary moments in architectural history could not be explained syntactically as one would expect at first sight. What happened, for example, in recent architectural history is that only the communicative meaning has been minimized while social evaluation - that is, pragmatic meaning - has been enlarged and has been mainly dominated by economic values."<sup>18</sup>

17. *Refer back to the discussion in Ch. 13*

18. *Refer to Appendix I and particularly to the 5th section.*

In the discussion which follows and which presents some architectural and ecoclimatic examples we shall see how different emphases have been given to the system of social evaluation - in a syntagmatic way - and also how such syntagmatic approaches differentiate the syntactic chains which might be derived from them. Some of these examples are discussed in Appendix I where they originated; however, I shall elaborate on certain aspects of them and, at the same time, introduce some additional ecoclimatic examples in order to illustrate further the syntagmatic character of ecoclimatic structures.

An understanding of the concept of "spatial schema" is an important step towards an understanding of the significance of Lynch's work *The Image of the City*. The term "schema" has been used earlier in Chapter 4 to refer to the ecoclimatic schema in an epistemological sense<sup>19</sup>. "Spatial schema", however, as it is used in environmental psychology, refers to a mentally structured reality, an image of a reality, which though related to the physical organization of space does not coincide with it. The spatial schema organizes space topologically. For instance, Lynch suggests that certain features of the physical environment create "edges" beyond which the individual does not typically penetrate. Also, Lee (1968)<sup>20</sup> and Steinitz<sup>21</sup>, among others, confirm boundary formations in cities. Such boundary

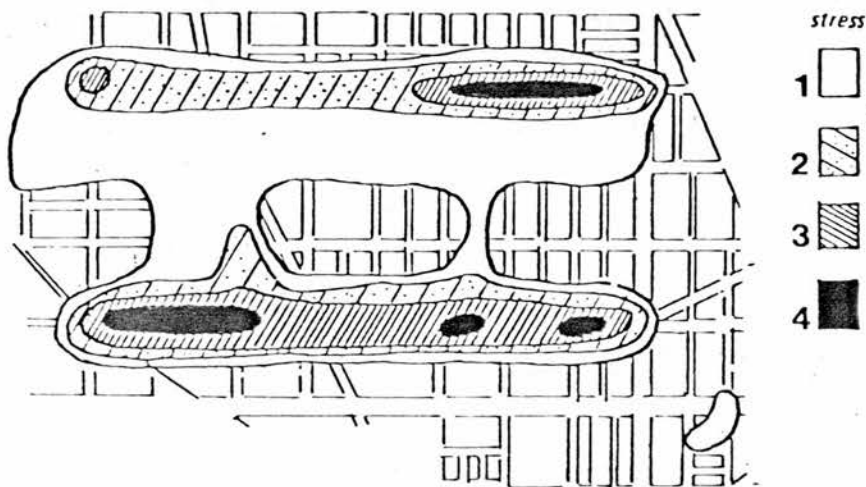
19. For the use of the term "ecoclimatic schema" refer to the discussion in Ch. 4, sec. 4.3 and 4.4.

20. See, LEE, T.R., 1968, *Urban Neighbourhood as a Socio-Spatial Schema*, *Human Relations* 21, pp.241-67, and also to his paper, *Psychology and Living Space*, in: DOWNS, R., STEA, D., (eds.), *Image and Environment*, (1973), pp.87-108.

21. STEINITZ, C., (1968), *Meaning and Congruence of Urban Form and Activity*, *Journal American Institute of Planners*, Vol.34, pp.233-48.



formations are based on systems of social evaluation (e.g. "perceived environmental stress", "preference", "unfamiliarity") which structure and group the spatial schemata of a culturally homogeneous group of people<sup>22</sup>. Experiments on what have been called "mental maps" are useful in showing how systems of social evaluation may produce syntagmatic chains which are totally different from the syntactic ones:



Mental mapping:

The perceived environmental stress surface for a portion of Philadelphia

In *The Image of the City*, Lynch is concerned with "the look of cities, and whether this look is of any importance, and whether it can be changed"<sup>24</sup>. He points out that:

22. According to T.R. Lee, the same schemata are shared by the same sort of people in the same kind of environment. See LEE, T.R., (1973), *op.cit.*, p.99. However, it is obvious that spatial schemata are also conditioned by culture, group learning and individual learning.
23. In: GOULD, P., WHITE, R., *Mental Maps*, Penguin, (c.1974), p.31. (After David LEY in: *The Black Inner City as a Frontier Outpost: Images and Behavior of a North Philadelphia Neighbourhood*, University Park, Pennsylvania, PhD Dissertation, 1972).
24. LYNCH, K., *The Image of the City*, MIT Press 1973 (c.1960), Preface.

"So various are the individual meanings of a city, even while its form may be easily communicable, that it appears possible to separate meaning from form, at least in the early stages of analysis. This study will therefore concentrate on the identity and structure of city images."<sup>25</sup>

Nevertheless, Lynch could not avoid the syntagmatic dimension in his work and hence admits that symbolic, aesthetic, and other values beyond the communicative one are also of equal, if not of more, importance. It might be argued that it is the syntagmatic character of city images that permits them to be grouped according to social classes, age, sex, profession, education, etc., even at a communicative level.

Our interpretation of Lynch's work, in the collective paper of Appendix I, was that he tried to investigate syntax chains which were evaluated socially in terms of human perception, cognition, and communication. The components of his elementary structure<sup>26</sup>, inevitably include this particular kind of semantic interpretation, and consequently, the whole structural chain does the same and therefore belongs, by definition to the syntagmatic approach<sup>27</sup> (see figure next page).

Gould and White's work on 'mental maps' is similar to that of Lynch but at a larger geographical scale<sup>28</sup>. Their approach, apparently of syntagmatic nature, emphasizes the difference between people's spatial or geographical schemata and reality. It also shows how flexible are the syntactic chain and social evaluation according to the system of meaning we use.

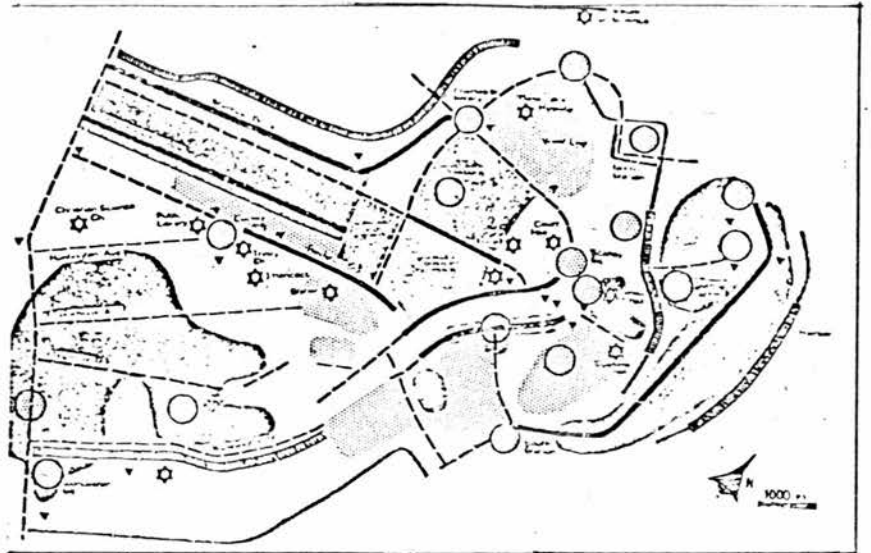
25. *Ibid.*, p.9.

26. "Paths", "edges", "districts", "modes", and "landmarks".

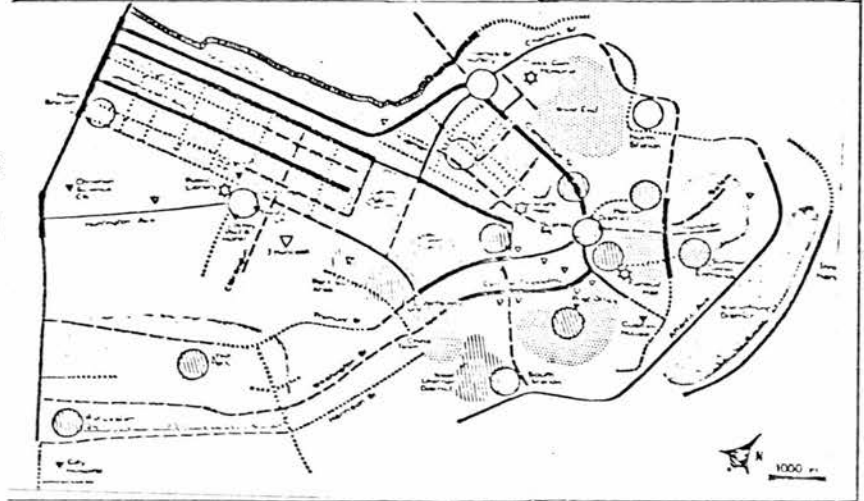
27. For a further discussion on this example, see Appendix I, pp. 404-5.

28. GOULD, P., WHITE, R., (1974).

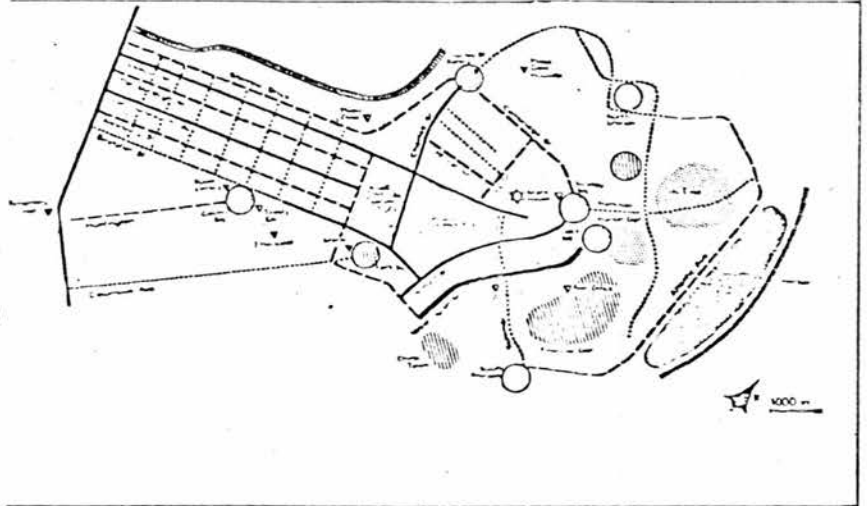
- (a) The visual form of Boston as seen in the field



- (b) The Boston image as derived from verbal interviews

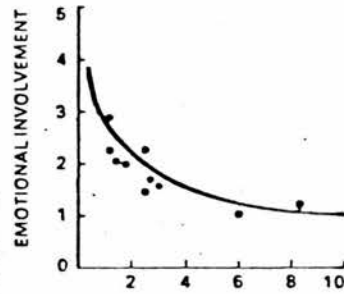


- (c) The Boston image as derived from sketch maps

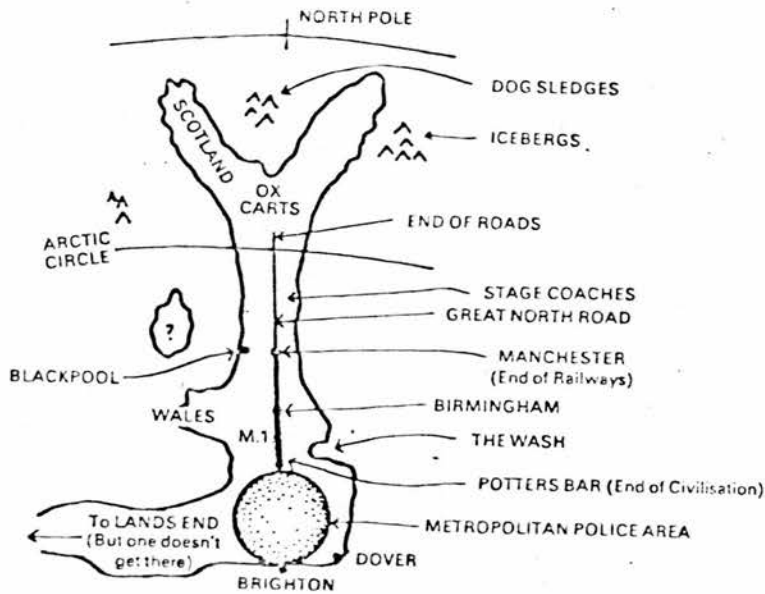
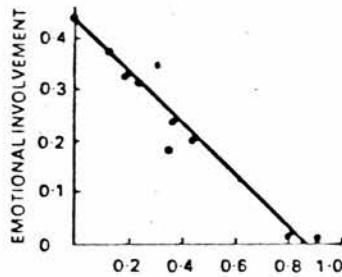


LYNCH, K., (1960), pp.146-147. *The system of meaning is derived from the techniques which are used for selecting people's syntagms on the basis of visual perception, cognition and communication.*

- a. The degree of emotional involvement related to distance in logarithmic coordinates



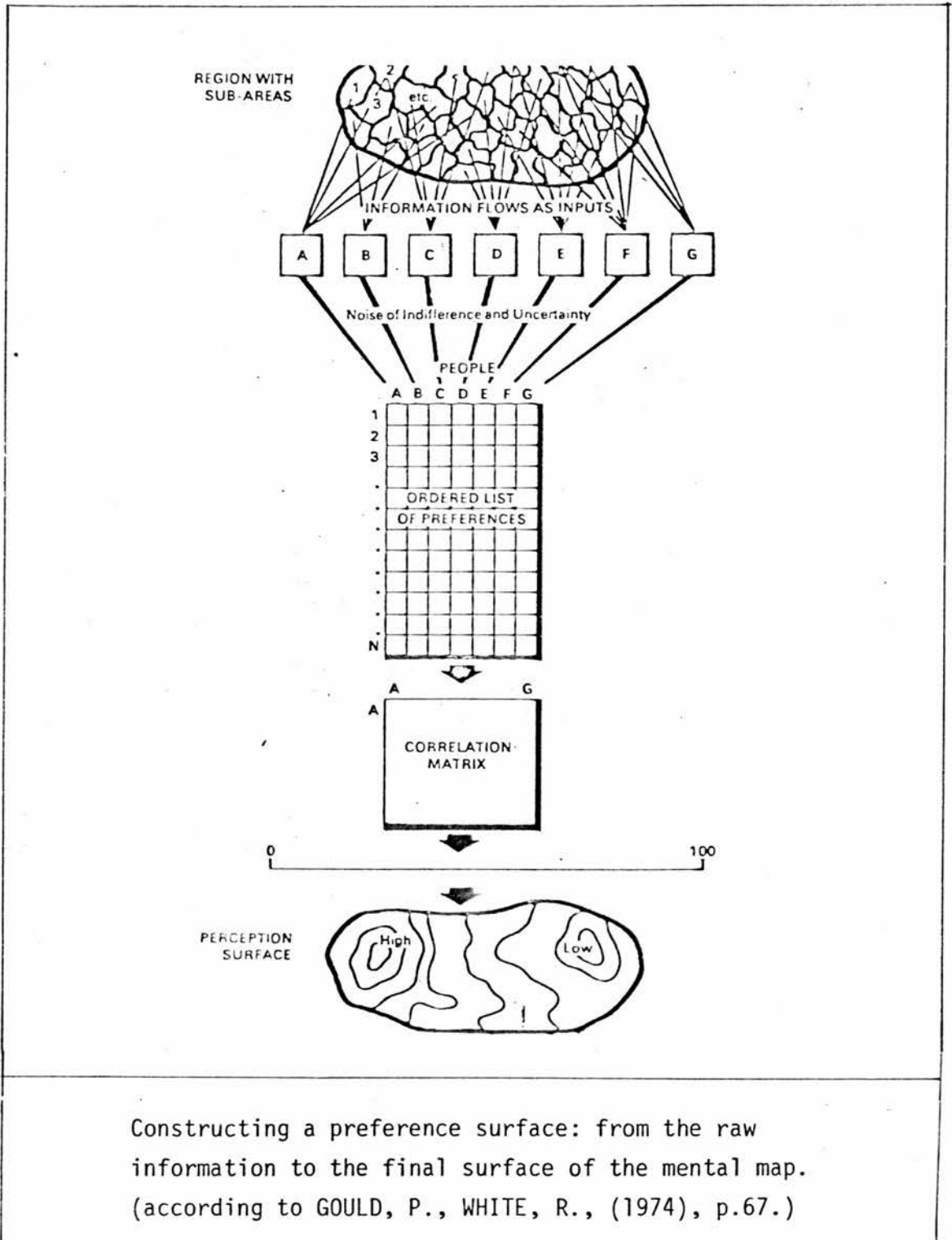
- b. Emotional involvement related to distance in standard coordinates



How Londoners see the North - at least according to the Doncaster and District Development Council

Space and distance change according to certain semantic dimensions. Meaning may derive from environmental, economic, business or social preferences. The above diagrams have been adopted from GOULD, P., WHITE, R., (1974), pp.40-41.

It is quite interesting to see how Gould and White have constructed a computational method for producing syntagmatic syntaxes, through systems of social evaluation, which they terms "preference surfaces":



In Appendix I we have argued that Christopher Alexander represents the kind of investigator who moved from the predominantly syntactic aspects of design to syntagmatic ones. In his first book *Notes on the Synthesis of Form* he tried to establish a general mathematical syntax according to which elementary structures were to be equipped with some semantic interpretation<sup>29</sup>. In the recent second edition of this book, first published in 1964, he states:

"At the time I wrote this book, I was very much concerned with the formal definition of 'independence', and the idea of using a mathematical method to discover systems of forces and diagrams which are independent. But once the book was written, I discovered that it is quite unnecessary to use such a complicated and formal way of getting at the independent diagrams."<sup>30</sup>

Alexander's work since 1967 reflects this remark, since it has been directed towards creating what he has called a "pattern language".

It appears, then, that Alexander accepted the idea of prototypes which were already structured (purely syntagmatic) and also the differentiation of their syntactic characteristics which are caused by cultural demands. By establishing an institution which he called the "Centre for Environmental Structure"<sup>31</sup> he recognized the social significance and the changing character of architectural prototypes and he tried to find a technique to record them in order to produce his flexible "environmental pattern language".

It is interesting to follow the logic on the basis of which Alexander and his colleagues formulated their 64-pattern language,

29. Alexander uses the word "needs" transformed later in his, *Atoms of Environmental Structure*, into "tendencies".
30. ALEXANDER, C., *Notes on Synthesis of Form*, Harvard University Press 1974, (c.1964), Preface.
31. *Proceedings of the seminar held by the Center for Environmental Structure in 1967.*



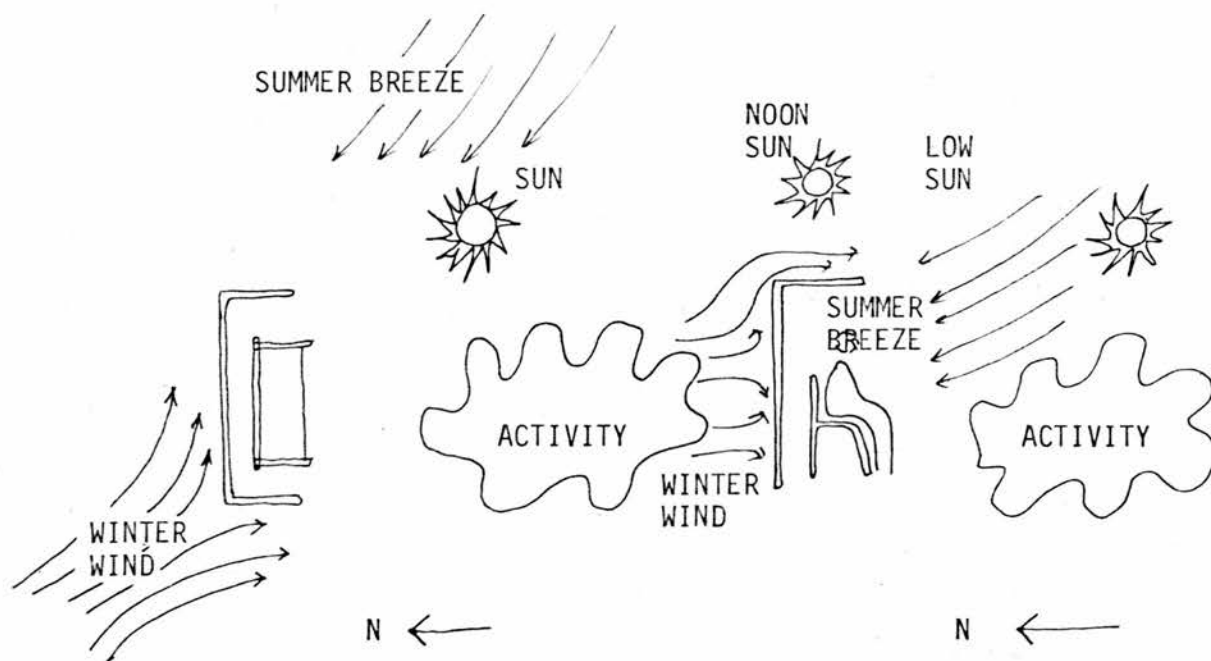
by presenting here the analysis of one of the patterns which are dominated by ecoclimatic and microclimatic considerations, for instance, pattern No. 29 called "outdoor seats". The following large extract presents the original analysis of pattern 29 as it was originated:

"PATTERN

IF: Any place in a city, but especially places within walking distance of old people's dwellings, where something potentially interesting is going on,

THEN: Benches should be placed in such a way that they meet the following conditions:

1. They face directly onto pedestrian activity.
2. They are open to the south, southeast and southwest as shown in the accompanying diagram, to allow sun exposure during winter months. (The exact angle depends on latitude).
3. In hot climates, they are covered by a roof or overhand, at the angle shown, to give such protection during midday hours of the summer months.
4. They are surrounded by adjacent walls on those sides where the winter wind comes down.
5. They are open to the direction of summer breeze, if any.



## PROBLEM

1. Old people are perennially bored, and seek something to watch, especially places where there are people, and where people are doing things. (For example, observations of Union Square in San Francisco at 3.00 pm on a sunny day following a foggy, cloudy day showed 175 people seated in the area; at least  $\frac{3}{4}$  of them were elderly men).

2. In a cool climate, or in winter, or at the end of the day, people will not sit in the shade, or in places exposed to wind. This is especially true of old people, who are more susceptible to rheumatism, colds, etc.

Karren and Palmer show that, given a choice of benches, a person will select those with best exposure to view and sun. ("Personal Space on Benches", unpub. ms., Department of Architecture, University of California, Berkeley, 1968).

We have two informal observations which support the same conclusion.

First, we made random spot checks of selected benches in dense pedestrian Areas. A small number of benches in Berkeley showed the following: At the moment of observation, we recorded four facts about each bench. Was it occupied or empty? Did it give a view of current activity or not? Was it in the sun or not? What was the current wind velocity? Of the eleven spot checks, three showed occupied benches, and eight showed empty benches.

At the moment of observation, all three occupied benches looked on to activity, were in the sun, and had a wind velocity of less than 1.5 feet per second. At the moment of observation, none of the eight empty benches had all three of these characteristics. Three of them had shelter and activity but no sun; three of them had activity, but no sun and wind greater than 3 feet per second; two of them had sun and shelter, but no activity.

A second series of observations compared the numbers of old people in Union Square, at 3:00 pm, on a sunny day, with the number at 3:00 pm on a cloudy day.

Number of persons sitting on 126 linear feet of bench in Union Square.	<u>Sunny</u> 65	<u>Cloudy</u> 21
--	--------------------	---------------------

The air temperature was approximately the same on both days. The wind velocity was 2 ft/sec. on both days.

These informal observations leave much to be desired. However, in the absence of any further evidence, it seems reasonable to conclude that benches should be placed in such a way as to give onto activity, to be in the sun during cool parts of the year, and to be sheltered from wind.

3. In a hot summer, during the hot part of the day, people do not want to sit in the sun, and do seek a breeze. For hot climates, benches should be placed so that they are shaded from the midday summer sun."<sup>32</sup>

A third example is Allsopp's work in his recent book *Modern Theory of Architecture*.<sup>33</sup> He advocates a new theory of architecture in an attempt to come to terms with the post-modern world and to provide the conceptual and design tools for what he calls "humane architecture". The key concept to his theory is what he called architectural "format" much related to the concept of architectural syntagm or of architectural prototype put forward here. Allsopp's argument is that design is possible through the adoption of structured prototypes (in his own words 'formats') which indicate the way in which the object of design is to be arranged. The format involves acceptance of limitations within which work must be done. Formats help to concentrate the creative mind upon essentials and even more the format becomes the frame within which quality can be achieved. He suggests that architects should discover the formats they can use best, as a poet chooses the sonnet or a composer the symphony.

His analysis, however, concerned with the origins of these formats and the way that they could be used in order to restructure the conventional practice of design does not extend beyond the suggestions that formats - not styles - should be the framework of design, that format-design calls for social conscience and public participation and that the format should be chosen by the architect in collaboration with the client.

Within a strict climatological and meteorological context there are very few examples of work on the syntagmatic character of climatic

32. ALEXANDER, C., ISHIKAWA, S., SILVERSTEIN, M., (1968), pp.173-174.

33. ALLSOPP, B., (1977).

and ecoclimatic structures. Interestingly enough, one such attempt has been made by R. Claiborne, a free-lance writer rather than a climatologist, in his work *Climate Man and History*<sup>34</sup>. Claiborne's work was developed in a similar spirit to that of Huntington's theory of climate and civilization<sup>35</sup> without, however, adopting Huntington's climatic determinism. He formulates his argument on syntagmatically dominated, rather than on purely physical meteorological and climatological grounds since he continuously refers to the need to equip our scientific tools of observation, description and application with a broader and less formal system of social evaluation<sup>36</sup>.

The syntagmatic character of ecoclimatic structures has also been recognized by climatologists especially when they have tried to popularize the importance and the use of climatological information. A little book which appeared in 1946 by the meteorologist A. Tinn<sup>37</sup> presents an interesting analysis of British weather carried out on syntagmatic principles. He introduces the British weather by speaking about "the method of rain", "the sensational months", "favourite climates" and so on, and uses these to try to present an interpretation of city climate and weather in terms of prototypes.

Apart from these very general and, in a sense, peripheral studies which are concerned with a syntagmatic investigation of the

34. CLAIBORNE, R., (1970).

35. See footnote in Ch.2, p. 59

36. It is characteristic that Claiborne starts his book by the statement: "This book will probably annoy quite a number of scientists" (p.11) and later points out that: "The theme of this book - man's social interaction and his climatic environment - is, I think, interesting and important in itself; ... But counterpointing this theme is another even more important: what science is all about." (p.17). In: CLAIBORNE, R., 1970, *op.cit.*

37. TINN, A., (1949).

climatic environment, specific studies (for instance at an experimental level) on these problems have not yet been carried out within the framework of climatology and meteorology and their applied sciences. Fortunately, however, some attempts of this kind have taken place in the fields of cultural anthropology and human ecology.

Duncan (1969), for instance, examines air pollution problems within a framework which necessarily demands social evaluation. This framework, which he calls "the ecological complex", deals with the problems of air-pollution at an interdisciplinary level where these problems are structured in relation to the simultaneous interaction of four systems: population, organization, environment and technology<sup>38</sup>. Similar work has been carried out examining, from an anthropological viewpoint, the effects of climate on cultural practices (WHITING 1969)<sup>39</sup> and the relationships between environmental and cultural factors (KROEBER, 1969)<sup>40</sup>.

The examples given above do not sufficiently represent the syntagmatic character of ecoclimate since they are too specific and

38. DUNCAN, O.D., *The Ecosystem Concept and the Problem of Air Pollution*, in: VAYDA, A.R., (ed.), *Environment and Cultural Behavior*, The Natural History Press, N.Y., 1969, pp.456-69. Refer, especially, to his analysis in pp.462-64.
39. *Studies of this kind have shown, for instance, relationships such as: (a) Sleeping arrangements and temperature; (b) long postpartum sex taboo is influenced by protein deficiency which, in turn, is related to rainy tropical climates; (c) patrilocal residence is associated with polygyny sex taboo; etc.... See, WHITING, J.W.M., Effects of Climate on Certain Cultural Practices*, in: VAYDA, A.P., (ed.), 1969, op.cit., pp.416-455.
40. *Kroeber suggests that large-scale climatic boundaries (at a regional level) determined in the past specific cultures. He refers, for instance, to the example of Pueblo culture arguing - in a rather simplistic way - that it is related to a climate with excessive summer rains. See, KROEBER, A.L., Relations of Environmental and Cultural Factors*, in VAYDA, A.R., (ed.), 1969, op.cit., pp.350-361.



outside a proper architectural framework. However, they do indicate one important thing: that a comprehensive understanding of the syntagmatic character of ecoclimate not only requires knowledge about the environmental and activity manifestations of ecoclimatic prototypes, but, more significantly, it requires knowledge about the social and institutional images of these prototypes. For instance, we need to know, at an environmental and activity level, the process by which microclimate and human activity produce specific spatial schemata, such as "shelter", "indoor space", "courtyard" or "outdoor seats", and, at the same time, at a social level, how the social milieu evaluates and structures these schemata into operational prototypes.

The problem of the relationship between spatial schemata dominated by cognition and spatial prototypes dominated by social evaluation is crucial to architecture. In connection with ecoclimatic research, the relationship can be transferred into the one between ecoclimatic schemata (as they appeared at a microclimatic-activity level) and ecoclimatic prototypes structured through a logic introduced within the systems of social evaluation. Within an epistemological framework this problem is discussed by Hillier and Leaman<sup>41</sup> who studied the interaction between "spatial space" and "logical space". Their argument is that:

"Logical space is an imaginary, many dimensional space created by and filled with systems of signs, symbols and representations. It exists neither purely in our heads, nor in real space outside, but constitutes the medium through which the relation between the two is made."<sup>42</sup> ... "We exist not in 'spatial space' pure and simple, but in spatial space as it has been constructed in terms of the contents and structures of logical space."<sup>43</sup>

41. HILLIER, B., LEAMAN, A., AD/8/73, pp.507-511.

42. *Ibid.*, p.510.

43. *Ibid.*



However, if we consider "logical space" as the structuring mechanism which is mediator between cognitive and real space, then this mechanism cannot be an imaginary one but is itself structured through the systems of social evaluation contained in it.

Cassirer's<sup>44</sup> philosophical analysis of spatial experiences provides a useful starting point for discussing the social evaluation of space. He differentiates between three basic categories of spatial experience: organic space, perceptual space, and symbolic space<sup>45</sup>. The first category (of "organic space") includes the kind of spatial experience which is genetically transmitted and is, therefore, biologically determined. The second category of "perceptual space" involves all kinds of sense modalities - optical, factual, acoustic, kinesthetic, - structured by experience and cognition in patterns which he also calls schemata. These schemata are conditioned, even at their cognitive level, by culture. Finally, "symbolic space" involves the experience of abstract spaces through logical mechanisms or symbolic representations which have no spatial dimensions (for example, geometry).

The difficulty of studying the interactions among the three modes of spatial experience does not arise because each mode in itself is not structured but because there are no obvious structural isomorphisms among them which may give rise to a mapping between one mode of experience (say the abstract logic of geometry) and another (the perceptual experience of space). Harvey, who discusses this point, argues that the physical space which dominates the first two

44. CASSIRER, E., (1972, c.1944).

45. *Ibid.*, p.66ff.

modes (organic and perceptual) is not isomorphic with social space (which dominates the symbolic mode of spatial experience). He points out that:

"Each form of social activity defines its space; there is no evidence that such spaces are Euclidean or even that they are remotely similar to each other. From this we have the geographer's concept of socio-economic space, the psychologist's and anthropologist's concept of personal space and so on ..."<sup>46</sup>

Furthermore, Harvey argues for the predominance of social space and thereby of social evaluation in structuring the other two spaces and consequently the architectural space as a whole:

"In other words, the shaping of space which goes on in architecture and, therefore, in the city is symbolic of our culture, symbolic of the existing social order, symbolic of our aspirations, our needs, and our fears. If, therefore, we are to evaluate the spatial form of the city, we must, somehow or other, understand its creative meaning as well as its mere physical dimensions."<sup>47</sup>

A similar approach to Harvey's, which in this work has been called syntagmatic, was developed much earlier by Lévi-Strauss in anthropology. He showed how the spatial layout of a whole village in a primitive culture may reflect in remarkable detail the mythology of the people and the social relationships which exists among various groups in the population. What is important, however, in Lévi-Strauss' analysis is not only that he discovers some of the structural principles which govern the mechanism of social space and especially those concerned with the articulation of physical space, but that he shows that spatial syntaxes have necessarily a syntagmatic beginning<sup>48</sup>.

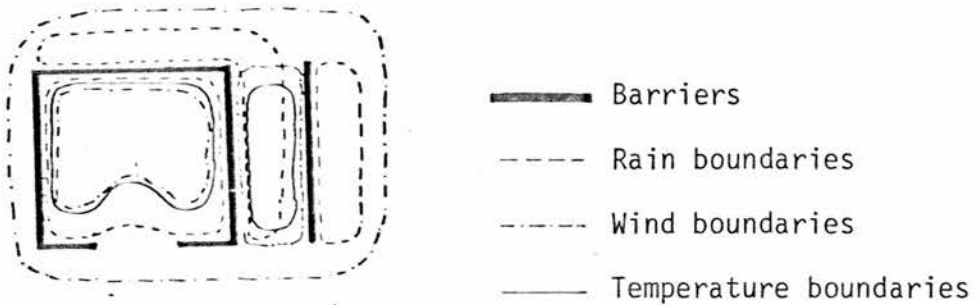
46. HARVEY, D., (1975), p.30.

47. *Ibid.*, p.31.

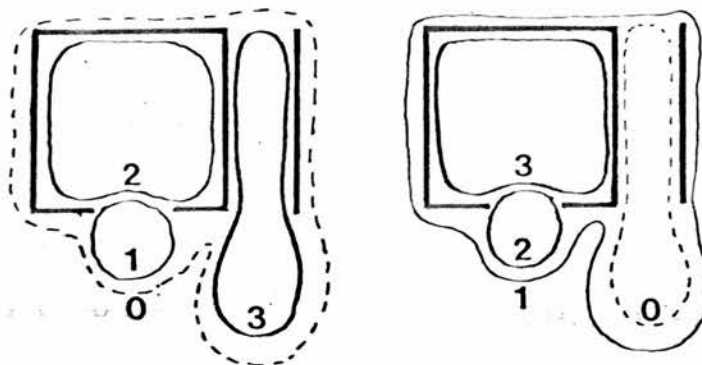
48. LÉVI-STRAUSS, C., (1972, c.1963), especially in Ch.VIII, pp.132-163.

It must have become clear by now that syntagm and syntax are interconnected in two ways. That is, a syntagmatic beginning produces different syntaxes and the abstract syntax is given meaning in the course of syntagmatic interpretations. However, the important difference is that abstract formulations generally start from other scientific fields (mathematics, climatology, etc.), while the syntagmatic ones come primarily from the problem area.

As an illustration of this, consider the following ecoclimatic example in which there is a specific set of microclimatic conditions (wind, rain, etc.) and microclimatic structures are to be mapped only topologically. This mapping, according to the analysis given in Chapter 13, though containing different boundaries, corresponds to a specific syntactic structure by which syntactic rules connect the forms of different boundaries among themselves:



At the same level of topological representation, syntagmatic considerations may produce quite different microclimatic syntaxes, as follows:



Hot Climate

Cold Climate

Contrast between comfort boundaries on a perceptual basis

0, 1, 2, .. Degrees of comfort

What is important here is that the structure is semantically transformed without altering at all the "objective" microclimatic conditions and, consequently, the purely syntactic structure. This indicates that the ecoclimatic structure, as we understand it, syntagmatically depends on the different predominancies (comfort, performance, cost and so on) articulated within the system of evaluation applied to the structure. If we consider "comfort", for instance, as a measure of social evaluation - in which the perception of climate by humans and their reactions are predominantly taken into account - we produce a topologically different structure than either the purely syntactic approach or another syntagmatic approach in which the system of evaluation belongs not only to comfort but probably to an economic basis as well.

#### 14.4 THE STUDY OF ECOCLIMATIC PROTOTYPES WITHIN THE FRAMEWORK OF SYNTAGMATIC STRUCTURALISM

Syntagmatic structuralism introduces a new area of research concerned with the "structure", "identity" and "dynamics" of ecoclimatic prototypes in the built environment, as well as with their problem solving capacity in terms of architectural design. It is clear that such an area of ecoclimatic research can only be identified through both theoretical and empirical investigations, within the philosophical context of the "social paradigm" and its powerful methodological apparatus of theoretical-practice used in this work to develop the starting premises of syntagmatic structuralism.

The key to such an investigation is the concept of ecoclimatic prototype. The epistemological and methodological behinds of these prototypes and their beyonds, in terms of design, are discussed in

this work. However, there are two areas of research in ecoclimatic prototypes which seem to be very crucial for their investigation and into which I would like to extend the discussion in this chapter of the thesis. The first is concerned with the "identity" and "dynamics" of multidisciplinary environmental structures, such as ecoclimatic prototypes, and the second is to derive a taxonomy of these prototypes within the broader framework of architectural research.

The questions of the identity and the dynamics of environmental structures have been discussed in detail and within the framework of syntagmatic structuralism in Appendix II. There, the main points of our argument, illustrated by ecoclimatic and other architectural examples, concern:

- (i) the kind of descriptive theories concerned with multidisciplinary architectural structures, produced within the framework of syntagmatic structuralism,
- (ii) the structural role of social evaluation in identifying and in describing the dynamics of environmental structures,
- (iii) the development of a syntagmatic dialect, called "contradictional logic" which may be used to identify different images of a structure (e.g. an environmental, an activity or an institutional image) and to evaluate the transformational potential which appears "within" or "between" the different images of this structure,
- (iv) the potential of conventional design action to resolve the problems identified by the syntagmatic language (for instance, we found that this potential is limited only at the level of "normal anomalies") and the description of the role of

revolutionary design in resolving problems appearing at the level of "leading contradictions".

It would be advantageous if the reader refers to these points in Appendix II before he proceeds with the following discussion dealing with a research taxonomy of ecoclimatic prototypes within a broader architectural framework.

In Part II of the thesis, I presented a taxonomic framework of architectural research within which ecoclimatic or other multi-disciplinary phenomena in architecture may be studied. The proposition there was that areas of architectural research, in general, and of ecoclimatic research in particular, should be identified and described with reference to both "subjective" (social whole, process of production of the built environment, and environmental object of research) and "objective" (time, space, and action accumulation) general descriptors<sup>49</sup>.

It is beyond the scope of this thesis to produce a detailed analytical taxonomy of the ecoclimatic prototypes. Nevertheless, it is possible to indicate here some points which might be of interest in understanding such a task.

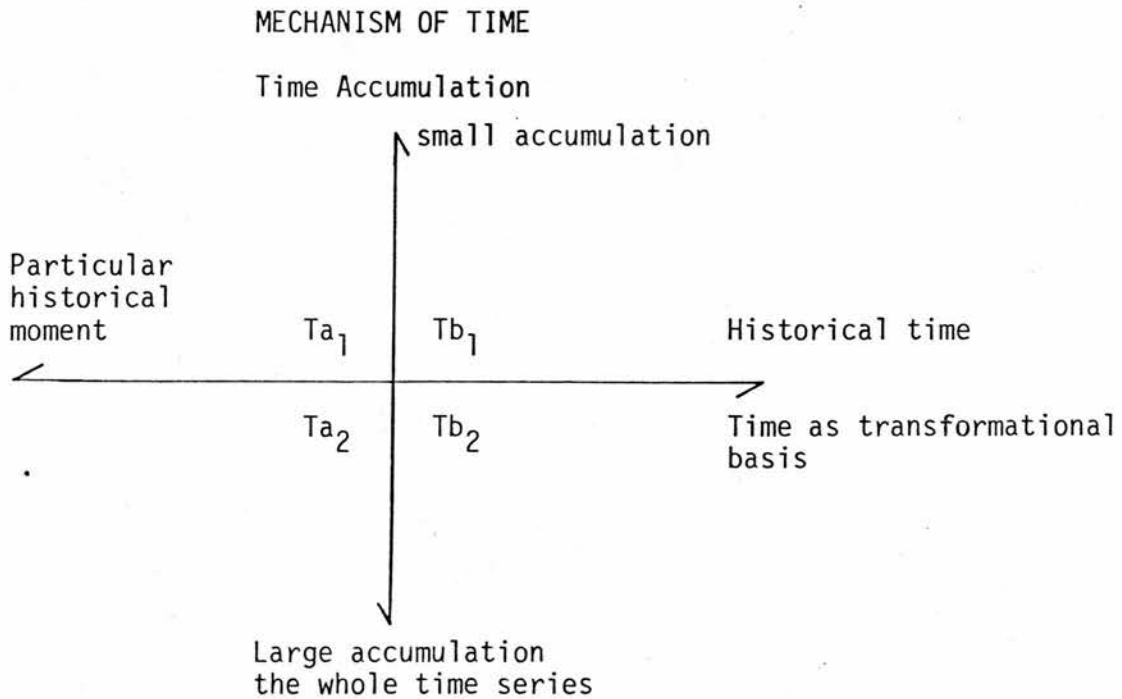
With respect to the subjective general descriptors given above and discussed in detail in Part II, the syntagmatic approach and its "contradictional logic" may be used to identify ecoclimatic prototypes with different predominant images (for example, environmental, activity, institutional). The way in which this can be done is indicated by the discussion in Appendix II. However, such a taxonomy should be supplemented in a dialectical way by the kind of

49. Refer to Ch. 5, pp. 131-140.



taxonomy introduced by the objective reference of architectural research (time, space, action accumulation).

Consider, for discussion, each taxonomic mechanism separately:



Examples:

Ta<sub>1</sub>: study of e.p. (ecoclimatic prototypes) based on m-w (micro-weather) events in a specific historical context.

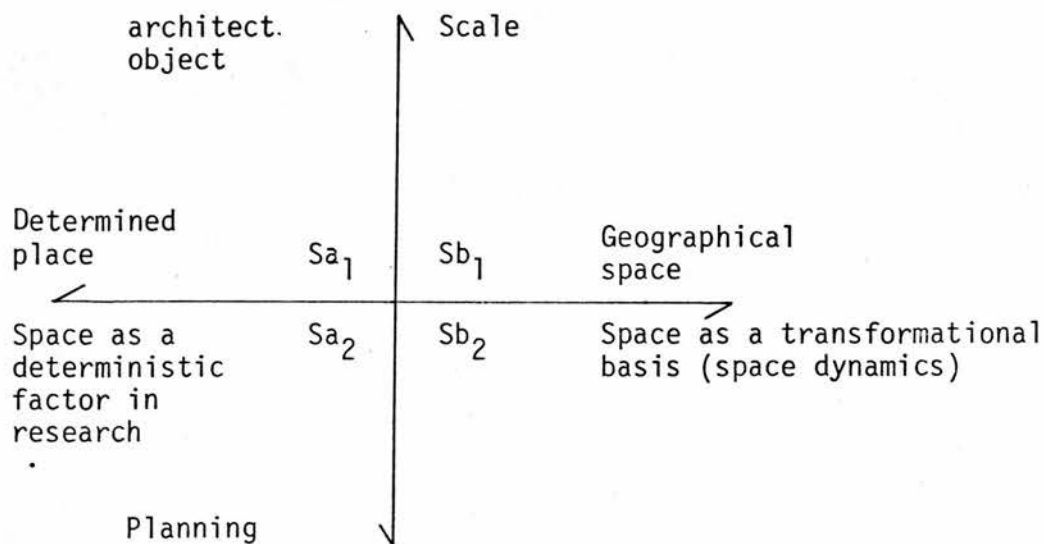
Ta<sub>2</sub>: study of e.p. based on m-c (microclimatic) events in a specific historical context.

Tb<sub>1</sub>: study of e.p. based on m-w dynamics in different historical contexts (e.g. cultural dynamics of the prototypes).

Tb<sub>2</sub>: study of e.p. based on microclimatic events in different historical contexts. (Socio-cultural and economic dynamics of the prototype).

## MECHANISM OF SPACE

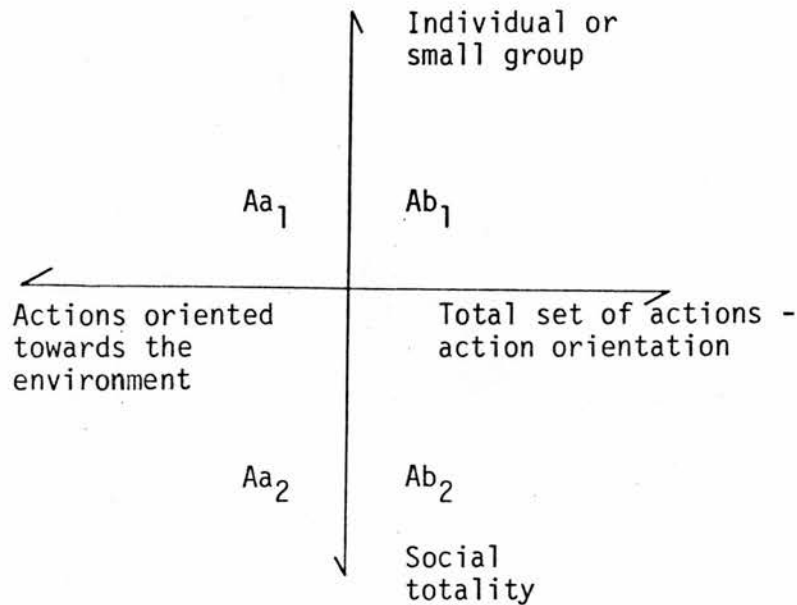
## Space Accumulation



## Examples:

- $Sa_1$ : Study of small scale e.p. at a particular geographically (climatologically) place. E.g., "indoor" e.p. of the Greek island architecture.
- $Sa_2$ : Study of ecoclimatic prototypes at a planning level of a particular town (e.g. e.p. of parks, streets, etc.).
- $Sb_1$ : E.g. Comparative study of certain e.p. in geographically (climatologically) different "indoor" spaces.
- $Sb_2$ : Comparative study of e.p. of the type ( $Sa_2$ ) in geographically different locations.

## MECHANISM OF ACTION ACCUMULATION



## Examples:

- Aa<sub>1</sub>: Study of individual e.p. influencing design decision and implementing action towards the environment.
- Aa<sub>2</sub>: Study of socially evaluated e.p. influencing design decisions and implementing action towards the environment.
- Ab<sub>1</sub>: Study of individual e.p. influencing environmental policies beyond the design level and at an socio-economic and political one (planning decisions).
- Ab<sub>2</sub>: Study of socially evaluated e.p. influencing env. policies at the above socio-economic and political level. (Planning decisions).

Combinations of the above mechanisms two-by-two or all three together produce more comprehensive areas of ecoclimatic research:

## SYNTHETIC LEVELS OF RESEARCH ON ECOCLIMATIC PROTOTYPES

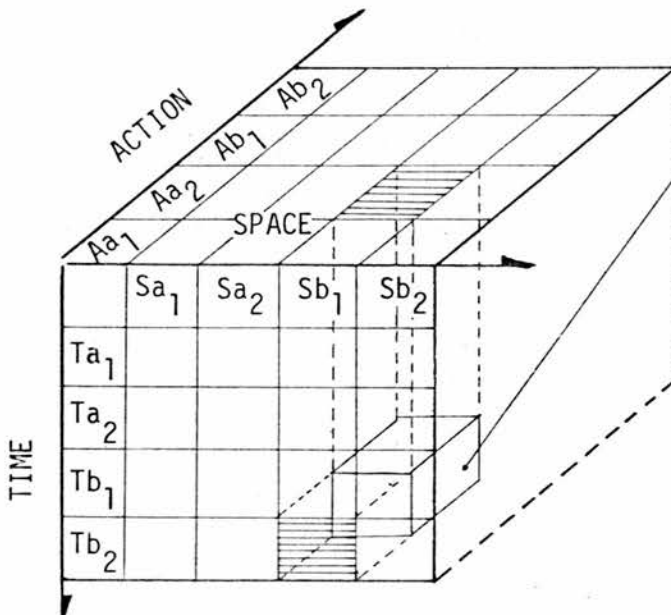
## MECHANISM TIME-SPACE

	Sa <sub>1</sub>	Sa <sub>2</sub>	Sb <sub>1</sub>	Sb <sub>2</sub>
Ta <sub>1</sub>				
Ta <sub>2</sub>				
Tb <sub>1</sub>				
Tb <sub>2</sub>				

Ta<sub>2</sub> - Sa<sub>2</sub>: Study of e.p. at a planning level and in a historical sense. (E.g. e.p. of parks, squares, streets of Hellenistic towns, medieval cities, etc.)

Tb<sub>2</sub> - Sb<sub>1</sub>: For instance, study of e.p. in two senses: (a) diachronically within the framework of given culture, and (b) synchronically, through comparisons of e.p. generated in different cultures.

## MECHANISM: TIME-SPACE-ACTION ACCUMULATION



Tb<sub>2</sub>-Sb<sub>1</sub>-Aa<sub>2</sub>: Study of socially evaluated ecoclimatic prototypes within the context of Tb<sub>2</sub>-Sb<sub>1</sub> influencing the design decision and implementing design action towards the environment.

The examples given above are simply indicative of the multi-dimensional complexity underlying any attempt to taxonomize systematically the variety of ecoclimatic structures that may constitute ecoclimatic

prototypes of the built environment. The taxonomic mechanisms discussed are useful only in terms of providing a conceptual simplicity in identifying general areas of research which may be isolated for further study and development through the syntagmatic approach.

However, such a taxonomy of ecoclimatic prototypes gets its significance and becomes practically useful only when considered in relation to the taxonomy introduced by the subjective references of architectural research mentioned earlier. The subjective taxonomy carried out within the methodological framework of syntagmatic structuralism would provide priorities for ecoclimatic research in relation to both the problem area (historically evaluated) and the particular image of the prototypes (socially evaluated). This means that a general area of research defined through the subjective taxonomy as, "influences of social or institutional organizations upon the process of production of the built environment and, thereby, upon the ecoclimatic organization of the built environment", could be further structured in reference to the "objective" taxonomy of ecoclimatic prototypes, for instance:

$$Aa_1 \rightarrow \begin{bmatrix} Aa_2 \\ Ab_1 \end{bmatrix} \rightarrow Ab_2$$

where:  $Aa_1, Aa_2, Ab_1, Ab_2$  are explained in p  
the arrow denotes influence and orientation of research.

The conclusions of this chapter and of the thesis as a whole are summarized in the chapter which follows. However, a final point concerned with the taxonomic framework of ecoclimatic prototypes should be emphasized. The major utility of this taxonomy can be found at the level of examining systematically the evolution of ecoclimatic

prototypes within the framework of the syntagmatic approach and in the context of social evaluation. It is through such a systematic investigation that contemporary ecoclimatic problems can be identified in all their different manifestations and predominantly in their institutional, activity, and environmental ones. At the same time, design action might benefit not only from the methodological tools offered in the work, but mostly from knowledge of its potentials and its limitations in dealing with the ecoclimatic prototypes of the built environment. These "potentials" and "limitations" are described in Appendix II.



## CHAPTER 15

## GENERAL CONCLUSIONS AND ORIENTATIONS FOR FUTURE RESEARCH

During the course of developing the present theoretical work a number of crucial decisions had to be made regarding the degree of generality of the multidisciplinary domain in which architectural problems, in general, and climatic problems, in particular, were to be attacked. Gradually, however, it became very clear that the present conjuncture which architectural and building climatological research have reached necessitates a general and critical return to the starting premises and the methodological assumptions by which building climatological research deals with the climatic problems of the built environment. As a result I felt that the contribution of the work might be greater if it were able to establish a basis upon which some major questions in building climatological research could be re-defined in relation to the broader framework of architectural empirical research, rather than in searching for answers to questions and problems originated outside such a basis.

I must, however, acknowledge that these decisions were taken not simply as a result of my own work but were also partly a consequence of substantial influences which resulted from long-term discussions about architecture with my supervisor, Professor C.B. Wilson and with my colleagues, Dr T. Kotsiopoulos and A. Awadalla.

I have pointed out, in the main Introduction, that the primary aim of this thesis is twofold. In the first place it is to direct investigation towards a comprehensive description of the phenomena of the built environment which may be of interest to architectural climatologists. In the second place it is to move towards a methodological framework for the study of environmental structures of the built environment within the multidisciplinary domain in which architectural actions operate either to create or to modify these structures.

On the whole the work has been developed in a dialectic manner between the study of physical phenomena and the methodological requirements of architectural research as a whole. Accordingly, the conclusions of the thesis can be summarized in two categories. The first of these contains conclusions which are strictly referred to the study of climate within a building climatological context. The second is concerned with the methodology developed here - syntagmatic structuralism - which is relevant to a broader context of architectural research. The conclusions in the second category may be understood in two different senses: as proposing an appropriate methodological framework for the study of multidimensional architectural realities (such as the ecoclimatic one) and/or in reference to the methodology of structuralism as it may be applicable to human practices concerned with different aspects of the artificial environment. I would like to stress, however, that the thesis is not intended to give answers in the form of a final statement. Rather, the various conclusions are intended to offer starting grounds on the basis of which long-term future research on the development of both the ecoclimatic approach and the methodology of syntagmatic structuralism could be carried out.

In this work I have distinguished between two interconnected, though conceptually different, levels of architectural climatological research. The first - the level of microclimatic phenomena - includes the conventional orientation of research in building climatology developed in the last three decades or so. I defined the nature and character of the phenomena that have been studied at this level in the following way:

Microclimatic phenomena are considered to be those concerned with (i) the transformation of the macroclimatic environment into the climatic conditions created or modified by the built environment, and (ii) the physical mapping of these transformations which is describable in the language of physics and specifically of climatology and meteorology.

At the other level - the level of ecoclimatic phenomena - I have attempted to identify a new area of research in architectural climatology and one which is significantly more important than the first, since it deals with the basic mechanisms by which the starting points and orientations of research at the first level can be comprehensively synthesized. I have defined the phenomena studied at this level as follows.

Ecoclimatic phenomena are considered to be those concerned with the semantics of the physical fields of climate and microclimate, that is, with human perception, understanding and evaluation of the climatic conditions of the built environment. These phenomena, therefore, cannot be defined by their microclimatic characteristics alone and they are not describable in a purely climatological and meteorological language, but only within a much broader conceptual framework where the process of producing the architectural environment

together with the semantic dimensions of the climate of the built environment are taken into account.

Furthermore, in some fields of applied climatological research, for instance in bioclimatology, in econoclimatology, and in socio-climatology, some conceptual frameworks have been developed lately which provide enough evidence to support the argument that social values are increasingly becoming recognized as inherent in these fields of applied science. This, in itself, suggests a more critical look at the "imported" knowledge to these applied sciences which is derived from a purely physical climatological context.

The diachronic level, provided through historical studies of the conceptualization of the ecoclimatic environment by man, has been proved in this work to be very useful in developing our knowledge about the nature of climate-built environment interaction. The main conclusions which emerged from the historical study in Chapter 2 may be summarized in the following points:

- (i) Man in history has always conceived and described the influences of climate on the built environment by internalizing complex prototypes in the structure of which social, economic, cultural, technological and physical (including climatic) aspects have been integrated.
- (ii) As a consequence of (i), ecoclimatic prototypes have been generated and transformed, not only with respect to the particular climatic or microclimatic conditions and the changes produced by them in the development and evolution of human settlements, but also with respect to the general socio-economic problem-situations which have always affected man's attitudes towards nature and towards his fellow men.

- (iii) The environmental and behavioural components of the ecoclimatic prototype are those more easily understood because they manifest themselves in recognizable images, such as natural or artificial environmental objects or behavioural patterns and activity organizations associated with particular climatic conditions. The socio-economic component of the prototype, though the most important since it largely dominates the structure of the other two, is much more difficult to internalize and, therefore, to consciously manipulate during the process of ecoclimatic organization of the built environment.
- (iv) The operational character of the ecoclimatic prototype is acquired through the predominance of the different images (e.g. environmental, activity, institutional) which are structured within the prototype at particular historical conjunctions. Two factors may account primarily for the construction of these pre-dominancies: first, the magnitude of the direct influences of climate upon man and his products; and secondly, the system of social evaluation within which these influences are to be understood. This work argues, however, that, in the particular conjunction of our times, it is the socio-economic conceptualization of the physical and climatic environment that may provide the bases for understanding the general processes which shape and transform the organization of the ecoclimatic environment as a whole.
- (v) The concept of the "ecoclimatic prototype" suggests on the whole that the existing epistemological distinction between socio-cultural and physical phenomena, as far as the conceptualization and explanation of the phenomena of the built environment are

concerned, is an artificial one and fails to describe comprehensively the nature of the processes that are involved in the production and the transformation of these phenomena.

Architecture as a discipline has a responsibility to explain the products of its practice. This means that so far as micro-climatic and ecoclimatic phenomena are viewed as products of architectural and planning activities, they should be described and explained within a broader architectural disciplinary context, rather than within those of physiology, psychology, sociology, climatology and so forth. Consequently, architecture has to build its own disciplinary models and methodological frameworks to explain adequately the products of its practice, whilst at the same time avoiding uncritical references to other sciences. It is possible to reinvestigate and reformulate these models within the domain of architectural phenomena by accepting a wider framework of architectural research and by organizing within this framework the spectrum of specific (for example, environmental) studies.

I have argued that problems of architectural complexity (and especially those referred to ecoclimatic phenomena within the context of architectural research) belong, in their greater part, to the higher form of "logical complexity". However, the conceptual domains upon which climatic and ecoclimatic research have been based - for the production of general models by which different interpretations, descriptions and practices of the ecoclimatic problems of the built environment may be found - have been formulated within the epistemological framework of "relational logic". Nevertheless, ecoclimatic problems of the built environment acquire their meaning and become available for comprehensive evaluation only within a broader archi-



tectural framework. This framework not only recognizes the importance of socio-cultural and institutional dimensions of ecoclimatic prototypes but, most importantly, it organizes and presents the different images of these prototypes by constructing among them "starting points" and "orientations" for more productive ecoclimatic research. It is a firm conclusion of this thesis that such a framework can be developed better by using a "structural logic" rather than a "relational one", even though the latter may be inevitable at higher levels of surface analysis.

It has been proposed that structural logic requires the adoption of a general taxonomic framework of architectural (and ecoclimatic) research which can provide sufficient room for the dialectics between objective architectural references like "time", "space" and "action" and subjective ones like "social whole", "process of production of the built environment" and "identity of the environmental object". In developing such a framework (in Part II of this thesis) in relation to ecoclimate, a significant conclusion emerged that although at a surface level of analysis the subjective references of architecture appear to be independent from one another, at the deeper level where comprehensive description becomes possible, the interdependence of these references becomes profound and indicates quite clearly the existence of a structured totality. Consequently, the comprehensive description of architectural phenomena, and structuralist methodology are strongly interconnected when dealt with at the appropriate levels of abstraction.

Another general conclusion about the organization of research in architectural climatology is that significant areas of microclimatic and ecoclimatic research can be identified, described and evaluated only in relation to both the complexity and the logic implied by the

"ecoclimatic schema" and the objective-subjective references of architectural research.

The major conclusions which emerged from the review of building climatological studies which was undertaken in Part III of this thesis, can be summarized as follows:

- (i) The compartmentalization of the structure of ecoclimatic problems has become an "a priori" assumption for the majority of the theoretical arguments or the empirical studies concerned with the climatic or the overall physical conditions of the built environment. The rationale of ecoclimatic problems achieved in such a way fails, in my view, in two significant points. First, in establishing the problematique comprehensively and, secondly, in transforming building climatological information into "effective knowledge" for design action.
- (ii) A number of extremely important studies (reviewed in Chapters 7, 8 and 9) particularly concerned with the relationships between the "hardware" microclimatic organization of the built environment and its "software" ecoclimatic manifestations, have suggested that the need for establishing holistic concepts for describing the man-physical environment interaction has already become imperative. The search for holistic concepts in architectural climatology is inseparably linked with the structure and practice of design action. Furthermore, holistic concepts should be developed in both environmental and social terms:
  - (a) In environmental terms the climatic problems of the built environment are simultaneously linked with the overall morphology and the planning characteristics of the built environment. At this level conventional design action alone becomes an ineffective

tool within the established professional role of the architect; and the separation of design, planning and landscaping processes, from the total process of decision-making and production of the built-environment, reflects a high degree of artificiality. In this way, design action itself becomes a major source of difficulties in dealing effectively with the ecoclimatic problems of the built environment.

- (b) In social terms the various climatic problems of the individual building are linked not only with the client or even its users and their capacity in acquiring certain comfort conditions - depending on their economic status - as conventional design practice assumes, but primarily with the general process of producing socially acceptable - and, therefore, socially evaluated - solutions to these climatic problems.
- (iii) The review has also shown that ecoclimatic research is still in an early stage of its development. If there were any conclusions to be made with respect to socially evaluated design action, these conclusions could only be concerned with the structure and the orientations of this particular field of ecoclimatic research. Such orientations are primarily concerned with the institutional image of the ecoclimatic organization of the built environment and how this image may affect the other two, that is, the activity and the environmental images of it. Some proposals concerned with the organization of ecoclimatic research within the institutional image have been presented in Chapter 9 which forms also the conclusive chapter of Part III.
- (iv) The overall impression given by the review in Part III is that building climatological studies, though they are of extreme

importance in providing information - sometimes in remarkable detail about different aspects of the interaction of climate with the built environment or with man - lack the underlying theoretical mechanism by which such information could be structured and transformed into "effective knowledge" required by the designer of the built environment. In practice, the designer faced with immediate, urgent and complicated problems, suffers not only from the lack of effective knowledge but also from the bombardment of numerous, unstructured and often conflicting bits of information. As a result of this it is commonly acknowledged that a major part of building climatological information unfortunately remains at a pre-operational stage as far as practical design action is concerned.

The present thesis accepts that such information is valuable and should become operational in design. However, the thesis also suggests that the route from the pre-operational stage of building climatological information to the operational stage is far from simple, and is certainly not self-evident. Above all it involves the transformation of building climatological information into "effective knowledge" during the design process and this transformation means that a number of difficult steps have to be taken in preparing information for the designer and in the design process itself.

The first step in the transformation is to change our methodological tools. The second step requires that the same methodological changes should take place in other fields of architectural research and particularly in those dealing with the physical environment. Finally, the third step which needs to be taken is that of restructuring the institutional structure within which

architecture operates today. In order to take these steps architecture as a discipline would have to overcome considerable difficulties but the route that they indicate is not a utopian one. It has been followed to a certain extent by other spheres of social sciences such as economics, anthropology and ecology with obvious success. The mere fact that architecture today is increasingly recognized as a social science is, perhaps, the best proof that it is on its way towards a restructuring of its own disciplinary basis.

Finally, what must be stressed above all is that if there is a social paradigm towards which architecture, together with other disciplines which describe human actions, is striving, this paradigm is still in its infancy. Consequently, it is the task of architecture as a discipline to check and re-check the tools - not on the basis of normative prescriptions, but in terms of social evaluation - by which architectural practice may participate effectively in the total set of human actions which are shaping human life in its dynamic evolution.

In the following paragraphs I will try to summarize the major methodological conclusions reached in this thesis during the development of syntagmatic structuralism as an appropriate methodological framework for ecoclimatic and architectural research.

Syntagmatic structuralism is a methodological framework, the basic postulates of which were originated within an epistemological paradigm dominated by social rather than scientific values and in close relationship with architectural realities. This makes syntagmatic structuralism a disciplinary methodology in its own right and distinguishes it from other structural methodologies, such as semiological



structuralism, syntactic structuralism, which have been "imported" directly into architecture from other scientific fields such as linguistics and anthropology. In claiming this I do not mean to deny the influence of imported structuralist knowledge on the development of syntagmatic structuralism, or that further developments of this methodology will not benefit from semiology or the linguistic model; after all syntagmatic structuralism has been developed in this work in close relationship with these frameworks. However, I do suggest that syntagmatic structuralism brings together the methodological advantages of both semiological and syntactic structuralism which are pertinent to the broader architectural systems and the human action that they imply.

Instead of presenting again the conclusions from the development and application of syntagmatic methodology to ecoclimate and to architecture, which are presented in detail in Part IV and the Appendices, I would like to comment further on the extent to which syntagmatic structuralism may offer a disciplinary methodological framework for architecture as a whole. The best way of doing this will be to explore the potential and the limitations of syntagmatic structuralism in throwing some light on one of the most crucial problems in architecture, that is the manifested conflict, commonly acknowledged as an applicability gap, between "design theory" and "design practice". The table on the next page summarizes very briefly the major postulates of this conflict.

Explanatory theories concerned with the organization of the built environment and design methods formulated on their basis, tend to forget the synthetic level in which design action occurs in practice. The usual methodology dealing with the physical organization



DESIGN THEORY	DESIGN PRACTICE
a. Describes design action formally in a normative way of "how design should be done". Usually assumes a rationalization of design action based on axiomatic and algorithmic principles	Produces the built environment through the mediation of design and planning action; characterized by: the prestructuring of the design problem - the intuitive use of prototypes in defining solution fields - use of social values attached to individual prototypes, etc.
b. Analyses numerical complexity by using simplistic levels of logical complexity.	Uses comprehensive mechanisms for resolving conflicts at higher synthetic levels of logical complexity
c. Usually ignores the socio-economic and historical boundaries of design problems and so operates beyond the limitations of "conventional design" action in an idealized problem situation	Operates necessarily within the limits of "conventional design" action, as they are defined by specific socio-economic and historical problem-situations which are imperative for the materialization of the design solution
d. Uses evaluation techniques within the conceptual domain of the "scientific paradigm" which calls for optimization, value-dependent systems (right, wrong and so forth).	Uses evaluation techniques within the conceptual domain of "social paradigm" which calls for satisficing methods; predominancies constructed within a value-free system depended on the situation at hand (e.g. possible solution, accepted solution).

CONFLICT OR APPLICABILITY GAP

of the built environment assumes a rationalization of design action which in many respects conflicts with the prestructuring of the design problem and the intuitive use of prototypes by designers. It appears that this conflict reaches its maximum at higher synthetic levels of design action. Accordingly, the materialization of the design solution has to follow its own practical procedure which usually

deviates considerably from the prescribed norms of theory. As a result rationalized methodologies have repeatedly failed to comply with design action. However, it seems that within the broader methodological framework of syntagmatic structuralism the theoretical method could be equipped with the necessary links to practice, not by attempting to "scientificise" practice as the present epistemology of architecture assumes but by shifting the theoretical methods closer to practice. This attribute of theoretical-practice which characterizes syntagmatic structuralism, has already proved useful in other fields of social sciences where their general epistemology is dominated by social rather than scientific paradigms.

I have spoken about syntagmatic structuralism as a particular "methodological framework" in architecture and not as a "specific methodology" for it, because I believe that the multidimensionality of architectural realities makes it impossible to construct a methodology by which explanation and action can be exercised upon these realities in a socially meaningful way. Within the methodological framework of syntagmatic structuralism however, the construction of specific methodologies leaves room for the dynamics of architectural realities and their social evaluation to continuously change the postulates of any particular methodology. This follows by reference to the crucial notion of "syntagmatic syntax", which indicates that different methodologies or syntaxes can be produced to study different architectural realities depending on the historical context of these realities and the particular balance of systems of social evaluation existing at their conjunction. Thus, "syntagmatic framework" and "syntax as a specific methodology" are in two ways interconnected. A syntagmatic framework can produce different syntaxes and a particular

syntax gets its meaning and evaluation within the syntagmatic framework.

In particular, the major postulates of the syntagmatic framework are: (a) It helps to force a shift in design methodology towards the adoption of the comprehensive mechanisms used by design processes in practice, and (b) as a consequence it helps the methodology to recognize both the limitations and the potentials of conventional design action. The advantages of (a) are obvious; the advantages of (b) occur:

- (i) in terms of defining the limitations and potentials of the methodology itself,
- (ii) in terms of defining the domain of empirical phenomena on the basis of which the theory may construct its models as an abstract expression of architectural realities,
- (iii) because theoretical action may be directed towards the maximization of design action potentials in dealing with multidisciplinary structures in the built environment, and
- (iv) because it identifies the role of a "revolutionary" design action which is extended beyond architectural design into the professional and the social role of the architect and planner.

All these points have been further developed in the paper of Appendix II in which we explored the application of syntagmatic structuralism to the problems of the "identification" and "dynamics" of environmental structures, and were led to the development of a "contradictional logic" and to the kind of syntax which this logic implies for the study of multidisciplinary structures in the built environment.

In concluding the thesis, I should like to indicate particular orientations for further work in both ecoclimatic and methodological terms. It has not been possible, although it would have been desirable, to support some of the major assumptions in the study through appropriate case-studies or other forms of empirical research. A choice between the generality of the present theoretical formulations of the ecoclimatic problems and the particularity of specific empirical research on these problems had to be made. I felt that given the time which was available and the circumstances under which this research was undertaken, it would be more productive to investigate comprehensively the climate-built environment interaction and to examine, in particular, the main reasons why such information is hardly used in design action. More research on the further development and validation of both the major assumptions and the proposals of this work should be carried out at an empirical level. This task presupposes a long-term basis for future research towards which my own intentions and, I hope, those of others, may be orientated. This thesis, therefore, does not claim to be a final statement on climatic design or on the methodological framework of syntagmatic structuralism, but rather a starting conceptual framework within which priorities for future work may be structured.

## APPENDICES

## A P P E N D I X I

## DESCRIPTION AND DESCRIPTORS IN ARCHITECTURE\*

Forward

This paper represents a combination of apparently different work carried out in the Department. The aim is both experimental, in terms of the effectiveness of this type of co-operative work, and essential in terms of the search for a common framework of description in architecture, within which architectural research may be organized. Fortunately - but not entirely by coincidence - the three individual approaches developed by the co-authors of this study<sup>1</sup> were found to be closely interconnected and constituting a conceptually self-sufficient system, as they have been corrected and revised by continuous feedbacks during the discussions. These revisions stimulated a reconsideration of each one's individual work.

The study is divided into the following five sections:

1. The dynamic nature of descriptive theories and their problem origin.
2. Comprehensiveness and structural approach to the descriptive theories.
3. The abstract syntax of microclimate and network descriptors.
4. The importance of semantic considerations; towards a generative approach.

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*This paper has been published collectively by the author of this thesis and his colleagues, A. Awadalla and T. Kotsiopoulos. Originally the paper appeared under the same title in Edinburgh Architectural Research Journal (E.A.R.), Vol.3, 1976.*

1. *"Network Structures and Building Design" (A. Awadalla). "Barrier Structures and Participation Problems in Urban Universities" (T. Kotsiopoulos). "Urban Microclimatic Structures" (Th. Maravelias).*



5. Syntagmatic nature of architectural descriptors and their problem-solving capacity.

1. On the dynamic nature of descriptive theories and their problem-origin

Descriptive theories are generally considered to be of static character. In this sense, terms like predictive, prescriptive, nomothetic, or normative are distinguished from the term descriptive. However, in this study "description" is used in its broader sense of "explanation". Within this context, description automatically implies both a "behind" as well as a "beyond" in terms of its historical evolution and its practical applications. Before discussing these basic characteristics of descriptive theories we shall distinguish between descriptive theory and descriptor.

Descriptors are the components of descriptive theories. In other words, they constitute the basis according to which a description may be implemented. A descriptive theory may consist of either one predominant descriptor which is being considered as the most important one, or a set of descriptors which supplement each other in a structural way within the framework of a descriptive theory. Comprehensiveness, therefore, emerges as one basic property of descriptive theories. However, comprehensiveness is not a property that a descriptive theory may technically acquire only by combining descriptors in isolation from both its historical origin and its structural context.

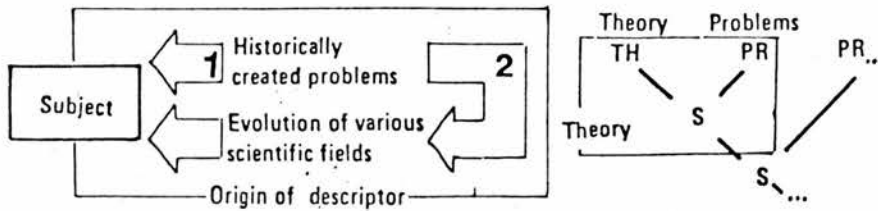
A basic assumption in this study is that sciences, as domains of particular knowledge, are historical products. This is especially true for the so called "social sciences" and the "sciences of the

artificial", in which not only their stock of knowledge, but also their very subject-matters are historically affected. The major explanation of this basic assumption is that these sciences describe human practices which are strongly influenced by ideologies. The additional reason that scientific paradigms in these sciences are equipped with "behinds" and "beyonds" is simply that it is extremely hard for the observer to consider himself excluded from the reality he investigates, though there are some serious objections to this particular thesis as far as comprehensive social phenomena, such as language, are concerned<sup>2</sup>.

In this study, it is not our intention to be involved in this epistemological question. What we are going to argue here is that descriptors in architectural descriptive theories are generated as products of historically created problems with which the practice of architecture is concerned. Thus, descriptors represent in a way the ideological struggle of the historical moment in which they appear. The history of description in architecture is quite short to prove this, due to the difficulties that the consideration of architecture as an art has imposed; a phenomenon common also to other fields such as language, music and painting in which the attempt of investigating an art in a scientific way is also a recent achievement.

Descriptors are derived historically according to the following general model:

2. See C. Lévi-Strauss' objections to Wiener's assumptions in: LÉVI-STRAUSS, C., *Structural Anthropology*, Penguin, 1972 (c. 1958, 1963), p.56.



1. DIRECT ORIGIN: From historically created problems and social realization and formulation of these problems
2. INDIRECT ORIGIN: From various scientific fields, where descriptors have been effective within analogous context.

We are going to explain this model in terms of two particular descriptors in architectural thinking. These are "microclimatic" descriptors and "network" descriptors of the built environment. The Industrial Revolution constitutes a common background according to which these descriptors have historically emerged and have been emphasized.

Present architectural thinking realizes that climate was always a basic generator of built forms. What led to the emphasis of microclimatic descriptors - apart from some obvious reasons directly derived from industrialization, such as pollution, conservation of energy, etc. - was the formalization of "comfort" as a commodity.

The demand for comfort has always been central to architectural practice. What happened, however, after the Industrial Revolution and the technological advance of systems by which comfort may be achieved, is that comfort has been included in the course that Mandel described as "a system for constantly extending needs". He wrote:

"The system must provoke continued artificial dissatisfaction in human beings because without that dissatisfaction the sales of new gadgets which are more and more divorced from genuine human needs cannot be increased."<sup>3</sup>

3. MANDEL, E., *The Causes of Alienation*, in: *The Marxist Theory of Alienation*, Pathfinder Press, 1974. (c. 1970), p.25.

It is very characteristic that P. O'Sullivan proposed the term "lack of discomfort"<sup>4</sup> in order to identify the subjectivity of the concept. This subjectivity is not only due to the inadequacies of psychological or other scientific tools to identify it, but is also due to the recent function of comfort as something which one could buy and sell and which is consequently subject to the unstable character of market forces.

In addition to this direct reason for the emergence of microclimatic descriptors in architecture, there are indirect ones such as the development of climatic considerations in other sciences, e.g. bio-climatology, psycho-climatology (connected with the general tendency towards a psychological approach to architecture), etc.<sup>5</sup>.

In the case of network descriptors, direct reasons are related to the possibilities of "channelization" that contemporary technology has introduced and made possible. Physical elements like light, water, etc. have always been considered as having a social usefulness. However, it is the channelization of these which transformed them to manipulable and spatially specialized sources. The LASER is an example of this tendency signifying what might be called a second degree of channelization of light by which even non-visual communication signals may be transmitted.

4. O'SULLIVAN, P.E., *Integrated environmental design of buildings*, Ekistics, Vol. 33/198, May 1972, pp.355-361.
5. *The establishment of Microclimatology by Geiger in the mid-20s, the development of Climatology, especially after World War II, beyond its purely descriptive base, and the emphasis attached to problems like adaptation, acclimitization, etc. in both man and machine constitute probably the most basic influences for the establishment and development of other scientific fields which have more directly influenced microclimatic descriptors in architecture. Such sciences are, for instance, bioclimatology - founded in 1956 and developed by Tromp in Holland -, forecasting climatology - especially developed in the 60s, but particularly for architecture in the early 70s.*

Apart from this first level of understanding direct historical evolution of network descriptors, there is a second level at which not only the very nature of the channel is taken into account but also the complexity and accumulation of networks which are involved in a given spatial form. Inevitably, to understand and solve this complexity, architectural descriptive theories have to exploit, in an indirect way, the evolution of mathematical theories of graphs and networks and, sometimes, to try to generalize them in order to understand the built environment as a whole<sup>6</sup>.

If we consider simultaneously climatic modification and production of networks at their very elementary level, we might understand the duality of elementary architectural actions; that is, of producing barriers, in order to differentiate a physically homogeneous situation, and of producing channels, in order to bridge a physically heterogeneous one. This basic syntactic duality leads us to a structural approach of description in architecture, but closely connected with its historically created meaning and social evaluation.

2. Comprehensiveness and structural approach to the descriptive theories of built environment

Environment has been considered in Ecology as the aggregate of external conditions that influence the life of an individual or of a population of organisms. The term "built environment" implies the

6. *Graph theory was founded with L. Euler's formulation and solution of the first graph theory problem in 1736. Incidentally, this had been conceived as a built environment problem. It was the famous Konigsberg Bridge Problem. More than a century later J.C. Maxwell and G.R. Kirchoff discovered some basic principles of network analysis in the course of their studies of electrical circuits. However, books on the subject started only to appear after World War I and wider interest was only much awakened after World War II. Now, of course, it is a well established branch of mathematics of wider popularity and applications.*

particular impact of man on modifying the natural environment of a specific place and producing what is generally known as "human settlement". In this sense, then, built environment might be defined either as a totality of natural and artificial components or as a set of elementary actions of modifications of natural space transformed into logically higher forms.

This distinction introduces two quite different ways of investigating the characteristic of wholeness which has been attributed to the built environment by the current descriptive theories in architecture. The first way reflects a present trend in architectural theories borrowed from the general tendency in modern sciences and well developed by Bertalanffy<sup>7</sup>; that is, to approach the notion of wholeness and consequently comprehensiveness from a "systemic" view. Here comprehensiveness is inevitably accompanied by continuously increasing complexity. In such a way, it places limits to the degree of wholeness which might be achieved.

The second way reflects the present structuralistic thinking which is also an approach to problems of wholes. However, it does so, trying at the same time to reduce complexity, by using the most elementary operations together with transformational rules which lead to higher structures, in order to attain comprehensiveness with simplicity.

According to Piaget wholeness can be attained genetically by "reflective abstraction". This means that while in the systemic mode of thought a property can be derived by being drawn out of

7. von BERTALANFFY, L., *General System Theory*, Penguin, 1973 (c.1968), pp.30,36.



things, by reflective abstraction properties are derived from the way in which we act on things<sup>8</sup>. It is quite natural to expect descriptive theories in architecture - dealing particularly, as other sciences of the artificial do, with the results of human actions - to be more amenable to reflective abstraction than to the systemic way of thinking. The deep character of reflective abstraction is that description becomes anthropocentric and consequently historically created. It is this point which has made many authors, including Piaget, conceive reflective abstraction in close connection with the Marxian concept of "praxis"<sup>9</sup>.

So structuralism and historical explanation become reciprocally related. History may be explained structurally - as in a way Marx did - and structuralism together with the descriptive theories based on it, may also be explained historically - as Piaget has clearly pointed out<sup>10</sup>.

The practical significance of this very general remark is that it introduces the only way in which the elementary structures may be formed. Furthermore, it shows the way in which the question of whether or not the investigator should try to find an abstract context for these structures may be answered; implying that this abstraction is simply without any importance if it is not to solve the problems that have produced it.

8. PIAGET, J., *Structuralism*, Routledge & Kegan Paul, 1971 (c.1968), p.19.
9. "Fortunately too, living scholarship leads to the rediscovery of the method by those who might not otherwise regard themselves as "Marxists". Perhaps the most outstanding example in recent times is Piaget. (p.287) ...Marx might be surprised to find himself described as an 'operational structuralist'." (p.288). See: HARVEY, D., *Social Justice and the City*, Arnold, 1975 (c.1973).
10. PIAGET, J., *Main Trends in Interdisciplinary Research*, G. Allen & Unwin, 1973 (c.1970), Introduction.

Piaget's "Genetic Structuralism" is a general method of inquiry based on the concept of totality (wholeness), self-regulation and transformation, common not only to linguistics and anthropology where it has primarily been developed, but also to mathematics, physics, biology, philosophy, the social sciences, etc.

"Semiological Structuralism" is another type of structuralism developed especially in the Saussurian linguistics and in the anthropology of Lévi-Strauss. It has developed out of the assumption that theories of structural linguistics are directly or indirectly applicable to all aspects of human culture in so far as all of these may be interpreted, like language, as systems of signs<sup>11</sup>. This way of thinking, in turn, presupposes the adoption of semiotic dimensions in these systems of human culture. This type of structuralism, though, adopts a quite distinct body of thought, accepts all the principles of Piaget's genetic structuralism. Piaget's later work<sup>12</sup>, however, has also been expanded to this type of structuralism which could investigate interdisciplinary problems of the broadest kind.

At present there is a tendency to formulate descriptive theories in architecture using semiological structuralism as a methodological background<sup>13</sup>. This is based on the notion that architecture is predominantly a system of signs which may be compared with purely semiological systems such as language, painting, music, etc.

We generally agree with this approach, not because architecture may be only semiologically explainable but more importantly because of the following two reasons which belong to the methodological

11. ROBEY, D., (ed.), *Structuralism: An Introduction*, Clarendon Press Oxford, 1973.

12. PIAGET, J., 1970, *op.cit.*

13. See, for example, JENCKS, C., BAIRD, G. (eds.), *Meaning in Architecture*, The Cresset Press, 1969.

aspect. Firstly, the notion of meaning which is implied by semiological structuralism is crucial to architectural description, particularly in the generalised form of meaning; that is, "social evaluation".

Secondly, there is a level at which the methodological advantages of both the genetic (general and abstract) and the semiological (socially meaningful) approaches may be resolved. We shall call this level "syntagmatic". One of the main aims of this paper is to show how this level may be generated, particularly in architecture. Before doing this we shall refer to some basic concepts starting from what might be called a purely syntactic approach to our descriptors.

### 3. The abstract syntax of microclimatic and network descriptors

Syntax may be considered as the level at which the generation of structures which may be apparently observed is investigated achronically according to the chain from the elementary to the complex. In linguistics - and other semiological sciences - the involvement of meaning has been mapped on syntax by producing what has been called the chain from deep to surface structures. There has been a long discussion between linguists on how semantics are involved in the "deepness chain" and we shall refer to the importance of this discussion to architecture in the next section.

Apparently, in architecture, both the syntactically pure complexity chain and the ambiguous deepness one may be considered simultaneously. Here, complexity chain means that we assume that the complex structures we observe have been generated by successive transformations of elementary structures. Hillier and Leaman, being

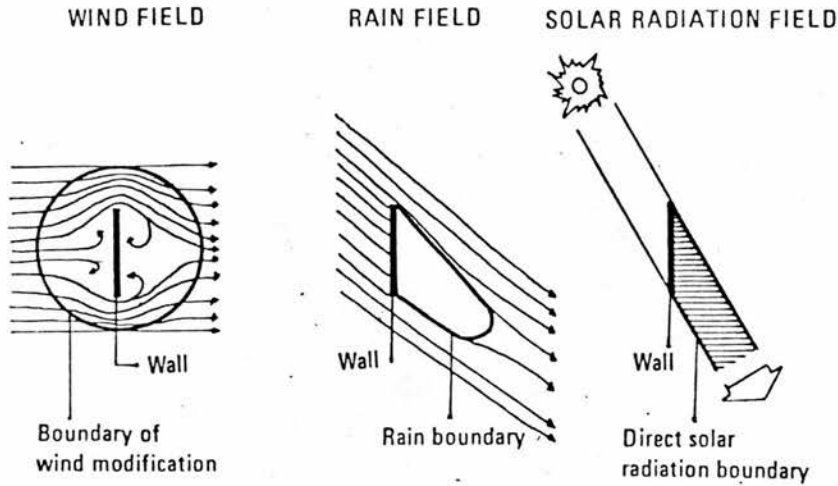
interested in the evolution of deep structures, are trying to introduce a syntactic terminology appropriate to architecture. They adopt the view that elementary structures in architecture are barrier-structures whose evolution towards higher structural degrees may be described by functional variables - such as contiguity, differentiation, boundaries, and permeability - and operational rules aiming at transforming simpler structures into higher ones<sup>14</sup>. The key to their analysis lies in the concept of the internal transformability of an object. This distinguishes the structural approach from the systemic one as far as intelligibility is concerned (mostly related to our term of "comprehensiveness")<sup>15</sup>.

The elementary operation in modifying climate - where it is considered achronically and on a statistical basis - may be described as an elementary barrierization of physical climate.

Consider a building element; for instance a wall. By creating a wall we modify the various climatic fields such as wind, temperature, radiation, humidity, precipitation, etc. The result is that different boundaries are produced, attributing to the specific operation of barrierization a multifunctional character. These boundaries indicate the particular differentiations which occur in each climatic field:

14. HILLIER, B., LEAMAN, A., *Space Syntax: a formal sketch*. Unpublished paper, March 1974.

15. HILLIER, B., LEAMAN, A., *How is Design Possible*, J.A.R., 3/1, January 1974, p.6.



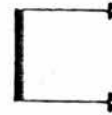
The physical properties that, in the classical theory of physics, interconnect these fields imply some fundamental characteristics of elementary microclimatic deep structure, analogous, for instance, to the rule of linearity in language.



Wind modification boundary: Always on both sides of the barrier



Rain boundary: Always on the one side of the barrier



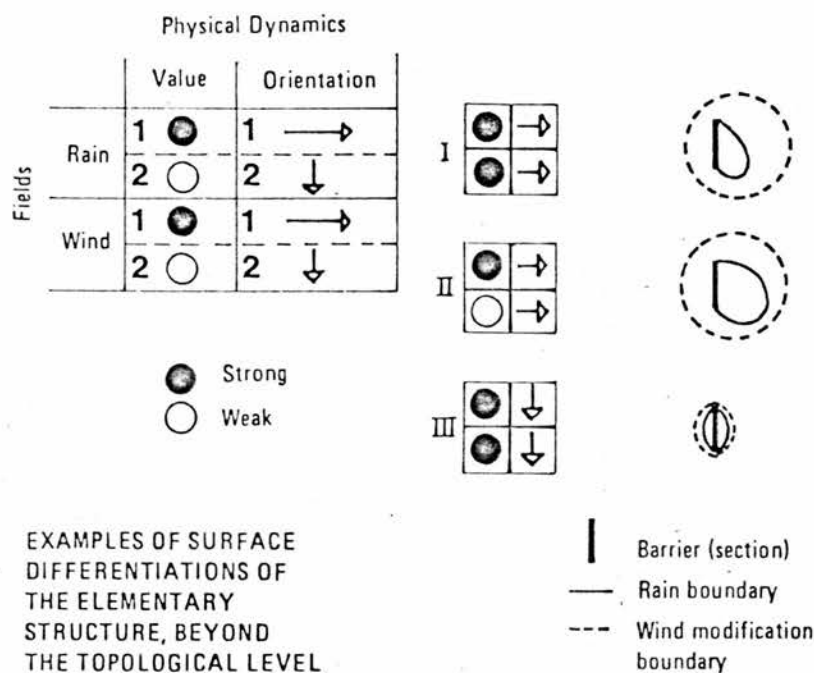
Direct solar radiation boundary: Always on the one side of the barrier

TOPOLOGICAL CHARACTERISTICS OF ELEMENTARY CLIMATIC BARRIER STRUCTURES.

Obviously, these are images which have been necessarily derived from the involvement of a semantic dimension rather than from a pure physical actuality. Of course, in a strictly physical sense, rain and solar radiation boundaries are topologically identical to the wind boundary. However, we have considered them in the way shown in the diagram above - speaking about "modification" in terms of wind, but, at the same time, about "presence-absence" in terms of rain and direct solar radiation - because of the fact that in architectural

thinking even abstract elementary structures cannot be isolated from a certain semantic context. This is a central point for this study to which we shall repeatedly refer at different levels leading to the notion of syntagmatic approach.

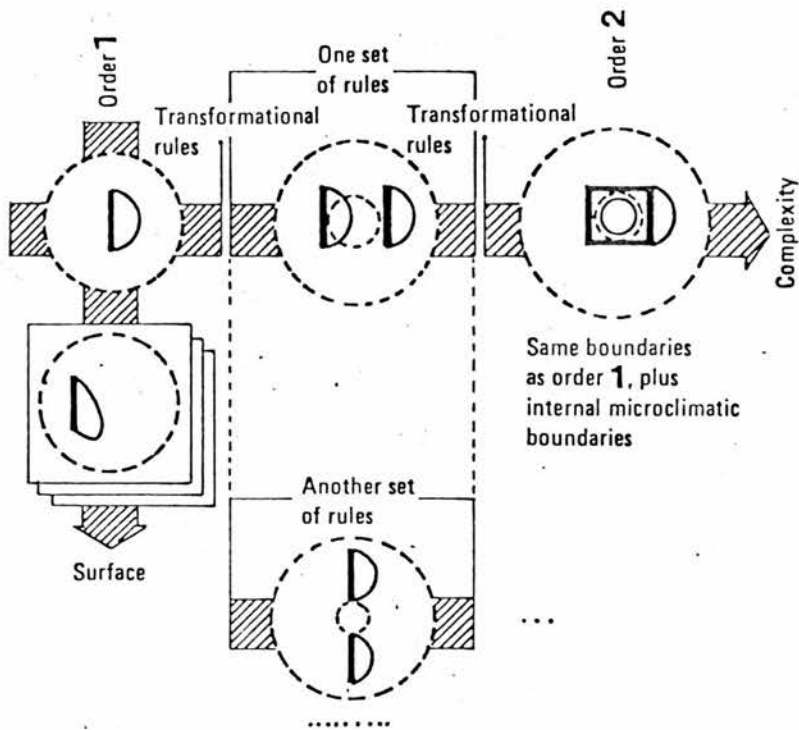
The path from deep structures to the surface ones, in terms of the syntactically elementary structure, may be understood by introducing the physical dynamics of the climatic fields, such as orientation, value, etc.



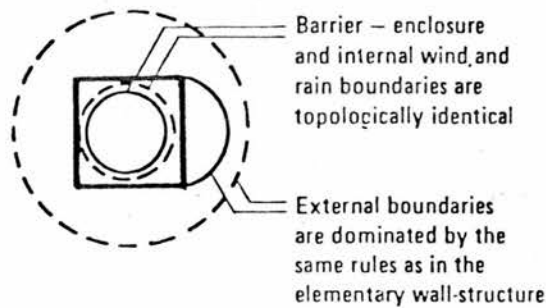
Built environment structures, of the elementary type discussed previously, are very rarely realized, since they are mainly understood after they have been transformed into structures of higher complexity, such as "enclosures". The application of transformational rules is characterized by an evolutionary chain in which a structure at a given complexity level becomes the generator for the one at the next level. Consider, once more, the elementary structure expressed in terms of



wind and rain climatic fields:



Again the physical properties that interconnect the microclimatic fields imply fundamental characteristics of higher complexity deep structure, such as:



Channelization of space may be considered as the elementary operation of eliminating physically or artificially existing barriers. Channels constitute elementary deep structures, which at a surface level may represent a variety of networks, such as electricity, water,

drainage, circulation, etc. The very nature of a channel implies, even at the most elementary level, a source, a destination, and a span between them which signifies that flow is a specific aim of elementary operations in channels, as opposed to the elementary microclimatic barrierization where the aim is to interrupt or disturb a physically existing flow.

Networks as we understand them in the built forms are already equipped with a semantic interpretation, in the same sense as microclimatic descriptors already include the semantics of the physical fields. In order to identify what deep structure - and consequently deepness chain - of a network could mean, we have to refer to the "Erlanger Program" by F. Klein, mentioned by Piaget in order to show the "fruitfulness" of structuralism<sup>16</sup>. So, the deep level at which we abstractly understand networks is the topological one and is expressed in the language of graph theory. According to this, graphs are just trees, semi-lattices or lattices where only connectedness is of primary importance. We have to introduce quantities in order to reach another level of complexity at which graphs begin to be transformed into networks<sup>17</sup>. In the next higher level, we may conceive of a network as a cybernetic mechanism. At this level, the nature of the network is identified by concepts like inputs, outputs, the particular identity of control mechanisms which it includes, etc.

The introduction of physical properties of flow leads to the last "deep" level in which a network is identified as energy, commodities, human circulation, etc. This level is quite different from what we

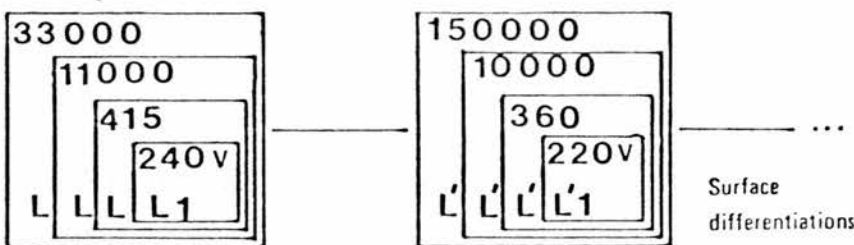
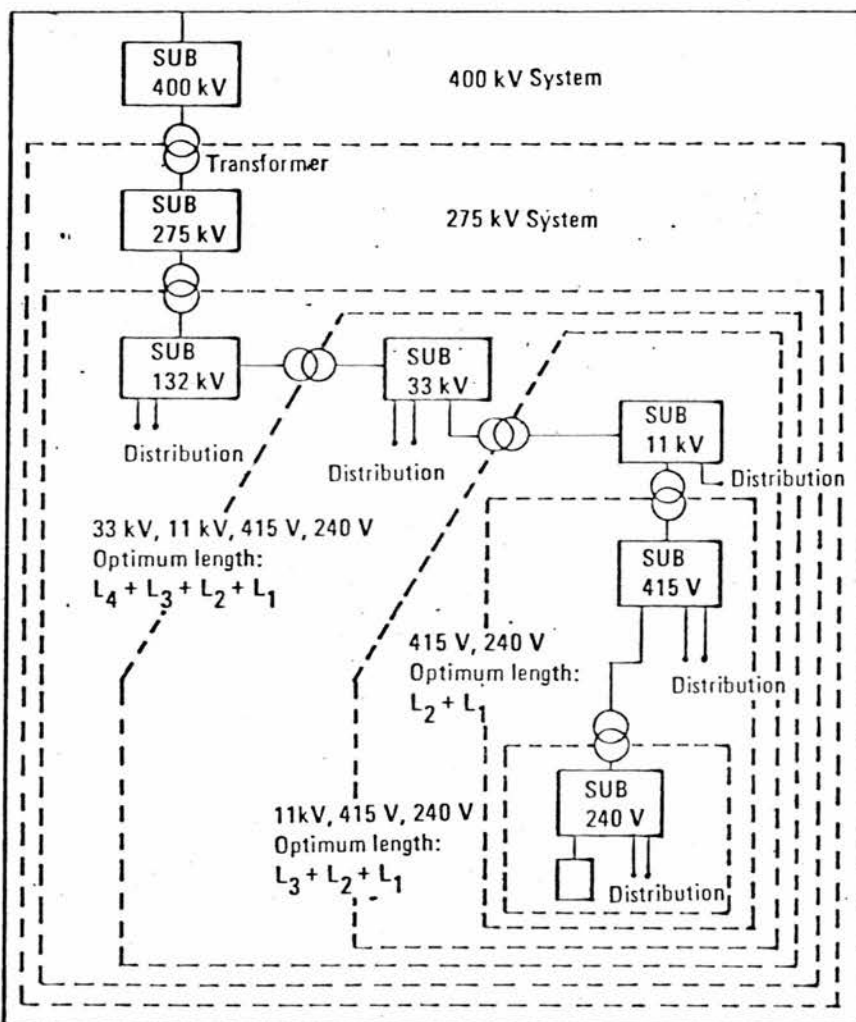
16. PIAGET, J., 1968, *op.cit.*, pp.21-22.

17. MARCH, L., STEADMAN, P., *The Geometry of the Environment*, R.I.B.A. Publ. Ltd., 1971, p.268.

mean here as a surface structure of a network.

If we consider networks as we understand them at this "deep" level in the built environment, we can identify chains of complexity which depend on the particular properties that may be identified at any of the previously mentioned deep levels. The important point here is that these complexity chains consist of concrete structural orders and are transformed according to a set of transformational rules.

Consider, for example, electricity networks:

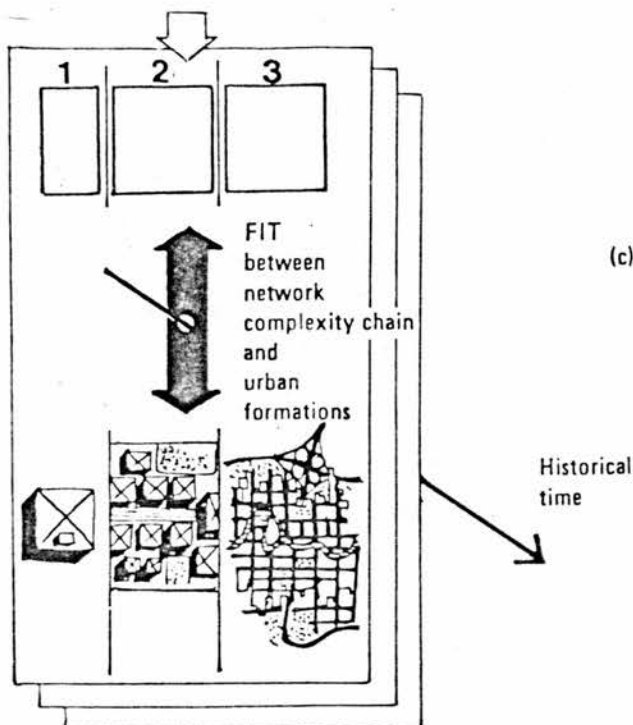
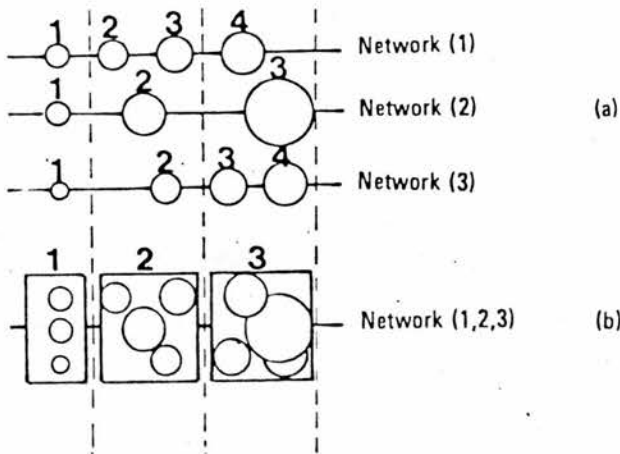


see note (18)

18. after *Electricity 72/73, Electricity Council Handbook of electrical services in buildings 1973, pp.30-31.*

To find what might be called a "general complexity chain of networks" in which all types of networks are to be combined, we note that we have to ignore the physical properties of networks as such, and to take into account the most deep levels of them. Such a general chain is represented by the following diagrams:

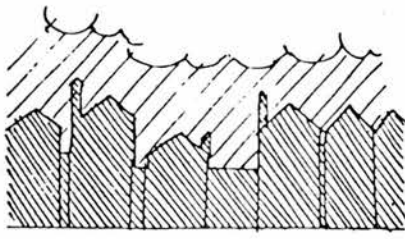
### Complexity Chains



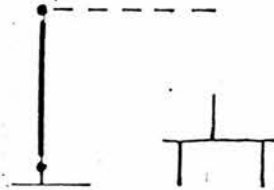
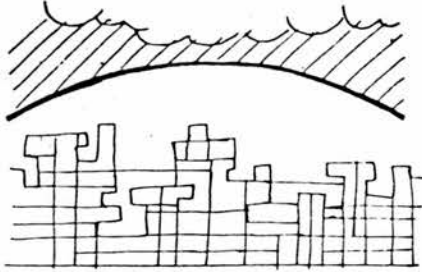
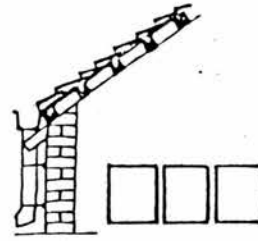
The reasons for producing such a hypothetical chain (b) is because we need to equip this chain with a higher semantic level in order to achieve, in a holistic way, the correspondence to the structural complexity levels according to which the artificial environment is formed. However, what happens in reality is that technology tries to modify the physical properties of networks in order to make this correspondence achievable, but, at the same time, built forms have to be structurally developed so as to be compatible with the existing technological level at a given time.

This general pattern, which is quite similar to the case of microclimatic descriptors, shows both the limitations of the purely syntactic approach and the weak connection between isolated syntactic approaches and problem solving processes, and leads to what we shall call later the "syntagmatic" approach.

Elementary architectural operations are initially concerned with barrierization in order to modify climate. Obviously, the history of architecture does not signify a very strong change in the way that this elementary barrierization is worked out, but signifies a remarkable change in the way this operation is socially evaluated. As opposed to this, the historical evolution of channelization does not show only a differentiation of the social evaluation of networks, but also important changes in the physical properties, the identities, and the complexity of them. We may refer to proposals like those of Buckminster Fuller, in which climatic fields (wind, temperature, etc.) would be altered, in order to imagine what such a change of physical fields by technology could mean in terms of the elementary barrierization:

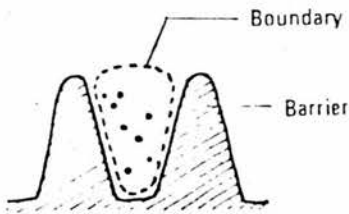


Usual manipulation of microclimatic barriers

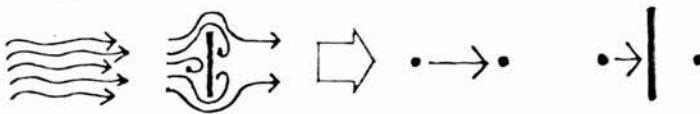


Manipulation of microclimatic barriers after an alteration of physical fields by technology

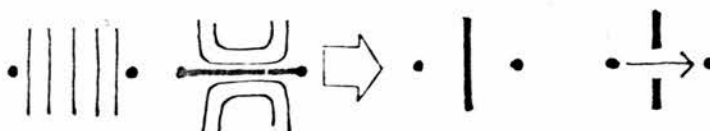
It is quite difficult to show how elementary architectural actions may constitute a subject of valuable description, apart from their semantic context. However, it is possible to show this in a very abstract way, in which the dialectics of the concepts of "barrier" and "boundary" have to be given deep consideration.



Elementary barrierization

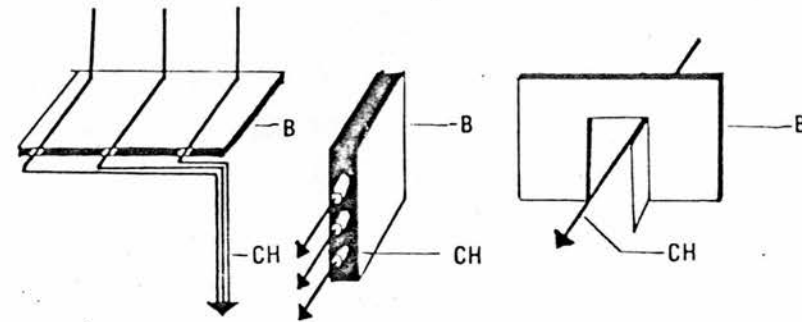


Elementary channelization



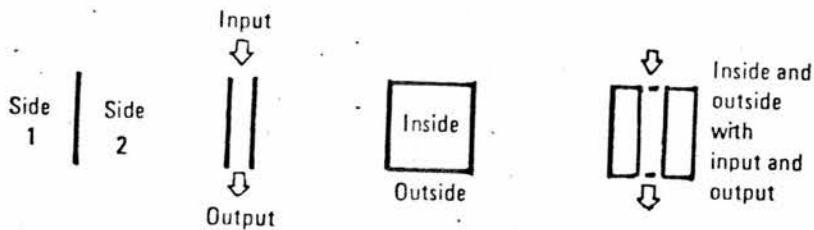


The simplest abstract architectural gesture is probably barrier-ization, but in simplest real architectural operations barriers are structured together with channel-boundaries. This very basic characteristic is shown in the following examples:

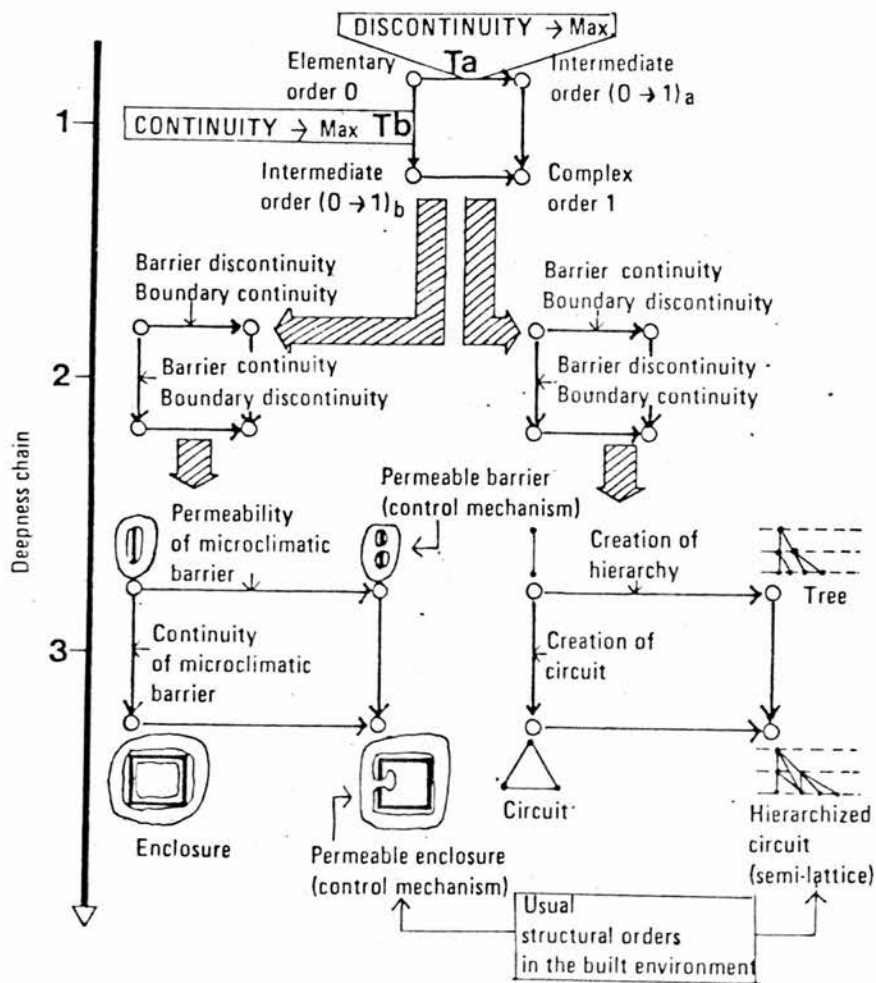


Dual identity of elementary architectural operations

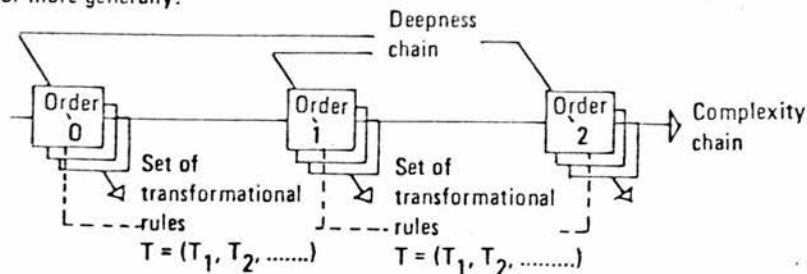
A theoretical mind, well convinced about the descriptive value of syntax, may proceed towards a common consideration of both micro-climatic and network descriptors in terms of their structural characteristics. A first way of approaching this is by constituting a chain in which even channels might be reached by transforming the elementary barrier deep structure.



However, this common consideration is better achieved if the transformational model (the model which structures the rules of transformation and the variables that characterize each structure) which dominates the syntactic chains, created by the two descriptors, satisfies a common logical basis represented in terms of a commutative square:



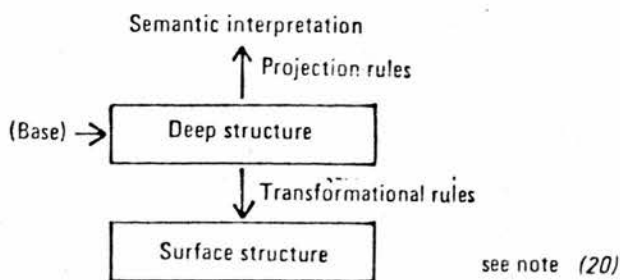
or more generally:



Such a highly theoretical consideration would be in danger of explaining intelligible and socially evaluated things in a complicated way, if it did not take into account what we will later call the "syntagmatic" identity of the structures. Even in the previous diagrams, we can observe the involvement of syntagmatic consideration when, for example, "continuity" and "discontinuity" first refer to barriers and boundaries and secondly take forms like "boundary discontinuity through hierarchy" (in order to reach the tree-network, useful for flow regulation) or "boundary continuity through permeability" (in order to reach the permeable microclimatic barrier, useful for microclimatic regulation). The syntagmatic consideration is discussed in detail in the course of the following sections.

4. The importance of semantic considerations; towards a generative approach

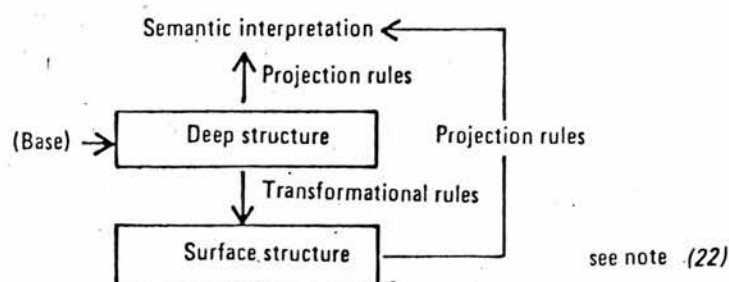
According to the initial model by Chomsky<sup>19</sup> semantics in linguistics are derived from the syntactic deep structure as follows:



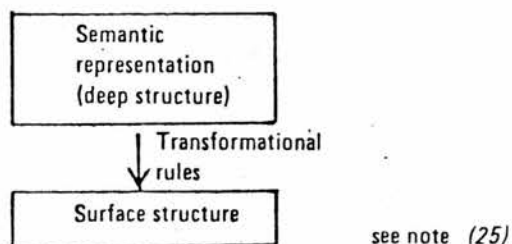
19. CHOMSKY, N., *Aspects of the Theory of Syntax*, MIT Press, 1965.

20. after LEECH, G., *Semantics*, Penguin, 1974, p.328.

By 1970, Chomsky revised this model<sup>21</sup> to the following one:



Both Chomskian versions constitute what has been called the "interpretive approach" to semantics and, thus, have been distinguished from a recent approach called the "generative" one<sup>23</sup>. According to the generative approach semantic interpretation is no longer derived from the purely syntactic deep structure, but the structure is so deep (this is what is called the "base" in the Chomskian versions) as to be identical with semantic interpretation. In this manner projection rules disappear and the model becomes simpler as follows<sup>24</sup>:



21. CHOMSKY, N., *Deep Structure, Surface Structure and Semantic Interpretation*, in: JAKOBSON, R., KAWANOTO, S. (eds.), *Studies in General and Oriental Linguistics*, Tokyo, T.E.C. Company, 1970
22. after LEECH, G., 1974, *op.cit.*, p.329.
23. *Ibid.*, p.324ff.
24. *We are not dealing here with phonology.*
25. after LEECH, G., 1974, *op.cit.*, p.330.

Traditionally, semantics deal predominantly with the concept of "meaning". C.K. Ogden and I.A. Richard (1923) wrote on what they called "the meaning of meaning"<sup>26</sup>. The important point made by Ogden and Richard, later by Bloomfield in "Language" (1933), and quite recently by Leech in "Semantics" (1974) is that meaning may best be studied as a purely linguistic phenomenon in its own right. Leech, however, proposed instead of meaning the concept of "communication value"<sup>27</sup>. Value in semantics explains the way in which the meaning of a semantic unit is developing from the total set of semantic units. In this way, value introduces the notion of "system of evaluation" which in the case of language is, of course, one aspect of the system of communication. This means that, apart from the system of verbal communication - with which language is concerned - we can refer to a broader semiotic framework which extends the dimension of communicative value beyond language.

Piaget points out that in all spheres of human behaviour there are systems of meanings, the essential parts of which are studied by linguistics, but he stresses the fact that, although language has played a basic role in the transmission of values and rules of every kind, it is not the only system of signs or symbols by which these values and rules have been originated. For instance, the appearance of representation in individual development is not due to language alone, but to a much wider semiotic function. He proceeds by suggesting that language constitutes a system of meaning in the power of one and it is accompanied in collective life by systems to the

26. OGDEN, C.K., RICHARD, I.A., *The Meaning of Meaning*, Routledge 8th edition, 1946, (c.1923).

27. LEECH, G., 1974, *op.cit.*, p.27.

power of two, such as myths, which are simultaneously symbols and semantic characters<sup>28</sup>.

It is the notion of "convention" - mentioned also by Piaget<sup>29</sup> - attached to signs and meaning that incorporates the social and historical character of meaning and that allows us to introduce a broader concept which is concerned with the "social evaluation" of signs. Thus to the chain of linguistic meaning → linguistic value → communicative value → broader value, we may add social value, directly dealing with historical evaluation. So, the simple concept of meaning, appropriate for linguistics, is replaced by the concept of "historically created social evaluation" which allows us, even starting from a purely semiological base, to enlarge its context in order to include the broader social character of systems like architecture. Morris used the analogous concept of "pragmatic meaning" in order to transfer the linguistic meaning - which he refers to as "syntactic meaning" - to the sphere of examining the sign in relation to operations and behaviours<sup>30</sup>.

The historical evolution of the social evaluation of products - which at first sight might be only evaluated semiologically - means that we accept that each particular historical period is characterised by a particular balance of systems of evaluation. Communication - and consequently communicative value - is, of course, only one of them.

Systems like painting, music and language have always been dominated by communicative values while architecture shows a different

28. PIAGET, J., 1970 *op.cit.*, pp.20-24.

29. *Ibid*, p.53.

30. MORRIS, Ch., *Signs, Language and Behaviour*, Prentice-Hall Inc., 1946.



history. For instance, it is quite easy to understand that communicative value has dominated the production of artefacts as far as official or religious architecture is concerned, from the Pyramids to the contemporary phenomenon of returning, at a morphological level, to the deep structure. This "return" is supposed to facilitate production, and produces another kind of communicative value by the very acknowledgement of this return. Banham emphasizes this point when he speaks about functionalism, saying:

"Under these circumstances it was better to advocate or defend the new architecture on logical and economic grounds than on grounds of aesthetics or symbolisms that might stir nothing but hostility. This may have been good tactics - the point remains arguable - but it was certainly misrepresentation. Emotion had played a much larger part than logic in the creation of the style; inexpensive buildings had been clothed in it, but it was no more an inherently economical style than any other. The true aim of the style had clearly been, to quote Gropius' words about the Bauhaus and its relation to the world of the Machine Age '..... to invent and create forms symbolizing that world.' and it is in respect of such symbolic forms that its historical justification must lie."<sup>31</sup>

What we have to add to this is that the deep structure of this contemporary symbolism signifies - not in terms of each architect's emotional reaction, but in terms of social evaluation - the development of an economic basis of symbolism and what is more important, the beginning of "internalization" of this development.

Such an "internalization" already dominated other fields of description of human practice and one of the most important deep characteristics of contemporary architectural thinking is that it does not only assume the significance of an economic basis in the limited symbolic context of architecture, but also acknowledges the

31. BANHAM, R., *Theory and Design in the First Machine Age*, *Archit. Press* 1972 (c.1960), p.321.

necessity of the interdisciplinary character of it.

Harvey is a good example of this. He points out that:

"In asserting the primacy of the economic basis Marx was proposing two things. First, he is suggesting that the relationships between structures are themselves structured in some way within the totality. In a conflict between the evolution of the economic basis of society and elements in the superstructure, it is the latter that has to give way, adapt, or be eliminated. Some structures are therefore regarded as more basic than others within a totality. Structures can therefore be ranked in order of significance. Marx obviously decided that the conditions concerning the production and reproduction of material life were fundamental - he certainly argued more strenuously for this view. And this led him to his second main point. When we attempt to view society as a totality, then ultimately everything has to be related to the structures in the economic basis of society."<sup>32</sup>

One should expect that economic bases have been constituting the fundamental system of social evaluation of architecture because of the hardware operations required to produce architectural artefacts and the difficulty of reproducing them. This has been happening also in other systems - consider, for example, stone writing or sculpture - but the additional property of architecture is that it has mainly to do with land use and economic resources. We shall try to make a rough comparison of four systems of human practice: Architecture, language, painting and music:

32. HARVEY, D., 1973, *op.cit.*, p.292.

COMPLEXITY CHAIN ↓	SYSTEMS				
	LANGUAGE	MUSIC	*	PAINTING	ARCHITECTURE
SUPER SURFACE STRUCTURE	Poem	Piece of music	Surface structure	Painting	Building
SURFACE STRUCTURE	Prose, Sentence	Elementary exercises on musical composition	Deep structure	(Painting as a picture)	(Building compartmentalization+ + activities' organisation etc.)
DEEP STRUCTURE	(NP - Aux - VP)	(Bar structure)	Underlying strings	Basic organization of painting	Basic organisation of building (enclosure + + access etc.)
UNDERLYING STRINGS (RULES OF THE BASE)	Linearity, Contiguity, etc.	Tonality, harmony, rhythm, etc.		Rules of combining materials + balance etc.	Building physics, etc. + + balance, etc.
CHOSEN ELEMENTS	a, b, c, .... phonemes, etc.	Tones, etc.	Chosen elements	Colours, materials, etc.	Materials, etc.
* After L. Bernstein <sup>(33)</sup>					

Social evaluation appears at a final level which has been already called "super-surface structure" and which, particularly in painting, music, and language, has been considered as the aesthetic one. Specifically in language, what has been accepted by Chomsky as surface structure constitutes a level which does not exist in the other systems as a self-sufficiently evaluated level and it is the result of the highly communicative power of language.

Nevertheless, in architecture it is not only the aesthetic evaluation which constitutes the system of social evaluation, as

33. BERSTEIN, L., *The Unanswered Question, Norton Lectures in Harvard, 1973 (shown on BBC 2, 1976).*

opposed to music and painting in which, because of the ease of reproduction, aesthetic evaluation has historically become predominant. The bipolar form-substance, for instance, may be used as a basis which clarifies a comparison among these systems. Although these systems are comparable in terms of form, they are quite different as far as the substance of their final product is concerned. Substance in painting is completely preserved from the chosen elements to the super-surface structure. Language and music belong to another category in which there is always the opportunity of conceiving both systems either in a written or in an oral substance. Architecture belongs to another category in which the super-surface structure is reached through a mapping which is quite different from the substance of the real product. The important difference between these last two categories is concerned with the process of producing the super-surface structure and not with the process of resolving and understanding it.

This deals directly with the economic bases of social evaluation in architecture, which allows us to interpret the nature of the production of architectural "syntagms" and what might be called pragmatic meaning in architecture. Indeed, the four systems of the artificial we mentioned, in terms of the properties of the super-surface structure may be compared as shown in the following table:

PROPERTIES OF SUPER SURFACE STRUCTURE (SSS) SYSTEMS	UNIQUENESS/PERFORMANCE	VALUE AS A COMMODITY	OTHER ECONOMIC UNITS	CATEGORIES
	A	B	C	A·B·C
LANGUAGE 1	Dynamic & reproducible character of the SSS	Minimized economic value of the SSS	Minimized cost of producing the SSS	DYNAMIC, EVALUATED COMMUNICATIVELY, REPRODUCIBLE 1·2
MUSIC 2				
PAINTING 3	Static & unique character of the SSS	Maximized economic value of the SSS	Low cost of reproducing the SSS	STATIC, EVALUATED COMMUNICATIVELY, REPRODUCIBLE (ERSATZ) 3
ARCHITECTURE 4			Maximized cost or producing and reproducing the SSS	STATIC, EVALUATED IN A COMPOSITE SYSTEM, REPRODUCIBLE BY CHANGING SUBSTANCE (MAPPING) 4

- \* Industrial design is a particular category in terms of production of artificial super-surface structure in which aesthetic value has been greatly replaced by a set of operational advantages concerned with the prototype. However, in industrial design, especially because prototypes are designed in order to be reproduced, the ability to be a commodity gets an aesthetic value, reversing the traditional scheme. This new kind of aesthetically evaluated functionalism may be very easily acknowledged in contemporary forms of architectural design (P.S.S.H.A.K., infrastructural design for flexibility, etc.).

5. Syntagmatic nature of architectural descriptors and their problem-solving capacity

The introduction of the notion of syntagm is an inevitable consequence of the complexity of social evaluation in architecture and the strong historical character of this evaluation.

Such a notion presupposes that we are closer to the generative approach in terms of the deepness chain and not to the interpretive<sup>34</sup> one, the last possibility being convenient for purely communicative and reproducible systems such as language and music.

According to De Saussure, syntagm in linguistics is a "combination of consecutive units supported by linearity"<sup>35</sup>. "Syntagmatic" relations are considered in semiology as being opposed to "paradigmatic" ones<sup>36</sup>. This philosophical distinction which might also be derived from that between "structure" and "taxonomy" would not reflect the real importance of the syntagmatic approach if the concept of syntagm does not include the logical understanding of a sentence which is the simultaneous reference in both syntactic and semantic levels. Thus, the syntagmatic approach to a structure

34. *These notions ("interpretive" and "generative" approach) have been discussed in the earlier part of section 4.*

35. *De SAUSSURE, F., Course in General Linguistics, Fontana/Collins, 1974, (c.1959), p.123.*

36. *According to Lyons, "syntagmatic relations which an element contracts are those which derive from its combinations with preceding and following elements of the same level... paradigmatic relations contracted by an element are those which hold between the actually occurring element and other elements of the same level which might have occurred in its place." See LYONS, J., Structuralism and Linguistics, in ROBEY, D. (ed.), op.cit., p.12.*



includes the social evaluation of even the elementary deep structures.

The function of prototypes in architectural practice has characterized its whole history both at a "language" level by producing different styles and at a "speech" level by influencing the individual way in which architectural surface structures have always been produced. What we propose here is that prototypes do not constitute anything, but syntagms, in which the semantic component cannot be isolated from the syntactic one. Particularly in architecture prototypes have played the role of "already structured" elementary units which have always carried a special meaning. Apart from this obvious way in which everyday-architecture has been practised, even revolutionary moments in architectural history could not be explained syntactically as one would expect at first sight. What happened, for example, in recent architectural history is that only the communicative meaning has been minimized while social evaluation - that is, pragmatic meaning - has been enlarged and has been mainly dominated by economic values.

Syntagms have been dominating not only the historical evolution of architectural practice, but descriptive theories in architecture as well. In recent descriptive theories, for instance, it is possible to see emphases and predominancies of particular systems of evaluation which define the specific character of them. The historical evolution of descriptors in architecture is closely connected with the historical evolution of these systems of evaluation.

Consider, for instance, three theories in architecture concerned with the description of the built environment and its "beyonds". In these theories - by people who have been basically trained in quite different disciplines - we shall see how the general

principles reflect the emphases on specific systems of social evaluation in the way we called syntagmatic, and also how such syntagmatic approaches differentiate the syntactic chains which might be derived from them.

Lynch in his "Image of the City" is concerned with

"the look of cities, and whether this look is of any importance, and whether it can be changed."<sup>37</sup>

His work, which is predominantly experimental, stresses the syntactic aspects of built form by analysing its "environmental image" into three components, "identity", "structure" and "meaning". By definition, the whole of this approach is based on the communicative value of built form. He points out that

"so various are the individual meanings of a city, even while its form may be easily communicable, that it appears possible to separate meaning from form, at least in the early stages of analysis. This study will therefore concentrate on the identity and structure of city images."<sup>38</sup>

Lynch could not avoid the syntagmatic dimension in his work - even working in a purely systemic way - since he had himself pointed out that symbolic, aesthetic, and other values beyond the communicative one are also of equal, if not more, importance. Furthermore, what is striking is that city images, even in terms of communicative value, are grouped according to social classes, age, sex, education and profession.

Lynch has tried to investigate syntax chains evaluated socially

37. LYNCH, K., *The Image of the City*, MIT Press, 1973 (c. 1960), Preface.

38. *Ibid.*, p.9.

in terms of human perception, cognition and communication. The components of his elementary structure<sup>39</sup>, inevitably include this particular kind of semantic interpretation, and consequently, the whole structural chain does the same, belonging by definition to the syntagmatic approach.

We have to look at his chapter concerned with "metropolitan form" in order to imagine how this chain may be descriptively identified and to show how flexible is the syntactic chain and social evaluation according to the system of meaning we use.

Apart from his first technique - which is less structural and more systemic<sup>40</sup> - to identify the way in which higher order structures (such as metropolitan ones) may be formulated, it is quite interesting how structurally valuable is the second one in which the elementary structures already contain the powerful attributes (always within the communicative context) that allow them to produce higher order structures. He points out that:

"The second technique is the use of one or two very large dominant elements, to which many smaller things may be related: the siting of settlement along a sea-coast, for example; or the design of a linear town depending on a basic communication spine ....."<sup>41</sup>

The structural chain that may be produced in such a way is syntactically different compared, for instance, with what we might understand as a hypothetical abstract topological syntax of a city, as might be suggested by the first technique.

Alexander represents the kind of investigator who moved from

39. "Paths", "edges", "districts", "nodes" and "landmarks".

40. LYNCH, K., 1960, *op.cit.*, p.112.

41. *Ibid.*, p.113.

the predominantly syntactic aspects of design to the syntagmatic ones. In his first book "Notes on the Synthesis of Form", he tried to establish a general mathematical syntax according to which elementary structures were to be equipped with some semantic interpretation<sup>42</sup>.

In a recent edition of the above book he states:

"At the time I wrote this book, I was very much concerned with the formal definition of 'independence', and the idea of using a mathematical method to discover systems of forces and diagrams which are independent. *But once the book was written, I discovered that it is quite unnecessary to use such a complicated and formal way of getting at the independent diagrams.*"<sup>43</sup> (his emphasis)

The recent work of Alexander (after 1967) reflects this remark, since it has been directed towards creating what he has called "pattern language".

So Alexander accepted the already structured prototypes (purely syntagmatic) and also the differentiation of their syntactic characteristics caused by political, social - in a word cultural - demands. By attempting to establish an institution like the "Centre of Environmental Structure"<sup>44</sup> he simply realized the social significance and changing character of architectural prototypes and tried to find a technique to record them and to produce his flexible "environmental pattern language".

42. Alexander uses the word "needs" transformed later in his *Atoms of Environmental Structure* into "tendencies".

43. ALEXANDER C., *Notes on the Synthesis of Form*, Harvard Univ. Press, 1974 (c. 1964), *Preface*.

44. *Proceedings of the seminar held by the Center for Environmental Structure in 1967*.

In Harvey's work "Social Justice and the City"<sup>45</sup> the predominance of economic evaluation of environmental structures at the urban scale is quite obvious. Equipped with the powerful apparatus of theoretical Marxism combined with what Harvey calls the "operational structuralism" of Piaget, he does not try just to use economics as one basis of an environmental descriptive theory, but as *the* comprehensive basis for that. Harvey's purely syntagmatic approach goes further, structuring the syntagms themselves through the structure of social evaluation. He does not speak anywhere about what this means in terms of syntagmatic syntax, but we may realize what that might be, considering some of his basic concepts, such as "real income", "use value", "exchange value", etc. It is not our intention here to proceed in a detailed discussion about syntagmatic syntax as it may be formulated in relation to Harvey's work. Nevertheless, it will become more and more clear that Harvey's emphasis on the economic basis is considered here as being strong enough to stimulate further research on the syntagmatic nature of architectural prototypes.

It might have become apparent that in this paper we are opposed to the tendency to produce purely syntactical approaches either in describing space or in producing it meaningfully.

We presume that any descriptive theory is intended to solve some problems which have been created historically and which have influenced its origin.

It is clear that syntagm and syntax are in two ways interconnected. That is, a syntagmatic beginning produces syntaxes and

45. HARVEY, D., 1973, *op.cit.*

the abstract syntax gets meaning in the course of syntagmatic interpretations. The important difference is that abstract formulations generally start from other scientific fields while syntagmatic ones come primarily from the problem area.

There are some questions concerned with present tendencies to establish an abstract syntax in architecture. A first question is whether abstract syntax is applicable by projection rules - similar to the Chomskian version in Linguistics - and what are the difficulties of these applications.

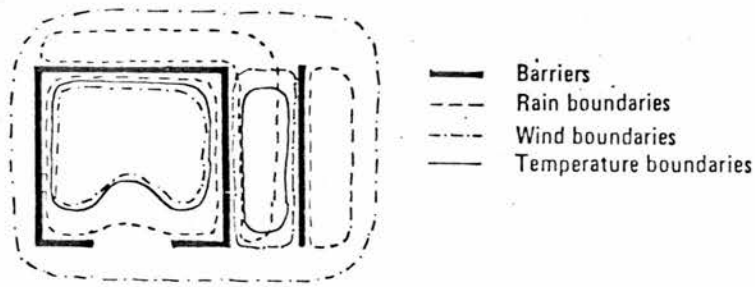
The second question is concerned with whether or not there is *the* abstract syntax and, coming back to the first question, what is the degree of abstraction and applicability of this syntax. Our answer to this double question is simply that although practice may be using abstract formulations, it does so by producing a variety of these and that this variety is directly influenced by the problem-origin of descriptors and the systems of social evaluation of their syntagms. We have already summarized this, speaking about the syntagmatic beginning.

We shall examine some of these points as far as three descriptors of the built environment are concerned. The first two, already mentioned, are those of microclimate and networks. We shall try here to show how their syntagmatic premise produces syntaxes quite different from what current attempts, working in an abstract way - similar to those developed in section 3 - have been trying to establish. The third, the participatory approach, is distinguished from the previous two because it has been developed exclusively at a syntagmatic level, particularly as a movement of architectural practice. We shall try to show, also, what this descriptive basis

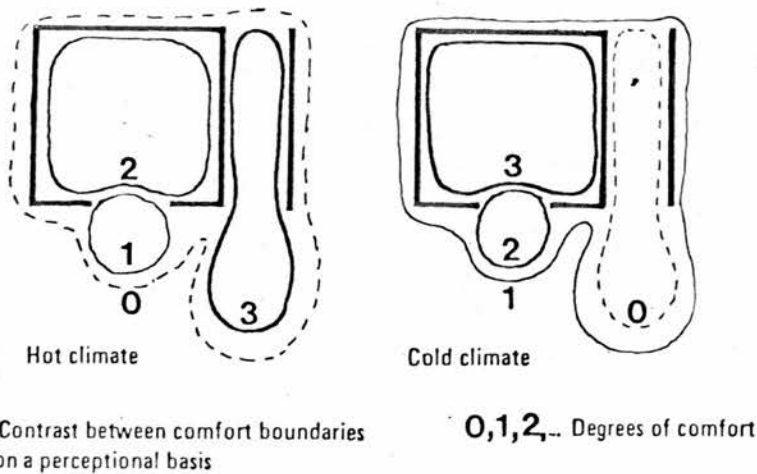


could mean in terms of syntax.

Consider microclimatic descriptors in an example in which there is a specific set of microclimatic conditions (e.g. wind, rain, direction, etc.) and microclimatic structures are to be mapped only topologically. This mapping, though containing different boundaries, corresponds to a specific structure according to which internal rules connect the forms of different boundaries among themselves.



At the same level of topological representation, a syntagmatic structure may be as follows:



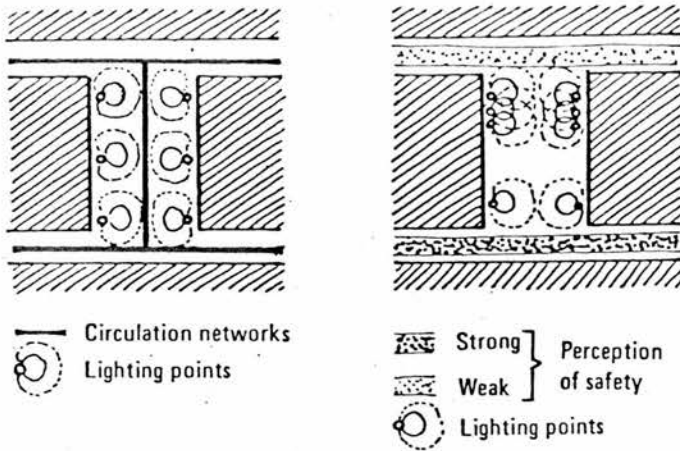
What is important here is that this structure is very flexible without altering at all the "objective" microclimatic conditions and, consequently, the previously mentioned purely syntactic structure. This indicates that the structure, as we understand it syntagmatically,

depends on the structure of the system of social evaluation and the predominancies within it. If we consider comfort, for instance, as a measure of social evaluation - in which the perception of climate by humans and their reactions are predominantly taken into account - we produce an even topologically different structure than either the purely syntactic approach or another syntagmatic approach, in which predominance belongs not only to comfort but probably to an economic basis as well. So, syntagmatic structures constitute already structured prototypes, highly valuable in architecture, which cannot be derived by applying projection rules to the kind of abstract structure shown in section 3.

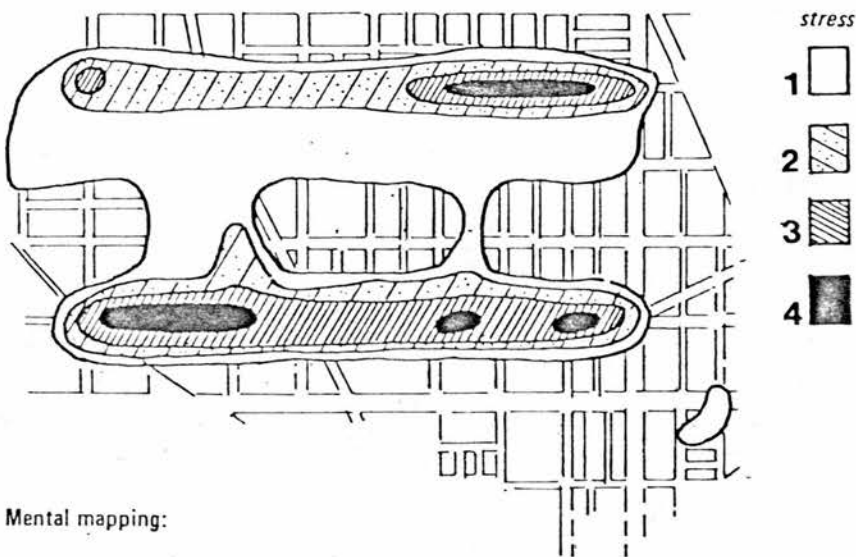
The network descriptors involved in architectural descriptive theories have also a syntagmatic character which generates syntactic structures quite different from those which might be generated by a purely syntactic approach (as those presented in section 3).

Consider, for example, a street network (refer to figure overleaf).

Experiments on what have been called "mental maps" have shown how the involvement of systems of social evaluations (e.g. "perceived environmental stress", "preference", etc.) may produce syntactic chains, totally different from the purely syntactic ones. In the street example, street lighting, for instance, is syntagmatically structured in terms of a pattern far more complicated than the purely syntactic pattern of "homogeneous" of lighting. However, transformational processes, which have always been working at the syntagmatic level in terms of microclimatic descriptors, sometimes lose their character when we try to understand them applied to networks. This simply means that some of the technicalities of recently



The street lighting example



Mental mapping:

*The perceived environmental stress surface for a portion of Philadelphia.*  
 In: GOULD, P. & WHITE, R., *Mental Maps*, Penguin (©1974), p. 31. (After David LEY in: *The Black Inner City as a Frontier Outpost: Images and Behavior of a North Philadelphia Neighbourhood*, University Park, Pennsylvania, Ph.D. Dissertation, 1972).

developed networks (e.g. electricity circuits) have not yet been entirely incorporated within the syntagmatic "lexicon" to the extent that other networks (such as waterproofing) have.

Microclimatic and network descriptors belong to a category in which the starting point of explanation lies nearer to the mapping procedure than to the social evaluation of a syntagmatic structure.

This means that, in order to understand a structure syntagmatically through microclimatic and network mapping, we have to structure predominances within the system of social evaluation, or, in a more objective version, to understand how the historical problem-framework has formulated these predominances.

Obviously, this is not the only way in which descriptive theories - not only in architecture - are structured. Problems and their ideological "behind" may influence directly at a more general level the starting point of these theories. Nevertheless, the movement towards "Social Architecture" shows how this process may produce too generalized tendencies which do not structure the system of social evaluation, necessary to produce the satisfactory syntagmatic levels for solving the problems. More attention, hence, has to be given to contemporary movements on architectural praxis. The "participation movement" is one of them and we shall see how it may be syntagmatically explained.

Participation, either at a community or at an individual level, is more intelligible as "maximum users' participation in the process of forming their environment". Apparently, there is a variety of goals that people, who exhort users to participate, hope to achieve; starting from the improvement of the built environment and ending in what might be a political mobilization of disadvantaged communities. Similarly, the "behind" of this practice and its ideological background vary considerably. No one can ignore that participation is often nothing more than an administrative technique or "strategy" (as E. Burke calls it<sup>46</sup>) closely connected with the process that

46. BURKE, E., *Citizen Participation Strategies*, Sept. 1968, p.287.

P. Selznick identified as "co-optation", through which, an -even repressive - organisation attempts to avert threats to its stability or existence<sup>47</sup>. However, participation as a community-based ideological context signifies, generally speaking, the antidote against *alienation*.

Alienation is a recent phenomenon of human history; at least at the generalized scale we observe it in contemporary industrial society. Marx in his first works, and especially in the "Manuscripts of 1844", referred to it, but it is Ernest Mandel who, starting from Marx's concepts, analysed it in a remarkable way, distinguishing among the different kinds and degrees of alienation<sup>48</sup>. He tried to answer the question of whether or not alienation is an inevitable phenomenon in industrial society, even if this society is a socialist one<sup>49</sup>. It is characteristic and convincing for the value of the bipolar alienation-participation that Mandel identifies this particular kind of practice as one of the answers to the process of disalienation.

What might such a general ideological background mean for the description of the built environment in the syntagmatic sense of the term?

Alienation and participation deal mainly with the process of production and, in our case, with the process of production within the framework of which the built environment may be identified. In this

47. SELZNICK, P., *Foundations of the Theory of Organizations*: F.E. EMERY (ed.) *Systems Thinking*, Penguin, 1972, (c. 1969), p.277.

48. MANDEL, E., *The Causes of Alienation*, *op.cit.*, pp.19-28.

49. See: MANDEL, E., *Progressive disalienation through the Building of the Socialist Society, or the Inevitable Alienation in Industrial Society?: The Marxist Theory of Alienation*, Pathfinder Press, 1974 (c. 1970).

sense, alienation indicates that the product no longer belongs to the producer and, very frequently, this product, by being involved in the market circuit, turns against the producer himself (Marx used the concept in this context speaking about "Entausserung"). We understand this process in the built environment at a general level, distinguishing between: (a) The traditional societal forms in which the user and the architect either were identical or perceived each other perfectly, so that there was no question of alienation in the process of producing built forms, and (b) the contemporary industrial societal forms in which the built environment becomes simply a commodity and is very often characterized by what Mandel called "technical increase of needs", as an inevitable consequence of market function. Furthermore, we understand that within this context of (b), the room for creativity has been transferred from the user to the architect, recently to the industrial designer, and finally to the economic manager; that is, it has literally disappeared.

This first level of understanding the process of alienation as the starting point of the ideological background towards participation - that is, towards progressive environmental disalienation - fulfils the semantics of the elementary structure with which a descriptive theory of built forms may be explained. Needless to say, such a syntagmatic elementary structure derives directly from economic measures and has nothing to do with the topology or any other "purely" syntactic structure of the built environment. Nevertheless, this kind of syntagm seems to be so important that it might be, for instance, the key concept for C. Alexander to find the context of what he called "good fit" between form and function and would solve his basic problem of identifying the otherwise arbitrary "needs",



"requirements", or "tendencies"<sup>50</sup>.

It is obviously a difficult task to map such an elementary syntagmatic structure, particularly because of the lack of information to identify the degree of creativity involved in the relationship between user and space and because of the adaptability of the surface of human behaviour. Users often simply accept their environment because they do not have the opportunity to do otherwise, because they are influenced by the illusion that they have chosen it, or because they do not realize how such a lack of creativity influences their behaviour as a whole. There is no doubt, however, that evidence of attempts to escape from this passive acceptance may be found and may constitute an index for such a mapping. Inhabitants of newly constructed villages, for instance, who had been previously accustomed to a traditional way of connecting themselves with their environment, try - desperately and primitively many times, but absolutely understandably - to transform their new shells, not just because the new homes do not correspond to their needs, but also because they try to connect themselves with their environment.

Alienation is a context of environmental structures that we can also understand at the degree of complexity which corresponds to urban space. We have been used to explaining this phenomenon by surface characteristics such as "the gigantic inhuman size" and "the extent of criminality" or by deeper ones such as the property of accumulation which is attributed to the built forms by the very nature of their materials. However, it is here that the deep structural

50. *This is not to argue that Alexander himself did not realize such inadequacies. The development of his thoughts is a remarkable example of successful understanding of such problems and of self-correction.*

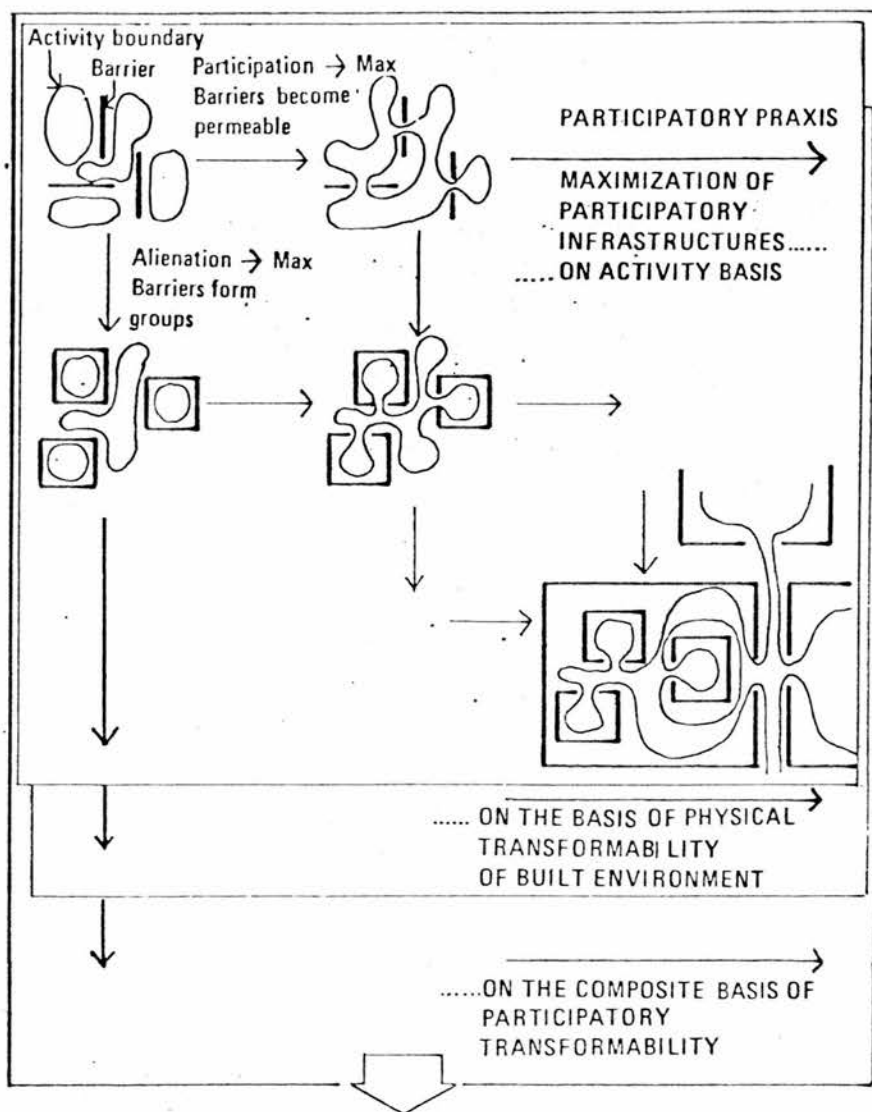
characteristic of alienation - or non-participation - that is, the activities' barrier, becomes significant in two ways; as a barrier between activities and, consequently, between groups of participants and, in a dynamic sense, as a barrier between a human group and an activity under development. Contemporary cities are predominantly characterized by this attribute and their barriers may be identified at a whole scale of signifiers, starting from what might be called "physical barriers" and ending in "institutional barriers", such as those which eliminate access to property accumulation, etc. The way in which the citizens of Paris suddenly realized their city, in the Commune time (1871) as a "festival"<sup>51</sup>, gives an example of both the deep structural identity of institutional barriers and the difficulty of recognizing it in contemporary cities.

It would be strange if we could explain this process towards complex alienation structures starting only from the barrier between user and environmental product. We have to deal, obviously, with an economic process which is very complex to allow only architectural creativity to be the key-point towards disalienation. However, what seems to be important here - especially because we start from a strongly ideological context, which is already structured and not from a lower "physical" level as in the case of microclimatic and network structural description - is that we are more interested in the way in which the variations of practice lead to a variety of elementary syntagmatic structures and less in the opposite process. We shall give an example of how one of these variations produces a syntagmatic syntax of the built environment.

51. VILLIERS DE L'ISLE-ADAMS (under the pseudonym "Marius"), *Paris as a festival*, article in the commune paper: *Le Tribun du People*, : St. EDWARDS (ed.) *The Communards of Paris, 1871*, Cornell University Press, (c. 1973), pp.140-142.

A particular interpretation of the participation movement is that the architects' advisory role is to play an important part. There are many interpretations of this role as well, from the most activist ones, in which architects become political organizers of a community, to the most "technical" ones where architects continue to act within the traditional context of their profession. But, in this last case, the context is characterized by a tendency to equip the participants with the necessary environmental infrastructures, in order to allow them to exercise their abilities in the easiest possible way. The organization of infrastructures becomes, in descriptive theory, the recognition of them, leaving the organizational part as the inevitably following "beyond" of the description. These "participatory infrastructures"<sup>52</sup> may be determined by surface characteristics, such as flexibility of materials, the users' tendencies to participate, the institutional background for participation, etc., but it is the bipolar stable-transformable which constitutes the key for the deep elementary structure of such a description of built forms. While the city or area form would be syntactically understood - in the "pure" mode - as a complex barrier-structure, according to such an ideologically stimulated syntax it would be understood as a structure of transformability, evaluated socially through the practice of participation:

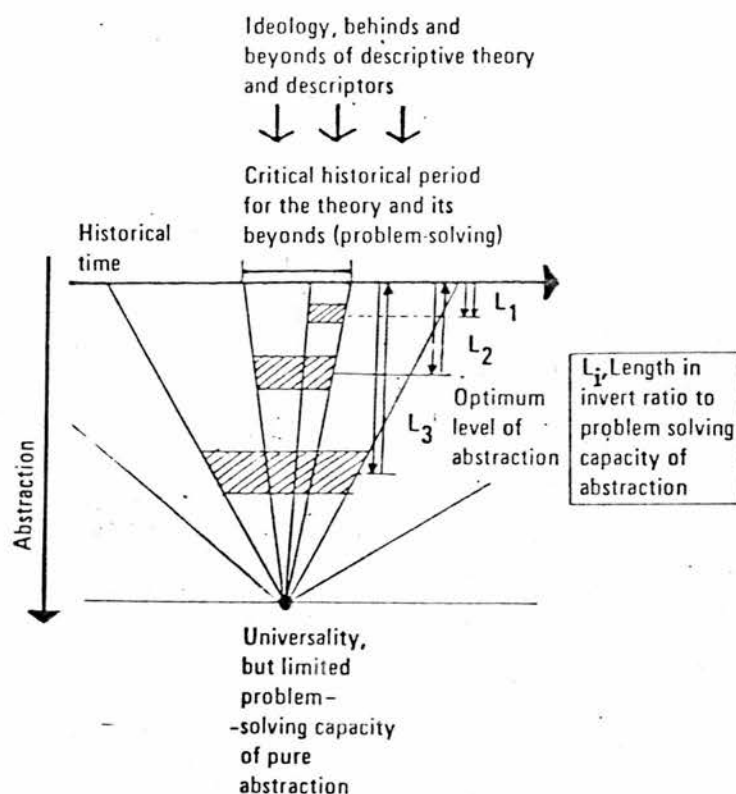
52. *The term "participatory infrastructures" looks, to some degree, controversial because it contains a descriptive estimation of a given reality through a non-existing condition. We may anticipate this criticism if we turn back to the basic assumption of this study that descriptive theories are characterized even at the most elementary level of the components, by "beyonds". The very notion of syntagm would lose its meaning, if its prescriptive component would be excluded and would not be transformed to the meaningful kind of syntax we already mentioned as syntagmatic one.*



SYNTAGMATIC SYNTAX OF BUILT ENVIRONMENT  
ON THE BASIS OF PARTICIPATORY TRANSFORMABILITY

Within the context and space of this paper it has not been possible - although desirable - to discuss in detail thoughts that apparently would require a further explanation. The reader may easily understand that we have attempted only to introduce a general idea and to develop the terminology concerned with it. However, there are some points which have been repeatedly stressed and, we think, are of particular importance for further research.

A first one is concerned with the impression which might probably be concluded from the text that we completely reject the notion of abstraction in architecture. What we really tried to do in this paper was to explain the limitations of the purely syntactic approach. The strong syntagmatic character of architectural problems, combined with the high level of structural complexity of architectural prototypes, provides an intermediate level of abstraction which is capable of giving a direct possibility to solve these problems, as they emerge and are transformed historically.



When we previously explained the syntagmatic character of microclimatic and network descriptors, we introduced one way in which the above argument on the optimum level of abstraction is adopted by practice. We have also shown the other way, when we discussed the alienation-participation syntagmatic structures. The first way is concerned with the process from the apparently syntactic to the syntagmatic while the second one with the process from an undoubtedly

ideologically stimulated syntagmatic context to the syntactic chains that interpret this context. It is obvious that, in reality, practice works in both ways simultaneously and reaches the necessary levels of abstraction that allow these ways to contribute to each other. And, it is not the achronic "scientific" syntax that would provide the key for establishing once and for ever these levels, for the simple reason that it is too poor and too general and too achronic to follow this complexity.

A second and final point is concerned with the particular aspects on which to concentrate further research. It is now quite clear to us that it is crucial to examine systematically the evolution of architectural prototypes within the framework of syntagmatic approach and the context of social evaluation. It is through this investigation that the structure of socially evaluated meaning may be identified and it is this structure that will enlighten this investigation as well as the solution of contemporary architectural problems. By this, we do not intend to argue that this necessity has not been recognized and elaborated by architectural thought in many different ways. We simply attempted to show how a method which at a first sight leads to abstraction can become the key for continuing this task.

We wish to thank Professor C.B. Wilson (Department of Architecture, University of Edinburgh) and Professor Harriet Ryd (Royal Institute of Technology, Stockholm) for their most valuable criticisms and comments.



## A P P E N D I X II

## DESCRIPTION AND DESCRIPTIVE THEORIES IN ARCHITECTURE\*

Forward

This paper supplements the work carried out by the same authors in E.A.R./3 under the title "Description and Descriptors in Architecture"<sup>1</sup>. In that article we have suggested that further research on this subject should be mainly orientated towards examining systematically the evolution of architectural prototypes within the framework of "syntagmatic approach" and the context of "social evaluation". However, instead of carrying out this task, in a necessarily short paper, it appeared to us that it would be useful to develop further the general idea itself and to clarify the terminology concerned with it which, as the discussion of the E.A.R./3 article has proven, was obscure on some points. These points are briefly discussed in the introduction and elaborated in the text of this paper.

The present study is divided into the following two sections:

1. Notes on the identity of environmental structures.
2. Notes on the terminology concerned with the dynamics of environmental structures.

\*

*This paper has been published collectively by the author of this thesis and his colleagues, A. Awadalla and T. Kotsiopoulos. Originally the paper appeared under the same title in Edinburgh Architectural Research Journal (E.A.R.), Vol.4, 1977.*

1. AWADALLA, A.B., KOTSIPOULOS, T., MARAVELIAS, Th., *Description and descriptors in architecture*, Edinburgh Architectural Research (E.A.R.), Vol.3, 1976, pp.37-75. For brevity, we shall refer to this article as "E.A.R./3 article" throughout this paper.

Needless to say there is no way of understanding the content of this article outside the framework established in E.A.R./3.

### Introduction

In the E.A.R./3 article we concentrated on discussing the problems of establishing a theory for the investigation of the built environment within a structural framework. By doing so, we outlined the methodological limitations of both purely syntactic and purely semiological levels of approach to deal comprehensively with both the logical and the semantic complexity of architectural structures. We have attempted, also, to show - through examples taken from each of the authors' individual research - the "syntagmatic" character of these structures and, furthermore, that it is imperative for any descriptive theory concerned with them to reach a level of "optimum abstraction" and to keep the explanation within both its historical framework and the social evaluation of environmental structures.

As mentioned in the forward, there are two major areas which, we think, need further clarification and development. First, the area of the identity of a structure (because of the strictly environmental point of view we took in the E.A.R./3 article) and second, the area of the dynamics of a structure (because of both the consequences of the enlargement of the first area and the limited discussion in E.A.R./3 about it).

The key-concept for the re-investigation of the identity of architectural structures and, therefore, for the descriptive theories concerned with them, is the "descriptive dimension". Structures in E.A.R./3 have been considered more or less under the assumption - though not clearly stated there - that their predominant representation

and consequently the starting point for their description is to be found at the level of the environment. The concept "descriptive dimension" means simply that, apart from the purely structural analysis according to the deepness and the complexity chains, there is room for investigating different representations of the structures - such as at the activity or the institutional level - which sometimes are nearer to the historical origin of them.

This consideration implies a whole new area for discussion about the "identity" of a structure intelligible at the environmental level. We shall be trying to identify some points of such a discussion in connection with the dynamics of structures and especially the potential for their transformation.

The potential and the nature of transformation are exactly the second area this article deals with and the key-concept to this is the notion of "contradiction". The simplified form of our central argument is that transformations are caused by contradictions within the structures and it is our task to identify and classify their nature.

#### 1. Notes on the identity of environmental structures

The term "structure" in architecture has gradually acquired a polysemic meaning, the complexity of which makes its use quite ambiguous. The traditional meaning and use of the term associates the concept of structure either with the loadbearing parts of a building or, in a more general sense, with anything built by man, from a house to a pyramid<sup>2</sup>. An *imported* use from other conceptual domains,

2. See, for example, *The Dictionary of Building*, Penguin, 1974, (c. 1964).

influenced by the development of "structuralist" thinking, associates structure with a number of other concepts like "system", "whole", "coherence", "set of relationships", etc., beyond the environmental level - though not yet necessarily of a syntagmatic character.

As is the case with the general epistemological use of the term "structure"<sup>3</sup>, its imported use in architecture is not clear and consequently the conditions for applying it to a given reality are not well understood. The multiplicity of connotations attributed to it doubts both the existence of a single definition and a single methodological orientation, which could be termed "structuralist" and, hence, the conceptual confusion surrounding the use of the term in general epistemology, and consequently in architecture.

In general, differentiations in the use of the term might be considered as taking place by the different values applied to it according to two major semantic bases:

- (i) The conditions under which a structure can be applied as such: For Piaget, for instance, conditions of "wholeness", "transformation" and "self-regulation" are applied to define "structure" as a system of transformations under some well-defined transformational rules<sup>4</sup>. Two extreme examples according to this basis may be given; the "mathematical group" (which Piaget considers as the finest prototype of his

3. BOUDON, R., *The Uses of Structuralism*, Heinemann Educational Books, 1971, (c. Editions Gallimard, 1968).

4. PIAGET, J., *Structuralism*, Routledge and Kegan Paul, 1971, (c. 1968), p.5, and by the same author, *Main Trends in Interdisciplinary Research*, Allen & Unwin, 1973, (c. 1970).

definition of structure<sup>5</sup>) and, a concept in general use, the "social structure" where no such formal conditions may necessarily be applied<sup>6</sup>.

- (ii) The degree of abstraction applied to a certain reality which is necessary in order to understand a structure: this basis leads automatically to the syntactic components of the "deep structure" and it is identical in its practical application to the Chomskian linguistic model of grammar<sup>7</sup>. According to this basis, structures are to be identified either at the abstract level of deep structure<sup>8</sup> or, alternatively, at a surface level of the observable reality. One attitude identifies a structure at a surface level under the condition that there is a deep level which is itself the structure, while a second attitude accepts the deep level analysis as inevitable without imposing conditions to identify a structure at a surface level.

Our position, reflected in E.A.R./3 and firmly held here, is that there is no objective way of imposing any conditions to define a concept of structure, and afterwards, using this concept for explaining a particular set of architectural realities. Obviously, the structural identity may be, in some cases, strongly implied by

5. PIAGET, J., 1971, *op.cit.*, p.19.

6. "Social structure" even considered in its broader sense may well depend upon higher structures, for instance, like those of "roles" and "character structure". For an explanation of this dependence see GERTH, H., MILLS, C.W., *Character and Social Structure - the Psychology of Social Institutions*, Routledge & Kegan Paul, 1957.

7. E.A.R./3, *op.cit.*, pp.55,56.

8. Compare with the concept of "space syntax" in, HILLIER, B., LEAMAN, A., STANSALL, P., BEDFORD, M., *Space Syntax*, Environment and Planning B, Vol. 3, 1976, pp.147-185.

conditions applied to the environmental image of these realities (e.g. a neighbourhood as a structure), in other cases, to the institutional image (e.g. a hospital or a university as a structure) and, in other cases, to a complex image (e.g. a town as a structure)<sup>9</sup>.

Before we introduce and discuss the concept of "descriptive dimension", it seems that it is necessary to elaborate further the distinction between description and descriptive theories we put forward in E.A.R./3; that is:

"Descriptors are the components of descriptive theories. In other words, they constitute the basis according to which a description may be implemented. A descriptive theory may consist of either one predominant descriptor which is being considered as the most important one, or a set of descriptors which supplement each other in a structural way within the framework of a descriptive theory. Comprehensiveness, therefore, emerges as one basic property of descriptive theories. However, comprehensiveness is not a property that a descriptive theory may technically acquire only by combining descriptors in isolation from both its historical origin and its structural context."<sup>10</sup>

Moreover, we took the view that:

"....."description" is used in its broader sense of "explanation". Within this context, description automatically implies both a "behind" as well as a "beyond" in terms of its historical evolution and its practical applications."<sup>11</sup>

Popper illustrates, in his own philosophical context, the major assumption in our thesis above. That is, comprehensiveness - in Popper's terms "understanding" - is unavoidably related to "problem-solving" when complex structures like those of his "objective third world" are concerned<sup>12</sup>. He emphasizes the importance of description,

9. See, for instance, Lagopoulos' definition of "town" as a semi-logical structure in, LAGOPOULOS, A., *Structural Town Planning*, Technical Chamber of Greece, Athens, 1973, (in Greek).

10. E.A.R./3 article, *op.cit.*, p.39.

11. *Ibid.*

12. POPPER, K., *Objective Knowledge*, Oxford University Press, 1973, (c. 1972), p.168.



considered in its broader sense of explanation, as being the aim of science and, furthermore, he argues that actions, and therefore history, can only be explained as problem-solving<sup>13</sup>.

However, in this study we further consider explanation to be closely related to the structure of descriptors and especially to the transformation "within" and "between" the different descriptive images generated by complex multidisciplinary structures. But, before we proceed to an extensive discussion concerned with the above argument, it is important to consider first what the general implications of the concept of descriptive theory in social sciences might be.

"Descriptive theory" is an achievable, if not common, reality in social science. That is, because, as Althusser emphasizes, descriptive theory is the "irreversible" beginning and "transitional" phase of a theory<sup>14</sup>. This becomes obvious considering that in social sciences the dependence of theory on practice is very strong. Both Harvey and Althusser have emphasized the dependence of theory on practice speaking about "theory as practice"<sup>15</sup> and "theory as specific form of practice"<sup>16</sup> respectively. It becomes, therefore, obvious that, since architectural structures are products of a specific form of social practice, the dependence of descriptive theories concerned with these structures on this practice is imperative.

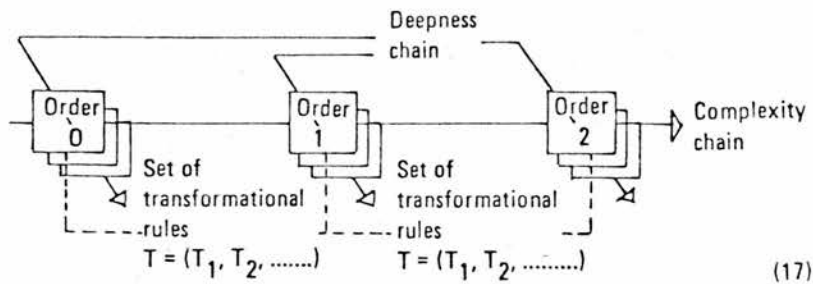
13. *Ibid.*, p.191.

14. ALTHUSSER, L., "Ideology and Ideological State Apparatus", in COSIN, B.R., (ed.), *Education: Structure and Society*, Penguin & The Open University, 1972.

15. HARVEY, D., *Social Justice and the City*, Arnold, 1973, p.13.

16. ALTHUSSER, L., *For Marx*, Allen Lane, The Penguin Press, 1971, (c. Librairie Francois Maspero, 1965).

Now, it is important to examine the relationships between three chains, all of which might be considered as containing distinguishable images of a structure with an environmental representation. In E.A.R./3, we spoke about two chains; the "deepness" and the "complexity" chain. Diagrammatically, these are represented by the following diagram:



(17)

The syntactic character of the complexity chain is obviously strong. Complexity chains are to be identified in the decision-making process but all of them are developed within the framework of a given substance. For example, a university complex is derived from accumulating elementary activity patterns. The transformational rules of a complexity chain deal with the transformations of the elementary to the more complex, although in the decision-making process it is sometimes clear that "elementary" might well mean a basic pattern for the whole master plan.

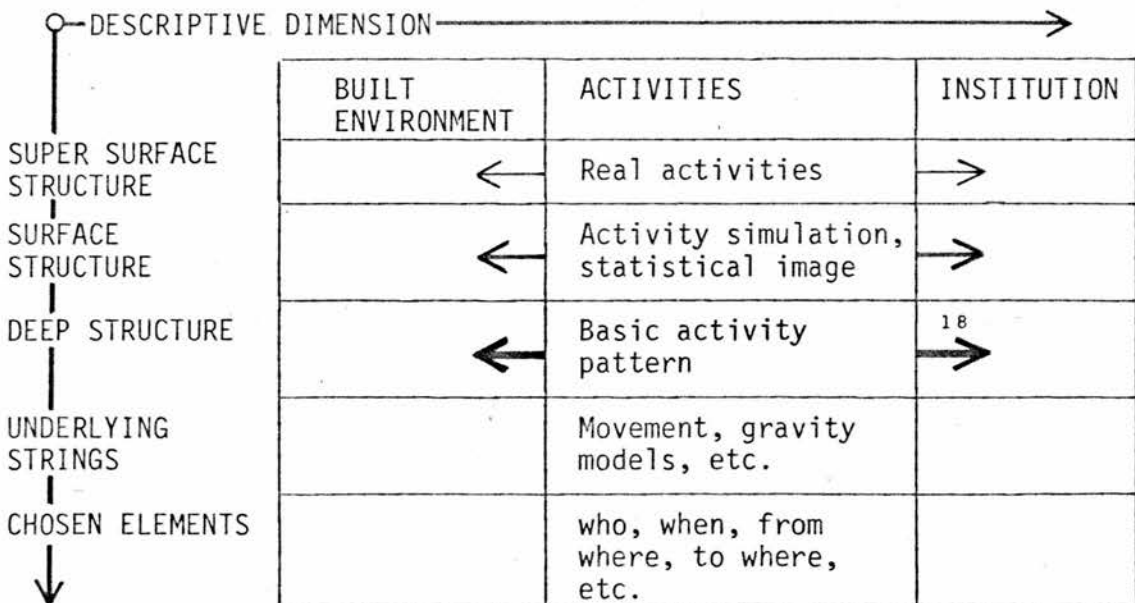
The deepness chain is a semantic chain connecting deeper levels of the structure with surface ones by means of transformational rules. In the E.A.R./3 analysis, conducted within strict disciplinary

17. *The structural dimensions of descriptors after E.A.R./3 article, op.cit., p.54.*

architectural configurations, this chain was represented by the following diagram:

DEEPNESS CHAIN	ARCHITECTURE
SUPER SURFACE STRUCTURE	Building
SURFACE STRUCTURE	Building compartmentalization + activities' organization, etc.
DEEP STRUCTURE	Basic organization of building (enclosure + access, etc.)
UNDERLYING STRINGS (RULES OF THE BASE)	Building physics, etc. + balance, etc.
CHOSEN ELEMENTS	Materials, etc.

However, in the case of structures whose origin might be found at more than one disciplinary area, it is possible to identify, even at the deeper level, other descriptive tools (e.g. organization of activities, etc.). Especially, in structures the origin of which is mainly institutional - like universities - the analysis of the deepness chain may be as follows:

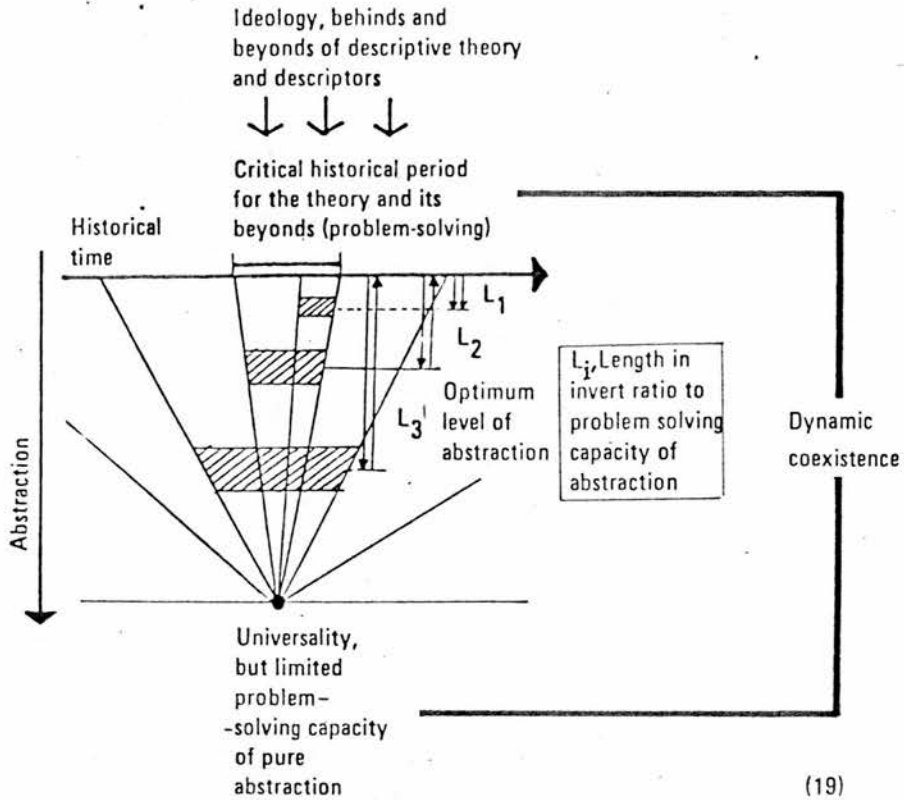


18. The arrows on the diagram illustrate the different degrees of cohesion between the representations of the structure. The deeper levels are much easier to relate than the surface ones.

The chains produced by the involvement of "descriptive dimension" in the diagram above, are different in terms of the substance of the available information, but this difference is minimized at the deeper levels where the cohesion of descriptors is maximized. Semantic levels, therefore, are established and explained in reference to both the deepness and the descriptive dimension. In summary, descriptive chains necessarily supplement both complexity and deepness chains when descriptive theories about multidisciplinary structures are concerned.

In social sciences and particularly in architecture, the involvement of the semantic dimension in descriptive theories attributes to them their subjective character. It would have been quite ambiguous to claim that a descriptive theory which has an historical origin, a problem-solving capacity and aims at ideologically influenced purposes of the practice which it follows, might be considered under any criteria as "objective". What might be objective is exactly this realization about the subjective character of descriptive theories. Accordingly, it is quite natural to expect that the logical tools - in our case the structural analysis - which are used to analyze and even to construct such descriptive theories, have to be objectified.

Instead of speaking about the "subjectivity - objectivity" bipolar, it might be more productive to raise the question of the degree of abstraction of a descriptive theory and its subject. The "dynamic coexistence", reflected in what we called in E.A.R./3 "optimum level of abstraction" between the abstract logical tools and the historically and ideologically originated problem, constitutes a fundamental characteristic of the kind of descriptive theories we are talking about in this study (see following diagram).



Both Piaget's "reflective abstraction" and Harvey's "operational structuralism" based on Marxism - which have been used as models in E.A.R./3<sup>20</sup> contain similar conceptual pairs. While "reflective abstraction" and "praxis" are abstract and achronic, the descriptive theories they generate are ideologically manipulable in terms of practice and historically emerged in terms of description. Accordingly, the concept of "syntagmatic syntax" reflects also the same coexistence. As mentioned in the E.A.R./3 article:

".....the syntagmatic approach to a structure includes the social evaluation of even the elementary deep structures."<sup>21</sup>

19. Adapted after E.A.R./3 article, *op.cit.*, p.74.

20. *Ibid.*, pp.42,65.

21. *Ibid.*, p.62.

The concepts "structure", "elementary" and "deep" reflect the abstract character of the linguistic model and the concept "social evaluation" (equivalent to "meaning") the historical and ideological origin of description.

Having examined the type of descriptive theories with which we are involved in studying multidisciplinary structures, it now becomes significant to study the question of how such structures are to be identified by these descriptive theories. Theoretically, the "identity of a structure" is reflected in a kind of structure of the different descriptors involved in a descriptive theory. It is easy to imagine that this structure of descriptors is transformed on both an historical and a geographical base. It is also easy to imagine that such transformations correspond to the changes of what in E.A.R./3 has been called the "system of social evaluation" of a structure or the "pragmatic meaning" of it.

However, "the structure of descriptors" may well represent what in E.A.R./3 has been called the "social evaluation" of a structural subject. What is implied here is that such an evaluation is "internal" in the investigation of a subject and, consequently, present in the articulation of the logical tools of a theory and especially in its descriptive dimension. Thus, we may argue that, when the structure of descriptors is broad enough to reflect the system of social evaluation which is in operation at a certain historical moment and comprehensive enough to explain adequately the transformations among the different descriptive images of the structure, then and only then, does such a set of descriptors constitute a descriptive theory. This "structural role" of social evaluation is greatly manifested in the construction of predominancies among the different descriptive images present in this study - the descriptive dimension. In this way the institutional, activity, or environmental image - which, among other alternatives, constitute the descriptive dimension in this study.



may become predominant within an explanatory framework which a descriptive theory acquires, depending on the particular system of social evaluation by which the different descriptors of the theory have been structured.

In summary, the identity of the structure of a descriptive theory defines a structural approach in which social evaluation becomes the basic tool for the development of the descriptive theory. What is implied by this is that the transformations from one descriptive image to another cannot be considered in isolation, but only within a system of social evaluation. The whole series of transformations, within a given period, represent the system of social evaluation as applied to the structure at that time.

To understand the structure of descriptors we have to understand possible transformations from one image to another, other than the systemic ones introduced by the "hierarchies" of modern practice. In the E.A.R./3 article's analysis, transformational rules took the form of a commutative square - that is they, being opposite to each other, supplement each other from the deep-elementary to the surface-complex level. Such rules were transferred into different descriptors (micro-climatic, network, etc.), but their abstract basis was common (continuity-max., discontinuity-max., channel, barrier, etc.)<sup>22</sup>. Apparently, at higher levels, the systemic logic between descriptors appeared inevitable. But, even within this framework, it is possible at least to identify the causes of the transformations of a structural subject, in terms of the contradictions or "anomalies" between the different images. The following discussion on the dynamics of environmental structures makes it obvious that design and planning

22. *Ibid.*, p.54.

action partly originate by the realization of the non-correspondence between the images of a structure at different descriptive levels (e.g. environmental, activity or institutional level) and partly by the contradictions appearing within the image of a structure at a single descriptive level.

2. Notes on the terminology concerned with the dynamics of environmental structures

A basic assumption in the theory which is based upon the philosophical dimension of Marxism and is known as "materialist dialectics" is that the fundamental cause of the development of a structure lies in the contradictions within the structure itself, under a set of given conditions. Mao has expressed this central point in his familiar epigrammatic way, writing that:

"Contradictoriness within a thing is the fundamental cause of its development, while its interrelations and interactions with other things are secondary causes." "... contradiction has a twofold meaning. One is that contradiction exists in the process of development of all things, and the other is that in the process of development of each thing a movement of opposite exists from beginning to end."<sup>23</sup>

The general discussion about "contradictions" could be very interesting, especially when it is concerned with the different interpretations and analyses of this concept. We do not intend to enter into a detailed discussion about the general epistemology of contradiction which is, undoubtedly, a very broad one; instead, we shall present certain views which offer a preliminary basis that we found useful in the conceptualization and extension of the notion of contradiction to this study.

23. MAO, Tse-Tung, Selected Works, Vol. 1, Foreign Language Press, 1975, (c. 1960 by People's Publishing House), pp.313,316.

One basic point of such analyses is the differentiations made between principal and secondary contradictions. Mao's attitude on this might be concluded from the following extract:

"The fundamental contradiction in the process of development of a thing and the essence of the process determined by this *fundamental contradiction* will not disappear until the process is completed; but in a lengthy process the conditions usually differ at each stage. The reason is that, although the nature of the fundamental contradiction in the process of development of a thing and the essence of the process remain unchanged, the fundamental contradiction becomes more and more intensified as it passes from one stage to another in the lengthy process. In addition, among the numerous major and minor contradictions which are determined or influenced by the fundamental contradiction, some become intensified, some are temporarily or partially resolved or mitigated, and some new ones emerge; hence the process is marked by stages."<sup>24</sup> (our emphasis)

In reference to Mao's work Althusser defines contradictions in terms of principal and secondary ones. For the first, he prefers the term "general contradictions" and defines it as:

".....the contradiction between the forces of production and the relations of production, essentially embodied the contradiction between two antagonistic classes..."<sup>25</sup>

He also writes that this "general contradiction" cannot of its own explain either a "revolutionary situation" or the "rupture and triumph of the revolution". He specifies that, in addition to this general contradiction, there must be an accumulation of what we might understand as "secondary contradictions", which are not necessarily solely derived from the same base as the general contradiction though they might be affected by it. He says:

".....They derived from the relations of production, which are, of course, one of the *terms* of the contradiction, but at the same time its *conditions of existence*; from the

24. *Ibid.*, p.325.

25. ALTHUSSER, L., *op.cit.*, p.99.

superstructures, instances which derive from it, but have their own consistency and effectivity, from the international conjuncture itself, which intervenes as a determination with a specific role to play."<sup>26</sup>  
 (his emphasis)

As opposed, to a certain degree, to Althusser's approach, Foucault classifies contradictions in terms of the history of ideas and discourse, distinguishing between contradictions of appearances (of discourse), and contradictions of foundation, which give rise to discourse itself. In this context, it is interesting to look at one quite long passage from his "Archaeology of Knowledge". He writes:

".....the fundamental contradiction emerges: the bringing into play, at the very origin of the system, of incompatible postulates, intersections of irreconcilable influences, the first diffraction of desire, the economic and political conflict that opposes a society to itself, all this, instead of appearing as so many superficial elements that must be reduced, is finally revealed as an *organizing principle, as the founding, secret law that accounts for all minor contradictions and gives them a firm foundation*; in short, a model for all the other oppositions. Such a contradiction, far from being an appearance of accident of discourse, far from being that from which it must be freed if its truth is at last to be revealed, constitutes *the very law of its existence*: it is on the basis of such a contradiction that discourse emerges, and it is in order both to translate it and to overcome it that discourse begins to speak; it is in order to escape that contradiction, whereas contradiction is ceaselessly reborn through discourse, that discourse endlessly pursues itself and endlessly begins again; it is because *contradiction is always anterior to the discourse*, and because it can never therefore entirely escape it, *that discourse changes*, undergoes transformation, and escapes itself from its own continuity. Contradiction, then, functions throughout discourse, as the principle of its historicity.

The history of ideas recognizes, therefore, two levels of contradiction: that of *appearances*, which is resolved in the profound unity of discourse; and that of *foundations*, which gives rise to discourse itself. In relation to the first level of contradiction, discourse is the ideal figure that must be separated from their accidental presence, from their too visible body; in relation to the second, discourse is the empirical figure that contradictions may take up and

26. *Ibid.*, p.100.

whose apparent cohesion must be destroyed, in order to rediscover them at last in their irruption and violence. Discourse is the path from one contradiction to another: if it gives rise to those that can be seen it is because it obeys that which it hides. To analyse discourse is to hide and reveal contradictions; it is to show the play that they set up within it; it is to manifest how it can express them, embody them, or give them a temporary appearance."<sup>27</sup> (our emphasis)

However, contradictions as such do not, by all means, constitute a comprehensive concept totally sufficient for interpreting the transformations of structures, particularly of those whose image may be identified at different descriptive levels. The mechanisms of transformations are very complex to such a degree that they allow only the connection between "contradiction" and "potential for transformation" to be made. Contradictions are quite understandably causes for change of a structure, but the path from the cause to the real nature of change is very long and quite complicated. Nevertheless, what seems to be possible is to identify in an empirical and predominantly *a posteriori* way, the core of contradiction within the transformation and to distinguish between the significance and the eventual marginal role of it for the transformation itself.

It is our thesis here that a descriptive theory in which there are various descriptive levels - such as the "environmental", "activity" and the "institutional" ones - articulates respectively the kind of contradictions which are eventually identified as connected with the transformations of the structure as a whole. Apparently, contradictions between the different images of the structure at those descriptive levels are by no means impossible. On the contrary, experience has repeatedly proven that such contradictions constitute

27. FOUCAULT, M., *The Archaeology of Knowledge*, Tavistock Publications, 1972, (c. Editions Gallimard 1969), pp.150-151.

fundamental causes for "design action". It is logical, however, to expect that such "inter-level" contradictions (for example, an environment which is not corresponding to a changing activity image or an institutional framework which is far beyond an environmental image or much behind an activity one) do express the existence of more general contradictions which are more intelligible at higher descriptive levels. It is dangerous, nevertheless, to exaggerate the capabilities of design action. Since design action is a specific kind of social practice, it is limited not only by its institutionalization within a given mode of production, but also by the very immediate nature of the phenomena it is dealing with. When it aims at resolving the inter-level contradictions, that is, contradictions between images of a structure, design actions has, as a rule, a limited potential for transforming the structures as wholes and for resolving leading contradictions - even if the expression of those inter-level contradictions is sufficiently clear.

In particular, when we consider structures in terms of their environmental image, it is possible to distinguish a specific category of contradictions caused by the differentiation of substance between the descriptive levels. We prefer to call this category of contradictions "normal anomalies"<sup>28</sup>, the most common kind of which are those

28. *Kuhn's epistemology is a clear example of the use of the notion of "anomaly" as the fundamental law on which scientific knowledge is developed. Kuhn's theory, in short, is that scientific paradigms (within the framework of which "normal science" is taking place), being historically originated human products, are transformed through the potential which is included in them in the form of "anomalies" as he calls them. Anomalies are the contradictions between what a paradigm should imply for the investigation of a structure and what the investigator observes. See KUHN, T.S., The Structure of Scientific Revolutions, University of Chicago Press, 1970, (c. 1962).*



between the stable environmental and the changing activity image of a structure. Normal anomalies of this kind, on the one hand, and conservative design, on the other, are perhaps the most typical bipolar in architectural design action.

Normal anomalies appear between the different images of a built-environment structure produced by different descriptors irrespective of the level of complexity and deepness at which the structure is looked at. The objectivity of the theory, that is, of the descriptors chosen, is reflected on the ability of these "anomalies" to represent real causes for transformation of the structure. Normal anomalies also represent, by the degree of their realization and resolution, the system of social evaluation of the structure at a specific historical moment.

In this sense, anomalies between the different images of a structure can function as potential for transformation of the structure as a whole. Thus, the supposed transformational rules between the different images of a structure are eventually characterized by such anomalies.

Is there any way of understanding these transformations in terms of the syntagmatic syntax and its commutative square?<sup>29</sup> By definition such a syntax would incorporate characteristics of an historical moment such as the acceptance of a given set of descriptors, the realization of "anomalies" among the different images of a structure and an "hierarchy" according to which such anomalies are practically manipulated.

29. *For an explanation of the notion of commutative square and its particular use in the work see E.A.R./3 and also pp. 455-57 of this paper.*

It is possible, however, to imagine from the first moment that the contradictions which are involved as transformational potential in such a syntax have a clear dual identity. They are either what we call "leading" contradictions which are to be found in different forms *within* each descriptive image of a structure or diachronic contradictions caused by the lack of correspondence *between* the different images, that is, "normal anomalies". Accordingly, the advantages of such an analysis would be that the systems of social evaluation are included in the expressional tools of the syntax and are not external to it as were in E.A.R./3. In this way, therefore, social evaluation becomes quite naturally a dialect of understanding the multidisciplinary defined structure and not a language for a particular discipline like architecture.

Leading contradictions, as opposed to normal anomalies, are more general and less circumstantial. The adjective "leading" means simply that they are present and recognizable, in different forms, perhaps, at more than one image of a built-environment structure. The character of leading contradictions depends on the individual attitude of the architect or planner, on his general position against the particular structure under investigation and on the particular system of social evaluation employed in the investigation of this structure. In terms of syntagmatic considerations of a complex structure, leading contradictions are determined through predominancies structured within a broader system of social evaluation. These predominancies - especially because of the *immediacy* of architectural actions required - are able to ascribe an institutional, activity or environmental character to leading contradiction or to hierarchize leading contradictions of different character according to both the assumption and objectives of the study and the assumed role of the architect or planner. (See the diagram on the following page).

CHARACTERISTICS OF NORMAL ANOMALIES AND LEADING CONTRADICTIONS AND THEIR EVALUATION IN TERMS OF DESIGN ACTION

NORMAL ANOMALIES	LEADING CONTRADICTIONS
a. Diachronic contradictions caused by differentiation of substance and, consequently, lack of correspondence <i>between</i> different descriptive levels of a structure.	Present and recognizable in different forms <i>within</i> each descriptive image of a structure. More general and less circumstantial than normal anomalies.
b. More objectified, since the objectivity of the descriptive theory is reflected in the ability of N.A. to represent real causes for transformation of a structure.	More subjective and ideologically influenced since they depend heavily on the individual attitude and the general position of the architect or planner against the structure he investigates.
c. High potential for transformation of a structure in terms of design action because normal anomalies, due to their nature, always suggest to a certain degree the spatial implications of their resolution (e.g. environmental-institutional, environmental-activity, and activity-institutional images)	Limited potential for transformation in terms of design action due to their ambiguity in suggesting ways for their resolution. This ambiguity stems mainly from their representation in very generalized form and only within one descriptive image of a structure.
d. Related to the system of social evaluation involved in the investigation of the structure, in terms of the ability of this system to construct predominant descriptive images of this structure.	Related to the system of social evaluation involved in the investigation of the structure, in terms of the ability of this system to construct predominant descriptors within each descriptive image of this structure

From the arguments previously given and summarized in the table above, the structural role of social evaluation can be seen in terms of:

- (a) Identifying the structure and hierarchy of normal anomalies and leading contradictions, thus defining transformation both in terms of its nature and its content within a structured whole.
- (b) Arranging the logical tools of the descriptive theory and, in particular, the descriptive dimension of the structured whole

by influencing the theoretical conception of the problem and indicating particular design action, thus operating within a given mode of "theoretical-practice".

Therefore, the resolution of contradictions - either in the form of design action of a conservative character, or as a revolutionary process, especially concerning the leading contradictions - takes place within an historically determined system of social evaluation which itself is contradictory and characterized by such leading contradictions.

According to a fundamental assumption of this study - especially discussed in E.A.R./3<sup>30</sup> - description as a whole reflects this system of social evaluation and, therefore, the contradictions within the context of its subjectivity. Although it is an exaggeration to claim that this subjectivity can continuously change the nature of the logical tools that a descriptive theory uses, on the other hand, it is necessary to admit that these tools express different concepts at different times. They should, in our case, without losing their abstract and generalized character, be articulated in order to include a "contradictional" interpretation of the transformations of structures which are of specific interest for the study of the built-environment. It seems, therefore, that there is room, here, for an interesting task for the theorist; that is, to check his tools and the concepts which are involved in any dynamic consideration of environmental structures, from this particular point of view.

In the discussion that follows we have tried to illustrate some terminological aspects concerned with the present contradictional

30. See E.A.R./3 p.74-75.

interpretation of the dynamics of environmental structures through examples taken from each author's work and from other current architectural theories.

Some of the most predominant and architecturally significant contradictions inherent in certain ecoclimatic descriptors, like "comfort", can only be identified if we consider carefully the different descriptive images generated by ecoclimate<sup>31</sup>

Comfort is usually considered as an environmental descriptor. However, at a deeper level of analysis, comfort description can be seen as deriving from a broader institutional framework within which the general human control upon nature is organized through technology and social organization which eventually, in a wider context, facilitates the intellectual and economic dominance of man by man<sup>32</sup>. Banham, among others, has successfully emphasized the institutional image of environmental descriptors arguing generally that:

"A large part of that ease and leisure comes from the deployment of technical resources and social organizations, in order to control the immediate environment: to produce dryness in rainstorms, heat in winter, chill in summer, to enjoy acoustic and visual privacy, to have convenient surfaces on which to arrange one's belongings and sociable activities."<sup>33</sup>

31. *"Ecoclimatic" phenomena as opposed to "microclimatic" ones are considered here to be those concerned with the semantics of the physical fields of climate and microclimate, that is, with the human perception, understanding and evaluation of the climatic conditions of the built-environment. In such context, therefore, the ecoclimatic phenomena cannot be defined by their microclimatic characteristics alone or describable in a purely climatological or meteorological language, but only within a much broader conceptual framework where the processes of producing the architectural environment together with the semantic dimensions of the climate of the built-environment are taken into consideration.*
32. *This view corresponds to the analysis which has been given by H. Marcuse and J. Habermas. See HABERMAS, Towards a Rational Society, Heinemann, 1971, (c 1968). See particularly chapter six, "Technology and Science as Ideology", pp.81-122.*
33. BANHAM, R., The Architecture of the Well-Tempered Environment, The Architectural Press, London, 1969, p.18.

Man's struggle to free himself from constraints imposed by the environment in favour of needs and activities extended beyond human survival has always manifested itself at an institutional level in which control over the environmental forces, such as climate, is "controlled" by profit through particular socio-economic and political structures. For instance, the unjustified isolation and description of comfort merely on environmental grounds facilitates, in the best possible way, the use of comfort as a commodity<sup>34</sup>.

Within the institutional image of comfort leading contradictions of the following type are easily recognizable. On the one hand, there is the general demand to naturalise the environment through particular means of production, planning and social organization, in order to achieve equal standards of comfort and amenity, and on the other hand, the means of achieving comfort are totally dependent on a growing technological and industrial society, in order to maximize capital profit. However, as far as design action is concerned, it could be rather philosophical and, in any case, unpractical to claim that the perceptual organization and functioning of the built-environment is generated by such leading contradictions of deep political character which dominate the institutional image of ecoclimatic descriptors. In fact, design action is generated only when inter-level contradictions between the different images of ecoclimatic descriptors (that is normal anomalies) and especially those between "environmental-institutional" and "environmental-activity" images are manifested within the environmental structure. It is easy, for instance, to imagine that normal anomalies between the environmentally

34. See *E.A.R./3.*, *op.cit.*, p.40.

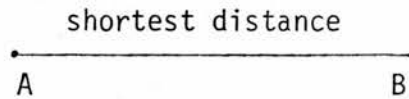


defined comfort problem-situations and the economic functioning of comfort commodities, account for a large part of the present deterioration of the urban environment as far as its ecoclimatic characteristics are concerned (e.g. increasing environmental pollution; energy crisis; class differentiation in comfort amenities; artificially created technological inadequacy for utilising cheap natural energy and so on, etc.), and, therefore, these anomalies implement particular causes and strategies for design action.

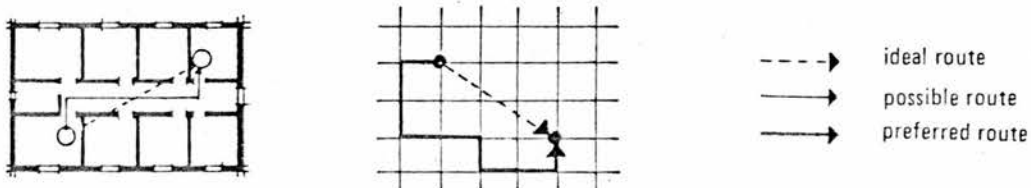
Normal anomalies of the "environmental-institutional" type can be recognized, for instance, in the commonly accepted requirements to maintain the present comfort standards by means of conserving energy resources on the one hand, and on the other to increase control over comfort operating without consideration of limited energy resources since this control is primarily "controlled" by profit. Also, in the contradictions inherent in the process of achieving comfort through an integrated consideration of the climatic forces which requires the ability to act on an environmentally defined spatial "totality" on the one hand and, on the other, the institutional demand for a disintegrated private space which prevents spatially integrated measures to be taken for achieving comfort or introducing solutions to other ecoclimatic problems.

Finally, normal anomalies of the "environmental-activity" type like, for instance, those appearing between the definition of a uniform comfort-zone without reference to the multi-usable character of space or to the cultural character of ecoclimate, and the functioning of activities with different climatic requirements organized within a uniformly considered ecoclimatic space are also very significant from a design action point of view.

Similarly, we can see how the use of the "grid" in layout design operates as a generator of contradictions. The main conventional communicative tools of design - the plan, section, elevation, etc. - are basically provided by the Euclidean conception of space, where the shortest distance between any two points is the straight line.



However, due to restrictions imposed by the use of grid layout and the insertion of barriers along the grid lines, for purposes of construction economy, building users are obliged to use building space in its "hodological" nature (space of possible movement)<sup>35</sup>. In this sense, any movement route taken from one place to another is far from being of a direct straight line nature. In most cases, however, it will be in a series of, perhaps, broken lines; the decision, which lines to follow along the circulation route, is not necessarily always the optimal one. In fact, there is no way to guarantee this will ever be possible because the "preferred route" is dependent on a much broader system of evaluation than the one provided by distance minimization or travel cost alone.



35. For a discussion concerned with the definition of the concept of "hodological space" refer to NORBERG-SCHULZ, C., *Existence, Space and Architecture*, Studio Vista, London, 1971, p.22.

This leads us to doubt the starting premise and ultimate objective of the majority of the present generation of analytic layout design methods. The starting premise of these methods is man's presumed greatest need (based on the "principle of least effort") for the minimization of travelled distances in a metric sense. The grid was adopted as a convenient start. Grid geometry, being Euclidean geometry, asks for shortest distances to be in direct straight lines. But, as we have just argued above, it is impossible in a situation which is affected by many restrictions imposed by grid barriers to travel in direct straight lines. Hence, and at the very base of its formulation, the route optimization problem in building layout (or in planning, generally) faces an obvious logical difficulty which it has only been able to surmount, partially, through a series of simplistic assumptions. These simplistic assumptions eventually forced many theorists into elaborate ways of problem formulations, only to find them insoluble even by using the fastest computer.

A major justification for the development of these methods is that organizations and hence buildings are becoming more and more complex, yet the solutions offered are of the most simplistic kind and firmly held in a deterministic world that overlooks change (i.e. transformation) which is the most influential single factor that continuously gives rise to the new complexities, rightly so manifested.

Moreover, this entire approach is based on the assumption that the structure and function of spatial organization is not a matter of how spaces happen to be used in practice, but on how fixed activities are assigned to them and on how trips are travelled and generated between them. This is very consistent with the fact that many of the proponents of this approach took a logician's view of space. They

viewed space in isolation from the dynamic circumstances in which it happens to be used. They have accorded "trip association" a position of great importance in their layout design theories and saw it as a universal category which has been ascribed a universal truth status of fixed meaning and valued wage costs. But, returning to our earlier analysis, we can see that a trip is not a universal category. It is a concept which takes on a specific meaning only in specific social situations. In search of any such meaning, we have to acknowledge the many contradictions (i.e. lack of isomorphisms) which are continuously manifested in the dialectic between a continuously dynamic and changing social process (activities and uses, etc.), that gives rise to social space, and the static geometry of physical form, that gives rise to physical space. In the terminology developed earlier in this paper, it is easy to imagine that such contradictions generated by a grid based and trip association design action are, obviously, normal anomalies which do emerge due to the lack of correspondence between the spatial, the activity and the institutional image of a structure.

Now, it is not surprising, therefore, to see that after more than a decade or so of analytic layout design methods and research, there is still little, if any, consistent evidence supporting the hypothesis that knowledge of trip associations will allow designers to predict the way in which buildings are to be used.

At a more general level, both Harvey's and Lefebvre's theories on the city and urbanism are concerned with a comprehensive explanation of those contradictions which are generated between a rational organization of society and every-day reality. According to Harvey,

"The city, likewise philosophy, historically covered the contradictions between the rational organization of society and the everyday 'reality'. But modern planning practice projected into reality a fragmented rationality that distorted the social practice of the urban dwellers."<sup>36</sup>

This leading contradiction between "rationalization" of society and everyday reality generates a number of secondary contradictions, especially concerned with the nature of urban space and its production. Such secondary contradictions are summarized by Lefebvre in the conclusive chapter of his "La Pensée Marxiste et la Ville"<sup>37</sup>. Firstly, Lefebvre emphasizes the contradiction between the socially produced total space and the private ownership of space which accounts for its compartmentalization. In this way, he argues, space becomes not only naturally compartmentalized in order to become a commodity, but also conceptually decomposed to fit the scopes of different disciplines<sup>38</sup>. Secondly, he emphasizes the contradictions between the urbanization of society and, therefore, the absorption of rural areas from the city, and the demand for ruralization of the city, for instance, suburbia, satellite settlements, etc.<sup>39</sup>. Thirdly, Lefebvre stresses the contradiction between the increasing control over nature connected with the growing forces of production and the technological advances, and the demand for naturalization of the city

36. See TCHUMI, B., "Henry Lefebvre's 'Le droit a la Ville' in AD/9/72, p.581.

37. LEFEBVRE, H., *La Pensée Marxiste et la Ville*, Greek translation and edition, 1976.

38. *It is interesting to note here the contradictions between the compartmentalization of space and our attempt of conceptual integration in describing space as a totality in terms of the structure of its descriptors, the comprehensiveness of the logical tools employed and the structural role of social evaluation.*

39. *These, obviously, represent normal anomalies at higher levels of planning practice.*

by the elimination of the high degree of its artificiality<sup>40</sup>.

The importance of hierarchizing leading contradictions and normal anomalies through a careful consideration of the way in which a system of social evaluation constructs predominancies within a descriptive framework, either in terms of the significance of different descriptive images or the predominancy of one descriptor over the others, can be illustrated in the following example.

Peter Cook discussing the possibility that architecture will dissolve into being an everyday consumer-durable, a movement which he terms as "gadgetecture", argues that:

"The advent of do-it-yourself is more than just a marketing gimmick: it is *bringing back to the individual at least the "symbols" of involvement*. Perhaps one way through from the design point of view is to look at the problem of do-it-yourself elements as the straight marketing of a building. *Consumer choice then ceases to be a bland catch-phrase and the production of consumer-durables may set up a serious history of development.*"<sup>41</sup>. (our emphasis)

Looking at the above statement we are supposed to believe in several possible advantages of a "do-it-yourself gadgetecture" as advocated by Cook. These are mainly: (a) the advantage of containing "symbols" of individual involvement, and (b) the advantage of freeing consumer choice from being a "bland catch-phrase".

However, in our view, it is quite easy for anyone to discover that behind this surface level of observable reality the so claimed above advantages immediately disappear and, in fact, are replaced by "less individual involvement", "more consumption control over the

40. *This type of contradiction has been further exemplified by the discussion on "comfort" given in pp. 443-45 of this article.*

41. COOK, P., *Experimental Architecture, Studio Vista, London, 1970, p.128.*



habitat" and, of course, "less consumer choice"<sup>42</sup>. The distinction between leading contradictions and secondary set of contradictions can be used effectively to explain the reasons behind that. However, it might be more productive here to refer to a successfully formulated argument against a consumer-based architecture (gadgetecture) raised by Jencks. Jencks argues:

"If it had long been an assumption of capitalism that supply followed demand, then by the sixties it had become equally clear that *demand follows supply*, when this supply is dependent on advanced technology. John Kenneth Galbraith outlined and popularized the qualities which attend any advanced industrial state. First of all, as he pointed out, there is a tendency for wealth and power to accumulate in the hands of a few large corporations: the five hundred largest in the United States produce almost half of all the goods and services of the entire society. Secondly, to ensure their own survival and security, there is a necessity for them to keep pace with a changing technology which is all the time becoming more complex and sophisticated. In order to do this, they must call in expert opinion, which in turn effectively means that the knowledge of any one group or individual is not enough for a decision to be made upon. This decentralizes decisions."<sup>43</sup> (our emphasis)

Jencks carried on to cite the "Ford Mustang" example given by Galbraith as a paradigmatic proof of his above argument, and then comments:

"With so much at stake in terms of time, money and experts, the Mustang had to work, the public had to be conditioned to accept it, or simply, it had to sell. This it did in fact beyond all expectations."<sup>44</sup>

Further, he continues to stress that the "Open Society"<sup>45</sup>, in which

42. See Papanek's criticism of this type of advocacy for a gadgetecture - in his book *Design for the Real World and especially in chapter 4 which is characteristically titled "Do-it-yourself Murder"* - based on the grounds of social and moral responsibility of the designer. See PAPANECK, V., *Design for the Real World*, Paladin, 1974, p.54.

43. JENCKS, C., *Modern Movements in Architecture*, Penguin 1973, pp.359-360.

44. *Ibid.*, p.359.

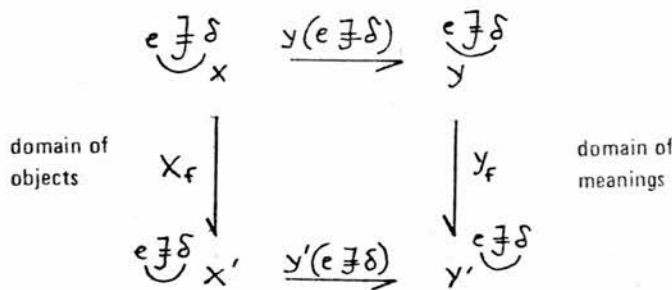
45. Jencks refers here to Popper's "Open Society".

a free consumer - based architecture is supposed to operate, is in fact a partially closed one:

"Thus we have an inversion of both the capitalist ethic and the morality which underlies almost all designers and architects. For the Open Society of consumer pluralism which they purport to serve in fact turns out to be a partially Closed Society which limits the amount and sensitivity of choice. One kind of freedom is being exchanged for another; the freedom to buy an article tailor-made to one's needs is being exchanged for the freedom to select from a limited number of technically sophisticated and conformist products. Or put in the terms of urbanism, the right of interest-communities to determine their specific needs and livelihood is being limited by the affluent majority."<sup>46</sup>

Finally, we may conclude the discussion in this paper through an example which illustrates how contradictions, either as normal anomalies or as leading contradictions, are involved both in the elementary architectural structures and in their transformational potential for higher order structures.

The notion of the simplest architectural structure has been given by Hillier and Leaman<sup>47</sup> in the form of a commutative square:



where  $\int$  is a wall = is a perforation  $e$  an enclosed space  $\delta$  a defined space and  $\underbrace{\quad}$  the structure sign.

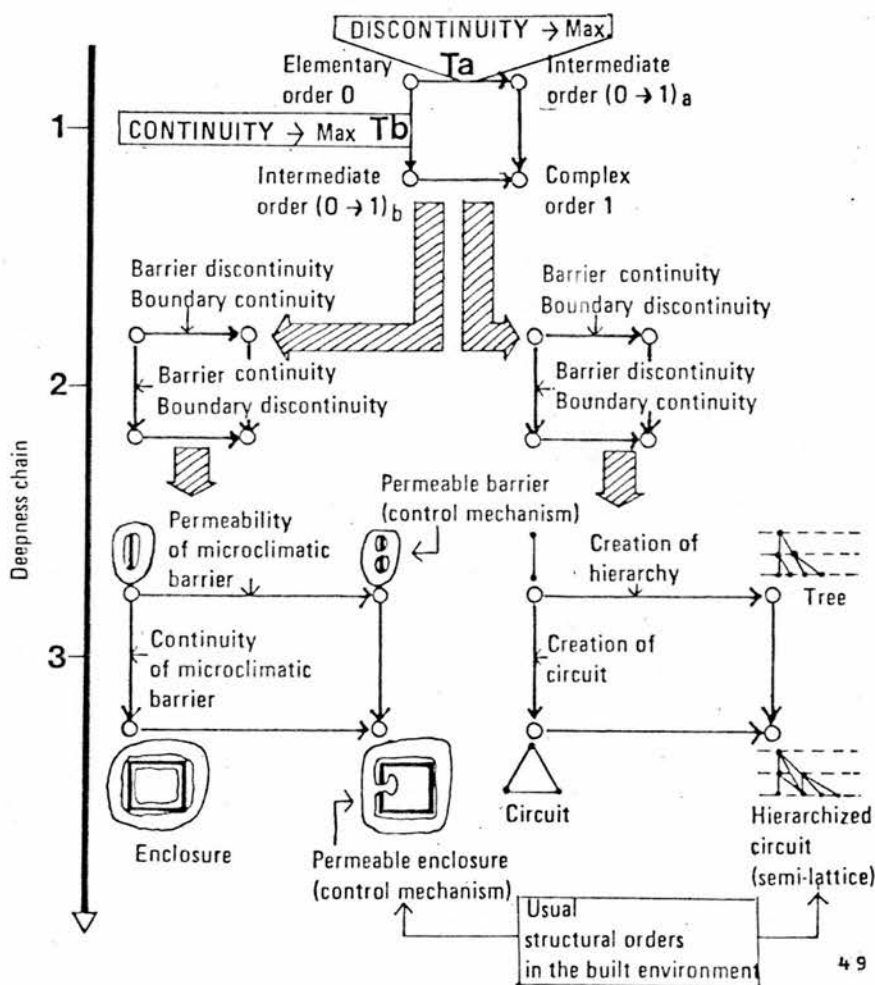
ARCHITECTURE: SIMPLEST STRUCTURE (according to HILLIER, B., LEAMAN, A. (1974))

However, such a purely Chomskian interpretation of architectural

46. JENCKS, C., *op.cit.*, p.360.

47. HILLIER, B., LEAMAN, A., "How is Design Possible", JAR 3/1, Jan., 1974.

structures, as mapping structures which permit a syntactic explanation of architecture, as the discussion in the E.A.R./3 article has proved<sup>48</sup>, would be in the real danger of explaining intelligible and socially evaluated things in a rather unnecessarily abstract and complicated way, if the syntagmatic identity of architectural structures is not seriously taken into account. In our use of the commutative square as representing elementary architectural structures, in the E.A.R./3 argument, the involvement of syntagmatic considerations have been apparently stressed as shown in the following diagram:

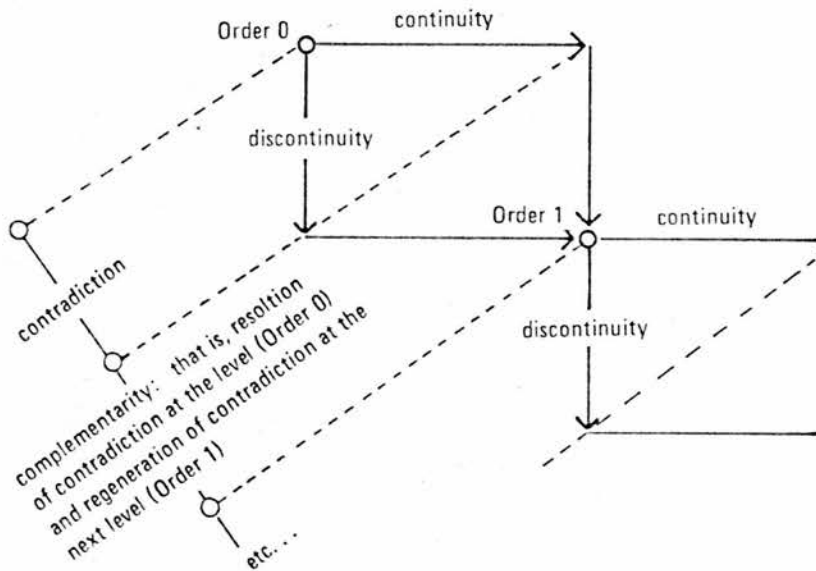


48. See E.A.R./3, *op.cit.*, pp.44-45.

49. *Ibid.*, p.54.

"Continuity" and "discontinuity" first refer to barriers and boundaries and secondly take forms like "boundary discontinuity through hierarchy" (in order to reach the tree-network, useful for flow regulation) or "boundary continuity through permeability" (in order to reach the permeable microclimatic barrier, useful for microclimatic regulation).

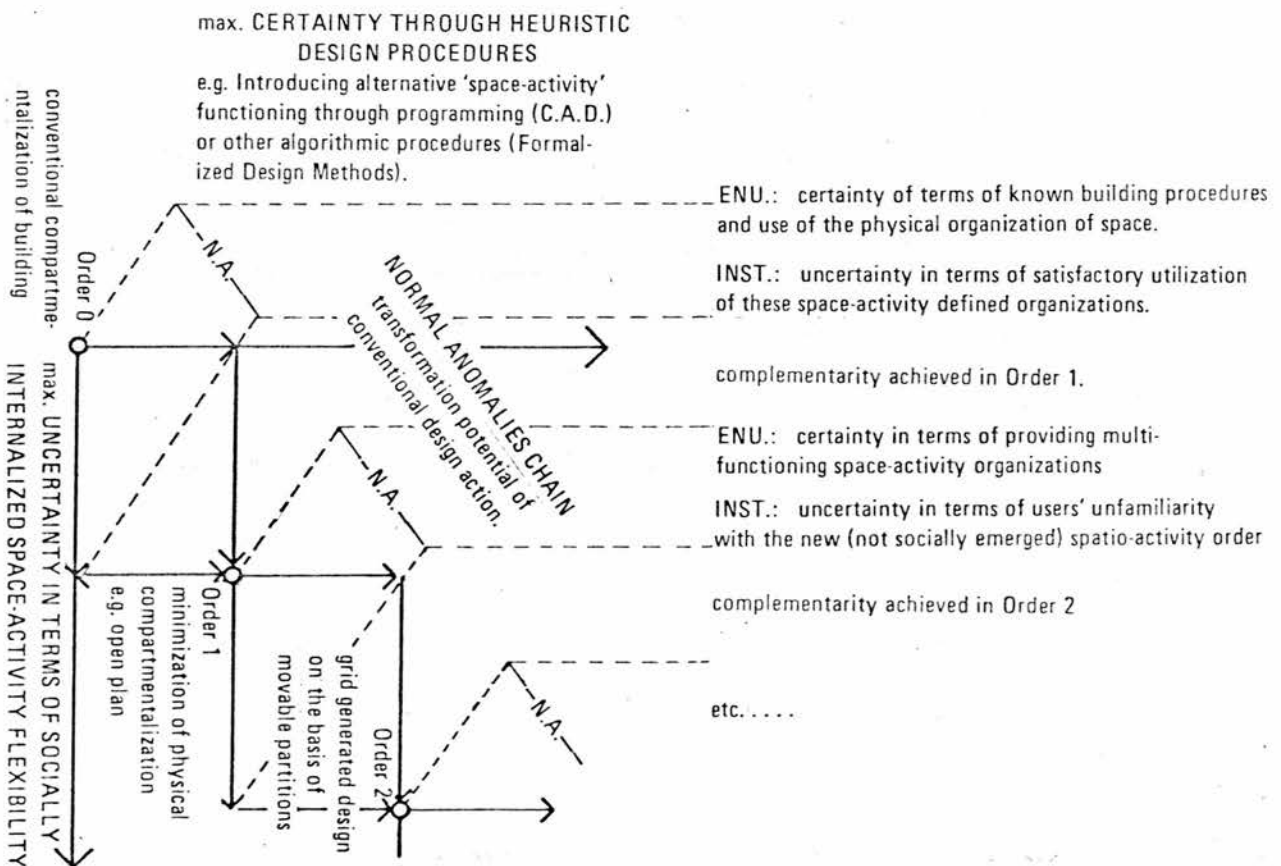
Such contradictory interpretation of even the elementary architectural structures, in fact, attributes to them their syntagmatic nature as well as their transformational potential. (see the following diagram).



However, apart from using a "contradictional logic" to explain the evolution of elementary architectural structures, such as microclimate and networks, it is also possible to consider this logic applicable to certain architectural movements, for instance, "functionalism", in order to explain how multi-dimensional (e.g. spatial-activity) structures acquire their transformational potential.

Thus, it may become apparent that both normal anomalies and leading contradictions are accountable for the transformation of the structure as a whole but, also, that at the level of design action contradictions are generally formed as normal anomalies, while leading contradictions - though present all the time - specifically contribute to the transformational potential of a structure only within a much broader socio-economic and political framework.

A way to examine the transformational potential of a spatial activity structure at the level of design action, is to consider comprehensive architectural descriptors, such as, design flexibility, within a commutative square logic defined by the bipolar "certainty" (in terms of the space activity multivariable function) and "uncertainty" (in terms of the social internalization of this function):

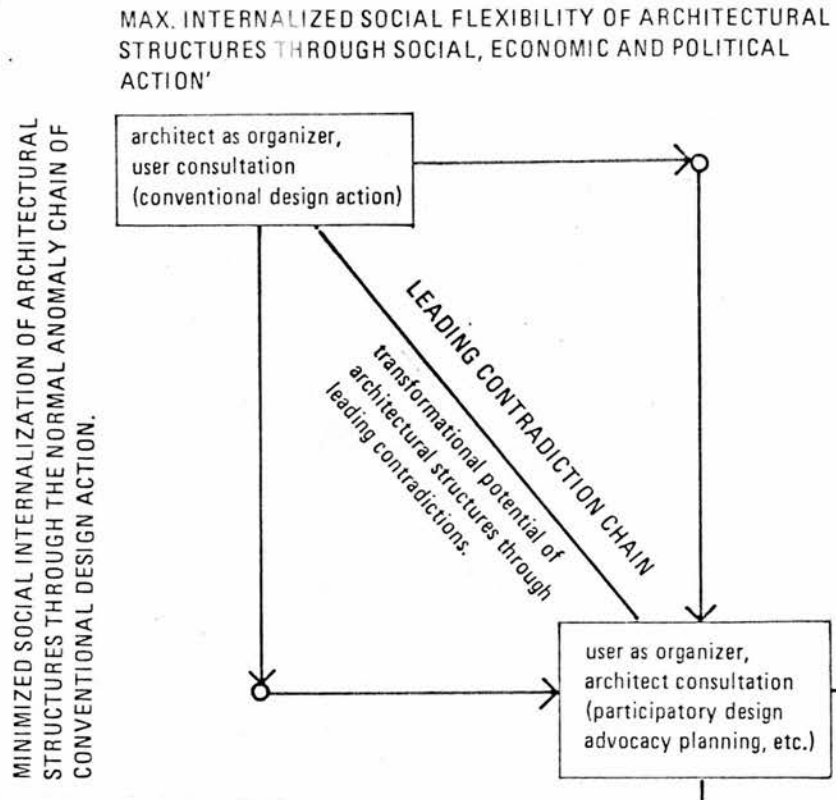


The contradictions which appear during the design action, that is, between certainty - in terms of providing, through heuristic procedures, a repertoire of alternatives at an environmental level for space-activity functioning - and uncertainty - in terms of the social internalization of these alternatives at an institutional or an activity level - are obviously normal anomalies well recognizable within the context of conventional design. The above diagram explains how a structure acquires its transformational potential through a repetitive process of resolution and regeneration of such normal anomalies<sup>50</sup>. It also shows the structural role of social evaluation in terms of identifying normal anomalies which account for the transformational potential of a structure.

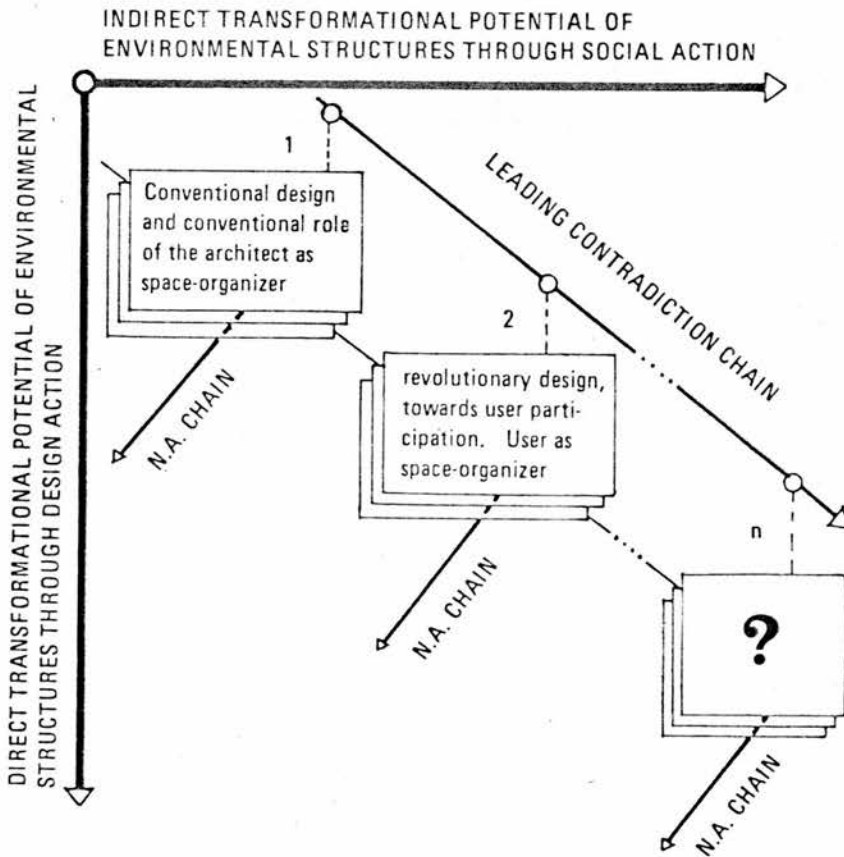
However, it is possible to identify transformations of architectural structures by means of leading contradictions occurring, for instance, only within the institutional image of these structures. Consider once again the above diagram. It is obvious that at higher levels where the structure acquires its maximum flexibility in environmental terms, the institutional image of it presents a very low social internalization of this flexibility. In this context leading contradictions of the following type are easily recognizable in these structures:

50. *The examples given in the diagram above represent one way of explaining through a contradiction logic the transformation of space-activity organization in buildings as it is observed in modern architectural practice. Furthermore, it is interesting to notice that the chain defined by these examples (order 0 → 1 → 2...) also represent a chronological order reflected in the modern history of architectural movements.*





The hybridization of the two diagrams above presents the total transformational potential of an architectural structure. This explains the importance of considering both normal anomalies and leading contradictions in describing integratedly the dynamics of these structures.



A CONTRADICTIONAL INTERPRETATION OF THE DYNAMICS OF ENVIRONMENTAL STRUCTURES.

To conclude, in this paper, we stressed the descriptive implications that the multi-disciplinary character of architectural structures brings to their investigation. In doing so, we extended the limited view of the concept of environmental structure we took in E.A.R./3 by further ascribing to it a descriptive dimension, which we found to be necessary if the formulation of any comprehensive descriptive theory is to be achieved. In addition we presented the view that a "contradictional logic" necessitated by the involvement of the descriptive dimension and incorporated within the methodological framework of "syntagmatic approach" becomes a useful dialect for studying the identity, dynamics and transformations of architectural structures and contributes to the descriptive theories concerned with them.

In both this article and the E.A.R./3 one, we advanced some theoretical arguments concerned with the problem of comprehensive description in architecture, developed within the methodological framework of structuralism, giving particular emphasis to the terminology concerned. It seems to us, however, that the discussion could have been further elaborated and developed, at certain points, to support our arguments, but at this junction, we feel it would be more productive to concentrate on a detailed experimental examination and evaluation of our major assumptions. To a certain extent, this is being carried out at the level of our individual research. Nevertheless, we hope that this task will consist a further area in which our future collective research will continue.

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