INFORMATION TO USERS

This was produced from a copy of a document sent to us for microfilming. While the most advanced technological means to photograph and reproduce this document have been used, the quality is heavily dependent upon the quality of the material submitted.

The following explanation of techniques is provided to help you understand markings or notations which may appear on this reproduction.

1. The sign or "target" for pages apparently lacking from the document photographed is "Missing Page(s)". If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure you of complete continuity.

2. When an image on the film is obliterated with a round black mark it is an indication that the film inspector noticed either blurred copy because of movement during exposure, or duplicate copy. Unless we meant to delete copyrighted materials that should not have been filmed, you will find a good image of the page in the adjacent frame.

3. When a map, drawing or chart, etc., is part of the material being photographed the photographer has followed a definite method in "sectioning" the material. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.

4. For any illustrations that cannot be reproduced satisfactorily by xerography, photographic prints can be purchased at additional cost and tipped into your xerographic copy. Requests can be made to our Dissertations Customer Services Department.

5. Some pages in any document may have indistinct print. In all cases we have filmed the best available copy.
ALP, AHMET VEFIK
AESTHETIC RESPONSE TO GEOMETRY IN
ARCHITECTURE.

RICE UNIVERSITY, D.ARCH., 1979
RICE UNIVERSITY

AESTHETIC RESPONSE TO GEOMETRY IN ARCHITECTURE

by

AHMET VEFIK ALP

A THESIS SUBMITTED
IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF ARCHITECTURE

APPROVED, THESIS COMMITTEE:

Anderson Todd, Chairman
Professor of Architecture

Frederick Sargent II, MD
Professor of Human Ecology

Dr. Stephen Tyler
Professor of Anthropology and Linguistics

Dr. Bruno Breitmeyer
Associate Professor of Psychology

Houston, TEXAS
May, 1979
ACCEPTED BY THE DEAN OF GRADUATE STUDIES & RESEARCH

MARCH 30, 1979
ABSTRACT

This study explored the aesthetic responses to different geometric organizations of architectural space. Besides, a comprehensive account of related areas of interest was provided, qualifying the study as a reference-frame on psychological considerations of architecture.

In the first chapter, the man-environment system, including man, his needs, values and activities, general aspects of the physical environment, and the theories underlying man-environment interaction, was reviewed. The second chapter investigated the visual perception by which people primarily interact with the architectural ensemble. The theories of perception, the factors governing the figural and spatial organization of the visual field, and other subjective and physical variables that shape the human perception were discussed. The third chapter focused on the experiential aspects of architectural surroundings. The functional, technical, and spatial dimensions of architecture, its visual variables, and its emotional and aesthetic potentials were reviewed. The fourth chapter was devoted to the geometrics of architecture. The essential elements of geometry, the pregnant directions and forms, and their properties were elaborated. The fifth chapter described the experimental research, and surveyed and evaluated relevant literature.

The experiment measured and compared the aesthetic effects of the geometry variable of the architectural space. The stimuli were three 1/20 (metric) model simulations of office spaces. They were equated on all visual variables, but geometric organization which was the object of the experimental manipulation. The subjects were four female and 13 male graduate students of architecture, and four female and 13 male graduate students of chemistry. The average ages of the groups were 25.2 and 25.6, respectively. All the subjects were white native Americans. The measuring instrument consisted of 26
seven-point continuum adjectival scales. The adjectives were selected as those by which people internally represent the aesthetic dimension of the built-surrounding. The test included two additional ranking questions. The ANOVA was performed on the data. The geometric manipulation elicited a very significant effect. The circular space-system appeared as the most aesthetically preferred, the rectangular the least aesthetically preferred organization, while the triangular lay between them. A significant interaction was also detected. The Chemists differed from Architects on the circular condition. The round forms were more preferred by the Chemists than by the Architects. Also, while the Chemists' means, obtained from the "seven-point" adjectival semantic ratings, were significantly different in all conditions, the Architects did not yield any significant difference between the aesthetic responses to the triangular and circular forms. The validity of the adjectival rating-scales appeared to be acceptable, and their reliability was very high.

The research shows the interplay of physical and subjective variables on aesthetic evaluations. It appears that "geometry" is a powerful physical variable in determining the aesthetic responses to the architectural space. In the context of the present experimentation, geometric organizations rarely seen in architecture, particularly circular space-systems, are found to be preferred over the familiar rectangular configurations which shape most of today's built-environment. Moreover, the professional background of groups of people sharing the same culture is seen to influence their respective aesthetic impressions.

The major contribution of the research was, first, to demonstrate that even the most subjective and conjectural aspects of architecture are amenable to scientific investigation; second, to indicate new areas of research; and to signal a new way of communication between architects and the people they design for. The latter point appears to possess a high potential to narrow the value-gap that exists between professionals and laymen, and to contribute, therefore, to a visually more satisfactory and to a more humane architectural environment.
ACKNOWLEDGMENTS

I am grateful to the Faculty of Istanbul Technical University, particularly to Professor Leman Tomsu; to Dean O. J. Mitchell and Faculty of Rice University, School of Architecture for their continuing support and encouragement during my doctoral studies.

Acknowledgments and thanks are extended to the members of my doctoral committee, Professors Anderson Todd (Architecture), Dr. Frederick Sargent II (Human Ecology), Dr. Stephen Tyler (Anthropology & Linguistics), Dr. Bruno Breitmeyer (Psychology) whose constructive suggestions and comments played a significant role in the development and culmination of the dissertation. I also would like to thank Assistant Professors Dr. Richard Schuberth (Psychology) and David Lane (Psychology) for their assistance concerning the administration of the experiment and statistical analysis of the data.

Special thanks are due to my wife Lale Alp who drew hundred of pictures and built the experimental models. She shared with me all the difficult times, and, therefore, her assistance has been of the utmost value.

Acknowledgments are also extended to my parents who, for so long, expressed their confidence in many ways and shared the tensions that I experienced during the development of the dissertation.
# Table of Contents

## Abstract

**INTRODUCTION** .................................................. 1

### CHAPTEr 1 MAN-ENVIRONMENT SYSTEM

1.1 The System ................................................. 7
  1.1.1 People ............................................. 8
    1.1.1.1 Needs and Values .............................. 9
    1.1.1.2 Activities .................................... 11
  1.1.2 Environment .......................................... 12
    1.1.2.1 Dimensions of the Visual Environment ....... 12
    1.1.2.2 Architectural Surroundings ................... 13
1.2 Man-Environment Interaction .............................. 13

### CHAPTEr 2 PERCEPTION OF THE VISUAL SURROUNDINGS

2.1 Sensation of the Environmental Stimulus-Information .... 19
2.2 Perception of the Visual Surroundings .................... 21
  2.2.1 Theories of Visual Perception ....................... 21
  2.2.2 Perception of Pattern and Form ..................... 25
    2.2.2.1 Perceptual Constancies ....................... 26
    2.2.2.2 Organization of the Visual Field ............. 26
  2.2.3 Perception as an Information-Processing ............ 33
  2.2.4 Space Perception ................................... 37
    2.2.4.1 Spatial Organization of the Visual Field ..... 41
2.3 Factors Influencing Visual Perception .................... 48
  2.3.1 Meaning ........................................... 48
  2.3.2 Familiarity ........................................ 48
  2.3.3 Culture ........................................... 48
  2.3.4 Mental Schematization ................................ 49

### CHAPTEr 3 THE EXPERIENCE OF THE ARCHITECTURAL ENSEMBLE

3.1 Dimensions of Architecture ............................... 51
  3.1.1 Functional Dimension of Architecture ............... 52
  3.1.2 Technical Dimension of Architecture ............... 54
  3.1.3 Spatial Dimension of Architecture ................ 57
    3.1.3.1 Elements and Relations in Architectural Space 60
3.2 Man-Architectural Ensemble Relations .................... 61
3.3 Aesthetics of Architecture ............................... 62
  3.3.1 Aesthetic Evaluation ................................ 63
  3.3.2 Architecture as a Symbol-System ................... 64
  3.3.3 Expression and Meaning in Architecture ............. 64
INTRODUCTION

The population growth and the advance in technology are two characteristic phenomena of our epoch, and one of their primary consequences is dense concentration in urban areas. It now becomes urgent to consider both qualitative and quantitative environmental requirements of man. This demand is of concern to the profession of architecture.

Architecture is part of man's "total environment". In the general sense, environment denotes any condition or influence outside the given organism, group, or system, and, in the light of Freud's thought and work, it has been one of the interest areas of psychology. However, psychologists have not devoted significant attention to the man-built environment (1). First, it has been assumed that human behavior could be best understood by means of social and organismic variables; second, there have been methodological difficulties arising from the complexity of the metrics of the physical environment.

The majority of man's activities and behavior takes place within or about the architectural and urban space. Man's physical surroundings cannot be overlooked, since they are pervasive and enduring, and they influence the physiological and psychological health of the human organism (2). Sargent (3) suggests that health is not a characteristic of man per se: "Man and environment constitute a system, health is a process of man-environment interaction within a specific ecological context".

The physical environment consists of the aspects of the world that human beings intercept by means of their sense organs. Saegert (4) enumerates six of its stress-inducing qualities. First, environments can be physically threatening. Extreme cold and heat, prolonged exposure to wetness, polluted air can be causes of physiological disorders. Second, stimulus-information overload of the surrounding can be stress-
provoking. Overintensified and over-quantified stimulus-information require more attention and decision from the individual. Third, the unsuitability of a surrounding for a particular or population can be cause of stress. The interruption or disturbance of ongoing task completion and activity may be a stress-provoking factor leading to frustration. Fourth, psychologically and socially meaningful messages associated with particular physical environments can contribute to the onset of the stress. The self-evaluation is important as a determinant of physical and mental well-being. The stigma attached to a certain place may indirectly contribute to the stressfulness of the surrounding by creating mistrustful relations among the occupants (5). Fifth, the amount of energy and resources required in transactions with a given environment can produce stress. Although similar to the "stimulus overload" notion, this aspect goes beyond the perception and cognition to include physical effort, time, and money expenditure factors (6). Finally, environments tend to be stress-inducing due to their stimulus-information deprivation. Normal behavior is interrupted by lowered sensory input (7).

Designers and planners should try to limit the quantity and quality of environmental stresses so that the human ability to adapt and cope is not exceeded. Research related to man-environment interaction, to the interference of the physical surrounding into the social and psychological life of man, began only about 20 years ago. Festinger (8) found that the distance and orientation of house units in a neighborhood affected the development of friendships. Similar findings were obtained for classrooms by Byrne and Buehler (9), for offices by Gullahoun (10), and for army barracks by Blake (11). To investigate how the aesthetic quality of a surrounding may affect behavior Maslow and Mintz (12) had college students rate photographs of human faces for "fatigue-energy" and "displeasure-well being" in beautiful, average, and ugly rooms, respectively. The results showed that, although the faces were identical, those rated in the beautiful room were judged significantly more energetic and well-being. Mintz (13), in a follow-up study, found that the effect of the rooms continued over time and did not diminish through adaptation. Other researchers investigated the affective aspects and meaning of "color" and "lines" (14)(15)(16), and of
art objects (17)(18)(19). A pioneering study in this context has been attempted by Vielhauer (20) who tried to specify the psychological dimensions of visual surroundings, by reducing, through factor analysis, the environmental descriptors to a parsimonious number of dimensions. Beginning in 1965, collective activities began to take place. First, Studer and Stea (21) circulated a list of 174 designers and social scientists involved in these issues. In May 1966, 80 related people gathered in the "Architectural Psychology Conference" held at the University of Utah (22). In May 1967, social scientists and architects met to discuss the flow of behavioral data into design practice (23).

The awareness of the effects of the physical surrounding on man indicates the complexity of architect's task. Indeed, beyond its instrumental purposes, architecture possesses psychological functions which call for the consideration of the private, subjective, and psychic entity of man. Yet, this is difficult to achieve. The disparity between success and failure of buildings illustrates the obscure situation that designers experience in predicting the impact of their design on people. The causes of this disablement are numerous: the increasing complexity and intricacy of today's environment; the consequent heterogeneity of clients and users, expressed in terms of polarizing wishes, values, tastes, and needs; and enlarging social and administrative distance between professionals and people (24). The profession of architecture has been late to comprehend this critical situation, and has not attempted to understand profoundly the changing roles of the practitioner and the client. The traditional interest of architectural theory has been concentrated on the relations of buildings to their architects rather than to people who experience them. Designers have preferred casual and unsystematic approaches to building-making. The result is a general disagreement between clients and architects, and even among architects themselves, that leads to a gradual diminution of trust in the profession of architecture. In fact, it is reported that, in some circumstances, owner-built houses have been assumed to be "better" than professionally designed ones (25). An explanation of this situation is advanced by Alexander (26). He notes that, once upon a time, the architectural design process was "unselfconscious". Building skills were learned through imitation, design decisions
based on custom. Learning building—making meant to repeat a single familiar physical pattern. Forms followed tradition, thus they were relatively stable. Because man in these cultures built the shelter he inhabited, he was alert to shortcomings. Therefore, whenever change was indicated, the recognition of misfits was immediate and correction adequate. This process of making architecture, then use, feedback and correction was continuous. It resulted in "fitting" buildings. Alexander adds that in our cultures the form—maker is the professional. Traditional design is not invincible and changes which reflect the creative ability and individuality of the designer become acceptable. Reactions to misfits are now indirect and delayed, if they happen at all. Social and administrative channels that should allow the users to communicate shortcomings to designers are ineffective. Today's problems increase in quantity, complexity and scale; materials, technology, social structure and culture change faster than ever before. The designer is overwhelmed by the flood of special information delineating his design problems. Increasingly, the designer's immediate clients are not the future inhabitants or users of his products. The actual user is not identified, in most of the cases, until the end of the construction process.

Alexander, too, perceives the distance between present day architect and the people that he serves. Furthermore, as soon as the issues go beyond physical and pragmatic considerations to encompass stylistic and aesthetic aspects, the architect becomes bewildered: He either insists on his artistic integrity at the risk of losing his client or abandons his personal autonomy in the service of his employer. Architects who fall in the first category advance that the wishes and tastes of artistically uneducated people should not be considered, while those in the second category design what the client wants, applying some haphazard cosmetics to his ideas. Unfortunately, neither of these approaches can lead architects to satisfactory solutions. To consider the first position, the architectural product will run the risk of being rejected, for it reflects designer's flavor rather than the user's preference and appetite. Taking the second position, the situation is no better: Clients are primarily interested in short-range investment viability and practical aspects. They, generally, do not consider that the architectural product constitutes a part of a
surrounding whose experience is shared by other participants. Basing design decisions on arbitrary and vague desires of the laymen may possibly lead architecture to visual chaos. It becomes apparent that an essential portion of the design process has to deal with the issue of adequate interpretation of users', clients', visitors', and other beholders' preferences. Architects should discover and achieve the right atmosphere for the participants of the spaces they conceive, and it is their duty to establish a systematic communication with the individual and the general public. Evidently, to accomplish this it is necessary to comprehend how people perceive, experience, and react to the built surrounding, and to understand what concrete and symbolic meaning architecture possesses for different sections of the population.

To succeed in this goal, the profession needs to borrow techniques and methodologies from the social sciences. The start of a collaboration in this direction dates from Hannes Meyer's attempt to incorporate "psychology" and "cultural history" courses at the "Bauhaus" (27). However, the classes had a very short life-span, perhaps due to their potential challenge to the inherited beliefs, social creeds, traditional design habits and principles of the architects. In fact, those concerned with behavioral research possess a scientific tradition while those involved in architectural design have literary and artistic background, a situation that complicates the collaboration of the two cultures (28).

Today, the disciplines of Architecture, Planning, Geography, and Natural Resource Management make efforts to achieve a better understanding of the transformations of the physical environment. Environmental Psychology, on the other hand, seeks to analyze systematically the variables of the natural and man-made environment. Significant efforts are being made by these disciplines to interrelate themselves for fruitful approaches. Architectural Psychology is the outcome of this collective work. Also, Ergonomics, Human Factors Research, and Environmental Physiology contribute to Environmental Psychology by studying the interrelations between environmental variables such as "heating";"noise";"air-ventilation";"lighting" and behavioral measures such as "comfort" (29).

The present thesis focuses on visual aspects of architecture and extends the environ-
mental variables to those of the designer who seeks better symbolic and aesthetic effects on people. These variables are "color", "illumination", "texture", "size", and "geometry".

The first chapter attempts to present briefly general aspects and processes of man-environment system. The second chapter studies the visual perception by which man and architecture primarily interact. The third chapter aims to explain how people experience architecture. The architectural ensemble is analyzed as to its phenomenological dimensions and its aesthetic implications are reviewed. The fourth chapter concentrates on a single visual attribute of the architectural ensemble: the geometry of space. In the fifth chapter, this variable is subjected to experimental manipulation, its aesthetic effects are measured, results reported, and conclusions drawn.
CHAPTER 1

MAN - ENVIRONMENT SYSTEM

1.1 The System

Man is engaged in a complex interchange with the environment that he modifies and shapes, and by which he is modified and shaped. This reciprocal influence is quite essential for the survival of the mankind, since every man is in a process of taking from and contributing to his surroundings in such a way that an all-encompassing equilibrium is maintained. In that respect, human organism and his environment constitute parts of an evolving, complex, interacting system (1). While in plants and primitive organisms this interchange is of elementary nature, it is much more complex in humans, who, mostly due to their intellectual and creative abilities, react to the environmental variables in varying and unpredictable ways (2). At this level, inner experiences such as perception, feelings, values, needs and motivations become significant in comprehending the mutual relations of man and his external world.

Architecture participates in this system as a major part of the physical and visible world. Human beings design, model, restore and shape the built-environment according to their needs, values and anticipated activities. Reciprocally, the built-environment affects, either positively or negatively, their physiological and psychological selves. In other words, a dynamic sub-system emerges composed, on the one hand, of people with their activities, values and needs, and, on the other hand, of the architectural surroundings as perceived and conceptualized by people. (Fig.1).*

References, figures and tables are numbered separately for each chapter.
Fig. 1 Model simulating the relation of man and the built-environment.

1.1.1 People

Man is the only free-living organism who has the capacity of insight into his origins and himself. He can perceive his environment, interpret it, foresee the consequences of his actions. In fact, the development of man's brain now allows him to control largely his own destiny and that of all the creatures of the world as well (3). The same development led man to experience tensions and symbolic satisfactions (4). Tensions have made him the unique creature subject to psychological conflicts, whereas satisfactions he experiences have helped him to cope with the stress caused by the conflicts (5).

In order to survive and satisfy his needs, man makes use of his sense organs. However, the major distinction of the human organism from other species comes from his psychological characteristics. Each individual is assumed to possess a distinct personality which is specific of the behavior patterns and modes of thinking that determine his adjustment to the environment. Man lives in societies in which are embedded particular value-systems. His behavior is culture dependent. Up to date, he has evolved along several cultural stages (6). Chronologically enumerating, the first one is the gathering stage which consists collecting vegetable materials as food, clothing and shelter. Then comes the hunting stage where man becomes a predator. He develops tools for hunting and fishing. The herding stage is marked by the domestication of wild animals. The agriculture stage
causes a drastic change in the life style of man. With the domestication of plants, stable communities and cultivated fields appear. The landscape leads to the creation of artificial systems oriented to the production of food and raw material for domestic and industrial needs. The most recent cultural stage is urbanization where almost all is artificial. Human populations live in crowded dense areas called "cities". Cities possess depending systems such as villages, recreational sites, and other satellite-communities. Configurations of architectural structures, complex institutions, and intricate processes symbolize the city which itself becomes dependent upon its surroundings, the resources that it consumes being supplied by the remaining lands (7).

At each of these successive steps, man has had specific relations with society and culture. At each stage, a new set of attitudes and values have emerged in such a way that man can be thought as the product of the ecological demands of his time (8).

The early man fought with nature for his existence and survival. Therefore, he was extremely dependent upon nature, even for supernatural beliefs. Long before the Middle-Ages, the world became social and conceptual. Ideas, thoughts, and beliefs were the factors for defining the self. Human behavior, attitudes, and values were dictated by religious interpretations and scientific discoveries were rejected. The Renaissance resulted in gradual dissolution of religion-oriented belief and value-systems. New and repeated scientific discoveries led man to the conclusion that he has some control of himself and the world. The tremendous increase of production technology has dominated the nineteenth century. Life acquired an industrial aspect and the population became profoundly involved in the machine-life. The recent times are marked by a new awareness of the self. Stimulated by Freud's ideas, the concept of identity, the notion of Man himself in all his psychological autonomy gained importance (9).

1.1.1.1 Needs and Values

Values, lifestyles, worldviews are culture-specific. They differ not only between individuals and populations, but within the same individual through time. The cultural
evolution of the mankind has determined the predominant value-systems. Those, in turn, affected how people saw themselves and were seen by others; the way they did things; how, where, and when they communicated. The meaning and symbolism of the built environment was altered accordingly.

Needs of human beings fit, in general terms, into physiological, psychological, and social categories (10). Yet, different classifications have been advanced as "basic human needs". A Report of the United Nations' World Health Organization (11) identifies these needs as "health", "nutrition", "work and working conditions", "house", "education", "public safety", "rest and amusement", and "freedom". The International Building Congress' Bulletin (12) attempts a quite different categorization, relating human needs to the sensorial system. Blachere (13), Leroux (14), and Basart (15) propose lists where man's needs are classified as related to habitat conditions. Appleyard (16) offers a comprehensive account of the needs and values of human population that he exemplifies with reference to "problematic" and "non-problematic" environments. Maslow's approach, however, appears more conclusive (17). It states that as man interacts with other people and things, and as his more essential needs are met, he becomes motivated by more subtle effects. Needs, therefore, should be arranged in a dynamic hierarchy of lesser and greater priority of potency (18). The less prepotent needs emerge upon the gratification of more prepotent ones, in such a way that needs at one level must be at least partially satisfied before those at the next level become effective. Therefore, man is dominated primarily by his unsatisfied needs. The hierarchy ascends from basic biological needs, present at birth, to more complex psychological ones appearing as intelligence develops (Fig. 2). It appears that aesthetic satisfaction, for which architects assume a major responsibility, is a higher-order need, placed almost at the top of the hierarchy. Yet, this situation does not imply that designers should not consider the aesthetic needs before achieving that of safety, for instance. Different people with different values, and occupying different levels in the hierarchy, will be motivated by those needs corresponding to their particular level and value-system.
Fig. 2 Maslow's "Hierarchy of Needs" (Hilgard et al, 1975).

1.1.1.2 Activities

Men engage in activities which are motivated by their personal set of needs and obligations. Activities and behavior have traditionally been the starting point of building programs. A basic classification of human activities dates from "Athens Charter" (19) where four main human functions were distinguished as "housing", "work", "recreation", and "transportation". Further work on similar listings abounds within the context of studies oriented to develop architectural and urban standards.

The activities that man undertakes in order to survive and reach better positions determine his relations to his surroundings. In the instrumental sense, man is related to the built-environment through his set of activities. Therefore, the activity-set functions as intermediary-link between the architectural ensemble and its users.
1.1.2 Environment

"Environment" connotes all entities, conditions, and forces that living organisms sense and react to (20). In the psychological sense, environment only exists when man experiences it.

In spite of all scientific breakthroughs, environments and environmental variables are still not completely understood and fully controlled. Russell (21) expresses this situation: "If our scientific knowledge had been completed, we would have understood ourselves, the world, and our relations with the world. Today, each of these are limited to some fragments of knowledge".

The total environment of man can be thought of as composed of sub-environments. A basic categorization distinguishes two major ones: the social environment, defined as anything which influences man and which is people; the physical environment, as anything which influences man and which is not people (22). The physical environment is, in its largest sense, everything that physically surrounds an organism or group of organisms. The visual environment refers to that aspect of the physical environment which primarily impinges on human visual mechanisms.

1.1.2.1 Dimensions of the Visual Environment

The visual environment is so complex that it escapes any systematic attempt to discover a common way of measuring it. Yet, recent critics agree upon "scale" and "degree of human modification" as the dimensions along which the whole visual world is conceived to change (23). The scale of the environment refers to its size relative to man. Everything is compared with man's anthropometry. The human modification varies along a continuum from "natural" to "man-made". The man-made environment, therefore, consists of that aspect of the physical environment created or significantly modified by human beings. Buildings, automobiles, weapons, aircraft are all elements of man-made surroundings. The built-environment is primarily made up by buildings. It includes all shelters that man has built in order to perform his tasks and satisfy his needs in optimal conditions.
1.1.2.2 The Architectural Surrounding

The smallest and simplest system of architecture is the "room". In the physical sense, buildings are adjacencies of rooms, and cities are adjacencies of buildings. The largest imaginable architectural system would be the design of the entire world, or the "Ecumenopolis" (25). Approaching the issue from this point of view, architectural surroundings are thought to consist of 14 scales, ranging from the single room to Ecumenopolis, each one being a sub-system of the next (Table 1).

Today, the discipline of architecture is unable to deal with this whole continuum. The influence of architectural and related disciplines is very strong at smaller scales. However, the situation changes for larger systems where the variables become numerous and complex. Then, architecture is supplemented by other disciplines which fully take over the governance for extremely large scales (Fig. 3).

1.2 Man-Environment Interaction

For its survival, the organism, human or animal, depends on the discovery of an environment which is adequate for it. The environment, on the other hand, is not stable and unchanging. It takes different aspects as the organism matures and ages (26).

Traditionally, three basic models about man-nature relations are discerned (27)(28): The subjugation to nature model stems from the idea of an environment which strongly influences the organism. According to that model, climate, topography, soil, and other geographical conditions determine, or, at least, largely affect the character, culture and activities of the human being. The followers of this model have considered the environmental factors as independent variables, and the human behavior and attitudes as dependent variables. The mastery over nature model views man as an environmental agent. The gradual development of human craft and industry have been the standpoint of this approach. Conversely to the previous model, here, human behavioral factors are suggested to be independent variables, whereas the environmental factors are dependent variables. Harmony with nature is the idea of a "designed earth". It includes the apprehension of a harmony
Fig. 3 Scales of the built-environment (adapted from Doxiadis, 1968).

Fig. 4 Application area of the disciplines dealing with the built-environment (adapted from Doxiadis, 1968).
and holistic patterning in the relations between human organisms, other species, and the earth. This approach constitutes a parallel line with the present assumptions of human ecology. The remarkable adaptive capacity of man and his intellectual power are continuously preventing the disturbance of the balance, the ultimate equilibrium between nature and man. It is to be realized, however, that a certain society will not opt for one of these models, exclusively. The models can be adopted concurrently.

1.2.2 Theories of Man - Environment Interaction

The environment as we perceive it constitutes a large part of the input into our mind. Thus, it deserves attention for the study and understanding of the consequent outputs such as behavior, activities, and attitudes.

Three major points of view have dominated subsequent research on this field: Freud's psychoanalytic approach, Behaviorism, and the Gestalt Psychology (29). Sigmund Freud was the first authority who emphasized the role of the environment in human psychological life. He felt that the social and interpersonal environment were the primary factors that shape and govern man's "life and death" strivings. A succession of psycho-sexual stages gains importance in his thoughts. Activities and concepts were manifestations and expression of this psychological system and its gradual development. Freud's theory implied that the physical environment was experienced rather than observed and responded to as if it were out there in an objective sense. Behaviorism stands in contrast to the psychoanalytic theory. It assumes that those events that can be observed and empirically specified are and can be the only references for the explanation of human behavior. The unit of analysis is "stimulus-response" relationships where observable behavior is generated by seen and measurable stimuli. According to behaviorists, a number of "S-R" units are biologically determined, and the rest of the behavior is based upon these response systems and learned by means of constructing new S-R relationships. Behaviorists do not reject that there are internal processes, but they prefer to study them translated in objective
and observable events. In that respect, the environment of the behaviorist is rather real and measurable, existing in its own right, similar to that of the natural scientist. 

Gestalt Psychology and Behaviorism can also be thought of as antithetical to each other. The Gestaltists' primary focus was not the physical, but the perceived, subjective environment. They have dealt with perceptual processes. Their basic premise is that "what is perceived is the whole, not the parts", either an object, organism, event, or architectural surrounding. Their attitude is expressed by their well-known dictum: "The whole is more than the sum of its parts" (30). The Gestalt approach sees human behavior and attitudes as rooted in perceptual and cognitive processes and suggests that those are not determined merely by the stimulus itself. Our environments possess structure and substance. Different environments, as well as the same environment at different points in time, differ in meaning, and, consequently, may evoke different behavior-patterns.

A number of man-environment theories appeared in the light of the above major views. The summary below presents them in the sequence ranging from the "least phenomenological" to "most phenomenological" (31).

Barker's Behavior-Setting Theory suggests that environments select and shape behavior by their "coercive" influence upon human beings. The theory assumes that organisms tend to behave in highly similar ways in particular environments, whatever their individual differences (32). The Subcultural Approach describes the environment in terms of values, attitudes, behavior, and roles of the population. It is in parallel with Barker's approach, and assumes that subcultures of large behavior-settings exert a coercive influence upon human organism. Members of a particular subculture tend to behave in basically similar ways as part of their common understanding and perception (33). Holland's Theory of Personality Types and Model Environments maintains that behavior is a function of personality and environment (34). Congruent environment-organism relations generally lead to individual stability, achievement, and satisfaction. Organisms tend to select environments consistent with their individual orientations. Holland studies the organism and its surrounding in terms of self-reported behavior (35). Stern's Theory is also
based on the assumption that behavior is a function of personality and environment. Stern suggests that these two entities are inseparable and must be studied together. He also refers to self-reports when defining the organism and its particular environment (36). The Transactional Approach, as the previous two, describes the organism and its environment in terms of self-reported perception and reactions. The human organism will always tend to be more satisfied and productive in a surrounding which moves it from its perceived-self toward an ideal-self concept. For each organism, there are particular physical and social milieus that tend to fit the individual personality characteristics. A match between the environment and its participant will result in higher degree of satisfaction and performance. The theory maintains that satisfaction can be best analyzed in terms of the interaction between man, his tasks, and environmental variables (37).

Kelly's Personal Constructs Theory (38)(39) states that people have alternatives or choices in the way in which they "read" their surrounding. Their relation to, and understanding of, the social and physical environment are, therefore, dependent on the way the individual translates his life and his environs for himself into a form that he can understand. Kelly expresses this idea by saying that "people try to make sense out of their surrounding-world by imposing a certain interpretation or structure onto it." In fact, man has the capacity to construe his environment, since he is obligated to operate different strategies or play different roles in life, these often calling for a reinterpretation of the external world. This model, therefore, conceives man as a conscious, goal oriented, open, and adaptive system who tries to understand and control his environment in accordance with his own ends. He anticipates by observing how events repeat themselves. Gradually, the recurrence of patterns begins to make sense for him and becomes his "constructs".

The review of man-environment theories makes it apparent that the dictum "behavior is a function of personality and environment", that Lewin coined, is generally a common point for each of them regardless of their central philosophy. Their difference lies in their conception of people, who are defined either as primarily motivated by external forces or
affected by influences deep inside themselves. In fact, non-phenomenological approaches look at people from outside, to the extent that they become treated as "objects" rather than conscious, goal-oriented living organisms. The behaviorist's "observable behavior" approach appears no more satisfactory, for the internal, subjective self of man is not even considered. These and parallel conceptions lead to a skepticism about the validity of assumed relationships between the given surrounding and its occupants, since it is questionable whether the observable behavior is caused by the selected environmental condition or by some other internal or distal influence.

As Freud and the Gestaltists advance, the world is experienced rather than observed and responded to as if it were out there in an objective sense. The relation between man and his physical surrounding is triadic by nature, the perceived surrounding being the intervening element. The world, including architecture, means different things to different people, and each individual possesses a mental representation of it in the form of a mosaic of personally significant fragments. People know more or less what they require from their surroundings, rooms, houses, offices, garages, or gardens, and they constantly make modifications adjusting them to their own images, preferences, and ends. They are active, purposive, and conscious, and possess the power of analyzing their needs and feelings (40)(41). The most natural, direct, and fruitful way of studying a given aspect of man-built environmental relations is, therefore, to ask the human subject. The aim of the professional contact is, consequently, to decipher in a systematic way, what people wish, like, and prefer in relation to their architectural places and accommodations.
CHAPTER 2

PERCEPTION OF THE VISUAL SURROUNDING

2.1 Sensation of the Environmental Stimulus - Information

On the one hand, architects dispose of a body of specific knowledge and methods concerning the practical, technical, and economic aspects of building buildings, whereas, on the other hand, they only have subjective and conjectural notions about the experiential and aesthetic implications of architecture. They do not possess the explicit elementary knowledge about the nature of the processing of the visual information radiating from the structures they build.

Perception is the process of obtaining and receiving information from the environment. It is by way of our sense organs that such information is collected to warn us of danger, to help us to recognize objects in space, to interpret events, and, coupled with emotion, to provide pleasure and pain.

The neural processing of the visual stimulation happens at different levels. The mechanisms function to reduce the magnitude of overcomplicated information, absorbing only its critical parts (1)(2). Much of the information conveyed to the brain-level is concerned with differences and changes in the environment. The nervous system has the inherent ability to transmit the information about changes in the visual field, while suppressing its steady and unchanging parts. The reason why something we stare at over a period of time does not fade is that the eyes continually make minute movements that cause the light from the stimulus to strike different retinal receptors from one moment to the next (3).

Experiments using microelectrodes to record the neural activity of single cells in the visual cortex of the brain have helped to explain the complex processes of the visual sensation and perception (4)(5). These studies show that there are at least three types of cortical
neurons called "simple cells", "complex cells", and "hypercomplex cells". Simple cells become active when the eye is exposed to a line stimulus or a boundary between dark and light regions. The activation of the cell depends on the orientation of the line and its location on the subject's visual field. A complex cell responds to a line with a particular orientation, but it is activated no matter where the line is located in the receptive field. It keeps on firing as the stimulus-line moves across the receptive field and maintains its proper orientation. Complex cells are believed to receive inputs from a large number of simple cells, all with the same field orientation. Hypercomplex cells are thought to be active only if the stimulus-line is in a particular orientation and is of specific length and width. These cells, in turn, appear to be connected to an array of complex cells (Fig. 1). The visual neural system works, therefore, in an hierarchical manner to arrive at the mental representation of the visual image. Recent research indicates that there might be still other types of cells that respond to specific configurations such as curves and angles (6). Hence, it appears that the visual system picks up the information in the form of "lines", "edges", "angles", and similar discontinuities in the visual field. That we seem to have mental pictures does not necessarily imply that there are corresponding electrical patterns in the brain. It is more appropriate to think that the retinal patterns are represented in higher levels of the perceptual network by coded combinations of cellular activity. It is now being shown that while primary visual information is represented at the surface of the of the visual cortex, the representation is more general in deeper parts which appear to be related to memory and other sensory information.

![Fig. 1 Activity of simple (a), and complex (b) cortical cells (Hubel & Wiesel, 1963).](image-url)
2.2 Perception of the Visual Surroundings

The study of perception is concerned with how minute sensations are put together and recognized as a particular pattern; how consecutive motions of the stimulus are detected as movement; and how depth is experienced by means of a two-dimensional retinal receptor surface. Thus, perception is not only the fact of seeing the stimulus, but also the processing and evaluation of the stimulus-information. Visual perception as a sensory organization comprises not only the forms and aspects of energy and objects considered as visual stimuli, but also sensing and encoding systems for the registration of visual displays. As a processing system, it has a cognitive component. It, then, deals with meanings that objects, surfaces and spaces of the surroundings might possess for the perceiver.

2.2.1 Theories of Visual Perception

There have been mutually contradictory theories concerning the perception phenomenon (7). The Emission Theory assumes that the content of our mind is a set of mental images which are projected out to the world, perception being, therefore, completed by the contribution of the organism. Oppositely, the Reception Theory states that perception is a passive process. Accordingly, objects which surround us emit images that are taken by our mind. Most of the recent theories of perception are based on these views. Two major categories are distinguished (8): the sensation based theories of perception believe that the surrounding stimuli arouse the senses and the sensations so aroused are integrated, in some ways, into perception. They deal with the supposed "units of perception", "sense data", or "sense impressions", and try to explain how these are put together in the human brain. All other qualities, for which there are no specific receptors, would be fabricated out of these basic pure sensations and brought to mind by association.

Johannes Muller is regarded as having given the formal status of the nativistic theory in 1826 (9). Mind directly perceives the spatial relations of the retinal images, since these relations appear to be preserved in the complex arrangements of the optic nerve fibers that have an apprehending contact with the mind itself. Nativists argue, therefore, that
man is born with the ability to perceive the way he does. According to them, the perceptual capabilities are innate, and these a priori functions constitute the basis of human perception. Descartes, Kant, Piaget, and Chomsky are sustainers of this approach.

The most persuasive personality of the empiricist view has been Lotze during 1852 (10). Lotze argued that the surrounding spatiality is given by intensities, every retinal point being associated with the intensity of a particular sensation, and the whole process being governed by prior experience. Later, amplified by Helmholtz's ideas of "differences of nerve fibers to explain the differences of spatial locus", this theory supported the view that all our perceptions and knowledge of the world were ultimately based on past experience and learning. Berkeley, Titchener, and Carr are well-known empiricists.

Deriving from Nativism, the Gestalt approach has attracted an enormous interest from architects and artists since its formulation in 1920 (11)(12)(13)(14). The Gestaltists suggested that perception is more than an assemblage of independent point-sensations. They focused on "patterns", and said that "the whole is more than the sum of its parts". In fact, the sustainers of Gestalt Psychology advance that the total impression of the stimulation cannot be predicted from the individual parts of the stimulating pattern: Gestalt is a German word that does not possess exact translation to English, although "form", "configuration" and "pattern" may be thought to come closer. Perception functions to draw the sensorial data into a "wholistic pattern" or "gestalten".

Gestalt's reasoning can be explained in terms of three basic concepts: "form", "field forces" and "isomorphism". The form is the fundamental notion of Gestalt Psychology. The organism responds to the pattern of stimuli to which it is exposed, and the appearance of shapes are governed by certain rules. The concept of field forces is imported from Physics. Forces, in the visual field, as in mecanics, have an area of application, direction and magnitude. The state of the field is the resultant of all forces acting in that field. A stimulation as simple as two dots on a sheet of paper initiates the interplay of energies. Chaos or order, monotony or variation result from the infinite combinations of these forces. In that respect, a certain "balance" or "tension" is said to exist in the visual field.
Lack of balance or tension between forces results in action and dynamism. The balance and homogeneity cause the inertia. Isomorphism is a term describing the congruence of the organization of internal neurological processes and distal stimulation-pattern. Gestaltists maintained that the experienced order in space is always identical with a functional order in the distribution of brain processes (15). They thought that electrical patterns, identical to the distal stimulation, come into existence in the brain.

The transactionalist approach can be considered as a recent variant of the empiricist standpoint. Its thinking emphasized the privacy of the individual's perceptual world. What is perceived is a function of the individual's life story, incentives and values. Each person creates his own perceptual world, and experience increases the probability that the world he sees is the same as the real one. Transactionalism can be defined by the work of Ames, Cantril, and Ittelson. Their main contribution has been to make us aware that different people attend to different things in the environment, in relation of their own experiences, education, and goals (16).

The information based theories of perception try to answer issues such as how we process the selected information, how we come to know our surroundings and the relationships that exist within it. These approaches focus on the amount of visual information rather than the physical stimulation.

The Ecological Optics, pioneered by Gibson (17)(18)(19), refers to the reverberating network of light rays of the terrestrial airspaces. The eyes register the ambient light reflected off the surfaces which surround us. This light has different intensities and directions, since the surrounding surfaces possesses various reflectances due to their orientation and material they are made from. The ambient light arriving at the eye is labelled the "optic array". It is considered to have a pattern that corresponds to that of the environment. It is, therefore, assumed that the optic array possess the complete information that the perceiver needs for a thorough perception of the visual world.

The primary learning experience of the visual perception is not that of making associations with elemental forms, as suggested by the structuralists-associationists, but of
distinguishing gradually smaller and smaller differences in the quality, quantity, and features of the stimulating pattern. Gibson also accords importance to "motion", either of the perceiver or the stimuli, since any slight movement results in a considerable change in the content of the optic array.

The theories of perception explain the phenomenon in terms of different baselines and focuses. Their primary distinction is the "stimulus-energy" versus "stimulus-information" (20)(21). The stimulus considered as an energy of stimulation is quite different than the stimulus considered as a source of information. The information coming from the surroundings is seldom perfectly correlated with its physical source. The physical stimulus and the corresponding information are obliquely, but nonetheless firmly, tied to each other. The theories also diverge from each other by emphasizing distinct portions of the visual system and processes such as the ways in which the distal stimulation is registered and structured by the eyes, the nature of the processing of the visual information by higher centers, and the acquisition of perceptual abilities.

A major modification in the area has stemmed from the challenge that atomistic-structuralistic theories have received from the Gestalt and Transactionalist schools and the information oriented approaches as well. Today, the "isomorphism" idea of the Gestalt Theory is completely discarded as a result of complex surgical experiments on the brain (22). However, its "field forces" and "formal organization" notions, and its warning about the difference between the total impression and details of the stimulation are still valid among architects, artists, and psychologists. A significant part of the "Basic Design Theory" is based on these conceptions (23).

While Gestalt's formal organization approach is mostly limited to two dimensions, Ecological Optics fills this gap. It explains the perceptual phenomenon with reference to "surfaces", "corners", "edges", "curvatures", "texture", and changing perspectives of the visual field. Apparently, this interpretation comes closer to the architectural context, for the architect thinks, not in terms of points and lines as the painter usually does, but
in terms of the variables that constitute the reference-frame of Ecological Optics. This approach, however, forms part of the efforts which attempt to avoid subjective judgment when studying visual perception. Nevertheless, its reasoning indicates the responsibility of the architect who structures the perceptual environment by manipulating visual variables.

This review of the various conceptions of perception reveals that there is not a totally cogent theory which can be directly applied to the architectural context. We can think of perception as having both some innate functions and some others which require experience and learning. Also, the visual surrounding should be approached in its objective and physical entity, but relationships, hierarchies, priorities, and social and cultural factors cannot be left aside.

Architects and visual artists are concerned with the phenomenological appearance of their work and the nature of people's direct experience. Given this situation, one can either focus on the determinants of the organization of the visual field or the aesthetic, visual and expressive qualities of such formal organizations as they are experienced. The latter direction, which also forms the core of the present study, promises to constitute a crucial link between psychology and architecture.

2.2.2 Perception of Pattern and Form

The neural organization of the visual sense is designed to provide information about the discontinuities in the optical projection on the retina. These appear to be coded directly by the receptive field organization of the visual system and represented in the cortex by the cooperative activity of cells. It seems reasonable that the presence of borders, edges, angles, corners, and contours would be the minimal information necessary for pattern and form perception, since they could provide the building blocks for the formation of segregated portions in the field as figures and objects. Non-homogeneous stimulation is a prerequisite of form perception (24).
2.2.2.1 Perceptual Constancies

Perceptual constancies allow us to see the surrounding world in an organized manner. Otherwise, without their occurrence, the surroundings would appear chaotic and incomprehensible. The constancy phenomena, therefore, cooperate to offer the perceiver an integrated and relatively stable world of objects, surfaces, patterns, forms and colors (25).

Color constancy refers to the fact that familiar objects are perceived to retain their color even under different conditions of illumination. Memory, as well as the color and illumination of adjacent and surrounding visual stimuli, assist the occurrence of color constancy. Shape constancy is the fact that objects do not seem to change their shapes although their projections on the eye retina becomes totally different due to perspective changes. The distance of an object to the perceiver does not greatly affect the perception of its size. The size perception is formed by a compromise between the perspective size projected on the retina and the real size of the object. We see an object as smaller at a distance, but not as much smaller as its perspective indicates. This phenomenon, called size constancy, depends upon the familiarity with the real size of the visual display and the presence of distance cues. Finally, the objects are perceived as enduring, as being the same even when we do not look at them. We also perceive the visual surrounding in an order that remains essentially fixed although we move around and our visual sensations are changing substantially. This fact is referred to as location constancy and is demonstrated to depend upon learning and past experience (26), as well as the cooperative functioning of eye muscles and brain during the perception of movement (27).

2.2.2.2 Organization of the Visual Field

Constancy phenomena suggest some organization in visual perception. In fact, the visual field happens to be perceived as organized in terms of structures. Some parts of the field are seen as patterned together, whereas others seem to belong to larger structures. This visual organization appears to happen spontaneously in such a way that partial sensations become ignored and submerged in the overall structuring of the stimulation pattern (28).
Patterns are perceived as "figures" against a "background", and, thus, appear to be like objects. This appearance, which takes place regardless of the degree of visual complexity of the stimulation, is called figure-ground segregation (29).

In fact, the visual field spontaneously segregates into two parts, the figure and the ground. The boundary between them is labelled "contour" and seems to belong to the figure. Although only one of the two parts of the field is experienced as a figure, there are cases where the distinction is confused and seems to reverse. Generally, the figure possesses a shape whereas the ground is formless. Also, the figure appears to be nearer, and is more easily identifiable than the ground. Finally, the figure is readily associated with meaning, feeling and aesthetic values, while the ground generally appears to be neutral (30).

The figure-ground organization follows some rules (31). For instance,

- given two differently colored or textured fields, if one is considerably larger and encloses the other, the enclosed small field will appear as figure;

- if the field is divided by a contour into an upper and a lower part, the latter will appear as figure (Fig. 2),

- a field may be composed in such a way that the ground looks exactly like the figure, and is occasionally experienced as figure (Fig. 3).

Actually, the organization of the everyday visual field into figures and backgrounds is much more complex than the impoverished examples given by the above cases. The background of an actual object or scene is rarely limitless. Instead, it is formed by other visual entities which are themselves figures against larger backgrounds. Architecturally speaking, buildings are perceived as figure against the background constituted by other distant buildings and/or the landscape, that are, in turn, seen as figure against the sky, the ultimate background. Furthermore, at a closer distance from the perceiver, the facades of buildings exhibit such organizations within themselves. This hierarchical leveling of the visual field occurs, therefore, in all scales of the surroundings.

As witnessed by the figure-ground segregation of the visual field, we have tendency to structure what we see. Elements of the field tend to be grouped into larger units, and the properties of these units are independent of the properties of the individual parts. In
Fig. 2 In (b) the hatched part is experienced as figure; in (a) the segregation is reversed (Rubin, 1921).

Fig. 3 Reciprocal figure-ground effect. (Hesselgren, 1969).

...fact, the adding up of minute elements becomes unobservable when combined with other parts: "The whole is different from the sum of its parts". The Gestaltists, particularly Wertheimer, have formulated a number of factors of organization which describe the perception as the result of the organizational processes that occur spontaneously among elements of the stimulating pattern (32)(33)(34).

_Proximity Factor_

Elements such as dots, lines and surfaces that are close to each other tend to be experienced as grouped together (Figs. 4 and 6).

_Direction Factor_

If elements of a pattern imply a common direction, they tend to be perceived together. Generally, the direction factor overrides the proximity factor (Figs. 5 and 6).
Fig. 4 Proximity factor.

Fig. 5 Direction factor.

Fig. 6 Co-action of similarity, direction and proximity factors.

Fig. 7 Similarity factor.
. Similarity Factor

Similar elements of the visual field tend to be perceptually grouped. The similarity factor usually overrides the proximity factor (Figs. 6 and 7).

. Closure Factor

Areas with closed contours tend to be seen as structured together, and define figures. Besides, if parts of such figures are deleted, they are visually completed. The closure factor overrides the proximity factor (Fig. 8).

. Good Continuance Factor

The line or figure which tends to be pre-eminently seen is that one which exhibits the fewest discontinuities, alterations or interruptions. These lines or figures are perceived as a whole even if they are intersected by other lines or figures. They are labelled "good lines" and "good figures" (Fig. 9).

. Symmetry Factor

Symmetrical patterns gather more easily than non-symmetrical ones to form whole figures. The symmetry factor dominates the similarity factor (Fig. 10).

. Common Motion Factor

Elements or objects which move together or alter together are perceived as a single structure. This is the only factor in which the motion variable is considered.

. Experience Factor

The structuring of a pattern depends sometimes on prior experience and learning of the perceiver. Meanings attached to configurations act as an organizational factor and perceptually structure the visual field (Fig. 11).

."Pragnanz" Factor

This factor governs all the previous ones. The psychological organization will always be "good" as the prevailing conditions allow. Good figures exhibit regularity, symmetry, inclusiveness, unity, harmony, and conciseness. The extreme good figures are labelled "pregnant figures". Those are shown to be perceived easier and with accuracy (35).

However, strict application of the above factors and consequent overemphasis on
Fig. 8 Closure factor

Fig. 10 Good continuance factor. The left figure is experienced as being the superposition of the lines in (a) because of their good continuity.

Fig. 10 Symmetry factor. (a) and (b) which are symmetrical are more easily grouped together than (b) and (c) which are similar.

Fig. 11 A 90 degree rotation of the figure allows the integration of the two parts of the pattern to form the letter "F".
simplicity in design may result in monotony. Unity does not necessarily require subjugation to all Gestalt factors. "Contrast" and "variety" in one part of the field can be balanced by "harmony" in another part, while introducing "dynamism" in the organization.

In some cases, the visual organization of the field tends to be ambiguous. The perceiver has, then, to generate alternative hypotheses about the actual organization of the stimulation pattern. The perceptual system senses actively the information and searches for the percept which matches best the information. If there is a reasonable number of cues for accurate interpretation, the exact percept is rapidly formed in an automatic manner. Otherwise, the nature of the visual organization remains unresolved. On the other hand, if the selected hypothesis is incorrect, an illusory organization will be perceived. The variables which assist the occurrence of such ambiguities are not fully agreed upon. Some of them seem to be the result of the influence of neighboring elements, while others appear to arise because of the lack of cues for an adequate interpretation. We may even experience configurations which are physically impossible (36)(Fig. 12).

The way that the figural patterns organize within the visual field is not easily amenable to measurement. However, there are attempts to explain the formal organization of the visual world in quantitative terms. These studies find application in Berlyne's experiments which investigate the correlation between the visual complexity of the figural pattern and the corresponding aesthetic arousal (37).

Impossible figures (Haber & Hershenson, 1973).

Muller-Lyer Illusion (Lyer, 1889).

Fig. 12 Visual Illusions
2.2.3 Perception as an Information-Processing

The information-processing approach emerged as a reaction to the critics who had admitted that perception is an instantaneous and automatic event, the percept being a copy of the stimulation. The approach distinguishes between the stimulus-energy and the stimulus-information, and leads to the consideration of the whole percepto-cognitive network as part of a larger system whose fundamental function is the processing of the sensory information. It has a cognitive aspect, and, basically, investigates how we recognize the elements of the visual world, and how they are visually remembered. Mental and psychic stages such as symbolic knowledge, feelings, thoughts, preferences, and mental development form the core of its interest area (38)(39)(40).

The information processing approach to perception provides a satisfactory account of the intricate internal processes of manipulation of the sensory data. Perception is not an instantaneous event. Instead, it is the outcome of a processing that has several successive stages, and, thus, takes time. The physical energy impinging on the sense organs is filtered by selective processes and represented within the organism. This representation stage is called "iconic storage". The visual features of the stimulation coded by the collaborative activity of the retinal and cortical cells constitute the material at this level. The "visual image representation" stage symbolizes the conscious awareness of the perceptual experience (Diagram 1). The formation of the visual image at this stage is made possible by the successive addition of the information provided by the consecutive saccadic fixations of the eyes. The Gestalt factors of formal organization play their role at this level. Because of the continual and rapid oscillations of the eyes, the visual image represents not only a particular region of the environmental stimulation, but rather the whole visual field which surrounds the perceiver. When the stimulation ceases, the visual image disappears unless it is reconstructed by the short-term memory. The link of the visual image representation with short-term and long-term memory explains the ability to form visual images in the absence of distal stimulus. The links from the iconic storage and visual image representation to short-term memory are supposed to function in parallel.
Diagram 1. Processing of the Visual Information
Therefore, the visual representation and the naming of the stimulus may occur simultaneously.

The short-term memory plays a crucial role in perception, since it is there that the coding of the visual information into linguistic and conceptual form takes place. It provides not only a continuity in perception, which is initially in form of discrete and erratic sensory inputs, but also a monitoring of the processing of the information. The short-term memory is a temporary storage. The information coded here is either registered to long-term memory or used for an immediate reaction, or forgotten. The content of the long-term memory seems to be type of semantic representation having a meaningful structure. In sum, each stage of the memory possesses two different functions: an aid to the processing of the information and the retention of the processed information. The short-term memory is rather a "photographic" storage, while long-term memory is a "symbolic" one.

The outputs from the overall system are organized by a motor-response sub-system. Responses can be written, spoken, actional, behavioral, emotional or any combination of these.

The **visual selection** is demonstrated by the fact that at every level of the processing of the visual information, from the retinal receptors to the final perception and cognition, some aspects of the information are transmitted at the expense of some others, and the material processed to a higher level is represented in a new form (41). The selection of a particular "bit" of information at a moment depends upon both subjective variables such as motives, past experience, internal needs, emotional states and personal values; and physical properties of the stimulus such as intensity, movement, novelty, meaningfulness and contrast. The visual attention is functionally related to eye movements, since the stimulation that is selected for the next glance is transferred from extrafoveal vision to foveal vision. The use of new experimental techniques allowed the quantitative illustration of the attention-attracting features of the stimulation, individual variations in visual selection, and the sequence of the fixations of the eyes (42) (43) (Fig. 13).

Most of the research in this area is related to the brain which has been considered
as a selector. It is strongly believed that the "reticular activating system", a brain structure known to be sensitive to stimulation from all sense modalities, plays an important role in the functioning of the processing system. In fact, the brain does not only filter the incoming signals, but it also has the extraordinary ability to process in parallel the sensory information transmitted by different sense organs.
2.2.4 Space Perception

An intriguing aspect of the visual mechanism is the fact that a two-dimensional concave retinal surface leads to the experience of a tri-dimensional space.

The empiricist view assumed that the projection of the exterior world onto the retina does not provide sufficient information for an adequate perception of space. It was thought that additional inputs of information are necessary to experience accurately the depth and space. In that respect, Empiricists attempted to demonstrate experimentally that the stimulation in the retinal projection is not enough to determine the perceptual outcome, and that complementary sources are to be sought in memory, learning and personality. In fact, a number of spatial configurations, different in size and shape, could give rise to exactly the same pattern of stimulation on the retina (Fig. 14). Also, the Ames' "distorted room" experiment offered evidence supporting the empiricist belief. If observed monocularly from a given point, the room with oblique floor, ceiling and rear-wall appears as a perfect rectangular space (Fig. 15). A quotation from Gropius summarizes the empiricist-transactionalist opinion (44):

"Widely different combinations of objects caused the same pattern on the retina of our eyes, and resulted in the same sensation; therefore, the sensation did not come from the objects in the environment, but from us. It comes from prior experience."

Thus, the cases in which the stimulation does not correspond with the experienced pattern and needs some additional interpretation constitute the support of the empiricist approach. The most frequent ones are:

. equivalent configurations where the stimulation does not reveal the actual spatial situation of the displays,

. constancies where the perceived properties of the objects do not correspond with their actual characteristics,

. illusions where the physical and the perceptual configurations differ, and

. organizational properties of the visual field where the individual sensations become unobservable and submerged in the overall structuring of forms and patterns.

On the other hand, Ecological Optics and the Modern Psychophysical Theory argue that the stimulation projected on the retina of the eye is completely sufficient to represent
all the information about the visual world. Their research emphasizes the transformations of the stimulation-pattern as the perceiver moves while observing: The physical surrounding is a combination of objects and slanted surfaces. It is perceived by scanning. A single fixation is not the normal way of observation, since the stimulation is dynamic and possess a temporal dimension. The visual field is altered by the movements of the body, head and eyes, and objects change their perspective, size and shape for different fixations. The successive patterns of stimulation are not melting or blurring one into the other, but are integrated like the separate frames of a motion picture. Moreover, the representation of the visual space is not Euclidean. It is more appropriate to think of visual points in space whose center is the perceiving organism. Such a space can be defined by means of a polar coordinate system, with the perceiver at the origin, and with spatial positions in terms of angular and radial distance from the origin (45). In order to determine the spatial positions of all points of the visual space, we must refer specially to one important surface among all others: the "ground surface" which extends from the perceiver to the third dimension. In fact, when the retinal projections are thought of in terms of individual points of stimulation, the difficulty arises in assigning their radial distance values if they are aligned along the axis of sight radiating from the eye. These points appear, then, superposed on the retinal surface (Fig. 16). Yet, the extended surface which contains the aligned points has its projection on the ground surface, and so do the aligned points. Their respective projections on the ground are distinguishable as separate stimulations on the retina, and by reference to them, the respective radial distances of the points may be determined.

The conception of a visual space made up of surfaces and their interrelationships explains the size and shape constancy phenomena, too. The perceptual constancies are the direct outcome of the textured surfaces which constitute the visual surrounding, since the texture gradients and consequent transformations of the retinal projections provide a constant scale for the visual field. Environmental displays are perceived as attached, by way of their projections to the ground and other surrounding surfaces, and are in relation with
their scale. The size of the visual displays does not remain the same as their positions in the visual field change, but their scale relation with the surrounding surfaces is always constant (Fig. 17).

Fig. 14 Equivalent configurations (Aynsley, 1974).

Fig. 15 Ames's "Distorted Room".
Fig. 16 Determination of the respective distances of points superposed on the retina with reference to their projections on the ground surface (Haber & Hershenson, 1973).

Fig. 17 Objects project different sizes on the retina, but are perceived as equal due to their scale-relation to the texture-pattern of the neighboring surfaces (Haber & Hershenson, 1973).
The experiments that the empiricist has performed to prove that the retinal projection is not sufficient for a complete and accurate perception of space cannot be considered valid, since the displays were observed in restricted and impoverished conditions, only a portion of the total visual information reaching the perceiver. He should have been demonstrated that the entire retinal pattern, stimulated under normal conditions of observation, is still inadequate for space perception and necessitates support from prior experience. The neglect of human motion and consequent alterations of retinal projections is incompatible with the natural act of observation (46).

It appears that Ecological Optics discovered more reasonable variables of experience in the retinal pattern. Supplemented by the information-processing approach which offers a convincing interpretation of the internal processes of manipulation of the visual data, it provides a more adequate account of the nature of the perception of the architectural surroundings.

2.2.4.1 Spatial Organization of the Visual Field

Some of the sense organs are more crucial for survival. Obviously, the eyes and the ears occupy the first ranks. Man possesses two of each, one being a spare in case of defect. People with one eye blind can experience almost all the visual events that a normal-sighted person does. However, in a man with both eyes, vision is more advantaged, due to his capability for stereoscopic vision, a result of the separation of the eyes. This fact causes slight retinal projection differences between two eyes looking at the same stimulus. The different sensations are integrated to form a single mental image, and yield the experience of solidity and depth.

Although monocular vision is completely sufficient for the perception of pictorial space, an adequate experience of real space is possible only with binocular vision (47).

The everyday visual space is organized according to certain factors. "Cues" are such features of the stimulating scene, which, in the bi-dimensional projection on the retina, and occasionally in collaboration with past experience, assist the experience of
of space and depth. Without them, the space would appear chaotic and incomprehensible. According to their very nature, they are conceived in two categories (49): the "ecological cues" are applicable to both monocular and binocular vision, they function during real and pictorial space perception; the "system design cues" are basically characteristic of binocular vision, they supply information essentially about the organization of real space (Fig. 18). The ecological cues generally dominate the system design cues (50)(51).

---

Fig. 18 Interplay of informational cues for space perception.
Ecological Cues

Superposition

The interruption of a spatial display by another one is interpreted as a cue for their respective distances to the perceiver. Closer objects tend to obscure distant ones. Displays with continuous border are perceived to be nearer than the ones whose contour appears interrupted.

Size

Distant objects are perceived smaller than nearer ones. The retinal projection decreases while the radial distance of the display increases.

Shape Deformation

The projection of the stimulus on the eye retina differs from its original shape. The deformation is a function of the slope of the surfaces of the display relative to the direction of sight (Fig. 19).

Texture

The texture of surrounding surfaces is projected on the retina according to the rules of perspective. Thus, the textural projection is a function of the distance and slope of the surface with respect to the observer. The density of the texture is a powerful cue for depth (Fig. 20). Moreover, sudden changes in the density of the texture are cues for the experience of "corners" and "edges" (Fig. 21).

Aerial Perspective

Retinal projections of closer objects are sharper and more saturated in color, and the distinction between the color of a visual object and the color of its background is reduced when the object is far away.

Illumination

Brighter objects and surfaces appear to be closer than dimmer ones. Furthermore, the shading of the stimulus assists the experience of solidity and shape (Fig. 22).

Height in Visual Field

The nearer a visual object is to the horizon, the greater its perceived distance is to
Fig. 19 "Shape deformation" as a cue for space perception (Haber & Hershenson, 1973).

Fig. 20 "Texture-gradient" as a cue for space perception (Neisser, 1968).

Fig. 21 "Texture-gradient" as a cue for edge and corner perception (Gibson, 1950).
the observer (Fig. 23).

Filled and Empty Distance

The depth filled by visual elements tends to look greater than the same distance devoid of visual elements (Fig. 24).

Motion Parallax

When the observer moves, the retinal projections change as a motion picture. The successive alterations of the retinal image is a cue for space perception (Fig. 25). Reciprocally, the respective movements of the visual displays in the field provide cues for the accurate perception of these displays (Fig. 26).

Accretion–Deletion at an Edge

Of two surfaces at different distances from the moving perceiver, the one which is more distant is subject to texture accretion or deletion.

Looming

When the distance between the observer and the visual display becomes gradually closer, the latter expands and looms to cover more area in the visual field of the former. This, and the previous two cues are labelled "kinetic ecological cues", since they are due to the motion of the visual object and/or the observer. They function at long distances.

System Design Cues

Convergence

The separated eyes converge to fixate the visual display. Close objects necessitate higher degree of convergence than distant ones. The angle of convergence is signaled to the brain as information about the radial distance of the object of vision.

Accomodation

The eyes adjust their focal distance to have sharp vision. This accomodation gives rise to chromatic and spherical aberration on the retina, and these are sources of depth-information to the brain.
Stereopsis

The separation of the eyes results in slightly different monocular fields. Although we still see a single image, the overlay of the right and left retinal projections is processed by the brain as a cue about the spatial relations of objects and surfaces (Fig. 27).

Fig. 22 "Illumination" as a cue for space perception.

Fig. 23 "Height in visual field" as a cue for space perception.

Fig. 24 "Filled and empty distance" as a cue for space perception. The empty part of the figure appears shorter than the filled part although they have the same length (Revesz, 1934).
Fig. 25 "Motion parallax" as a cue for space perception (Haber & Hershenson, 1973).

Fig. 26 Motion of the stimulus as a cue for space perception (Neisser, 1968).

Fig. 27 "Stereopsis". Projection difference between left and right visual fields as a cue for space perception (Haber & Hershenson, 1973).
2.3 Factors Influencing Visual Perception

2.3.1 Meaning

Almost all visual stimuli that surround us are meaningful. In that respect, "meaning", and "perception" are tied to each other. Besides its role as a factor of formal organization in the visual field, meaning governs the visual selection and attention. Visual configurations exhibit three different relations with their own meaning:

- meaning as an integral part of the visual configuration such as the human face;
- meaning attached arbitrarily to a visual configuration such as a number or a letter (public symbolism);
- meaning attributed subjectively and individually to a particular visual configuration (private symbolism).

In architecture, the latter aspect gains importance. Yet, due to its conjectural nature, private symbolism is the most complex semantic relation between an object and its meaning (52)(53).

2.3.2 Familiarity

The organism reacts differently to new and to previously experienced stimuli. Although the visual displays which are familiar can be more easily and rapidly perceived, the eyes fixate on novel features of the stimulation. A "bit" of information that has been already taken in by the organism appears to be less valuable than the unknown one. The perceiver is always receptive to original and unexpected stimulation, and, oppositely, uninterested by routine messages. He needs to explore newness and exhibits a strong appetite for changing and fresh information. Sensory monotony has been experimentally proven to be intolerable (54).

2.3.3 Culture

The specific ecological demands exerted upon a group of people and their consequent cultural adaptation shape the visual perception. Studies investigating the effects
of the ecological environment on perceptual abilities have been initiated by experiments using animal subjects. For instance, researchers had kittens raised in a visual surrounding that consisted solely of vertical and horizontal stripes. When the animals were freed of their cage, they were found blind to diagonal directions (55).

Another research used human subjects. Euro-Canadians raised in a built-environment of straight sidewalks and rectangular buildings were compared with a group of Cree-Indians who have been exposed to a much more diversely shaped visual surrounding. The results indicated that the Euro-Canadians exhibited a higher resolution for horizontal and vertical orientations than for the diagonal ones. The Indians, on the other hand, were found equally good at all orientations (56). The Western World mostly exhibits a rectangularly shaped visual environment, a realm of parallel lines converging by perspective. This is, however, not the case with the "Zulus", who, for instance, have hemispherical huts and arched doors, and who even plough their land in curvilinear furrows. This culture, restricted to circular geometry, is not affected by the "Muller-Lyer" illusion (Fig. 12). Hunting and fishing tribes are more sensitive to minute details and variations of the visual surrounding than food-gathering tribes. Another parallel case is noticed in tribes living in dense forests. These people cannot experience distance and distant objects (57). Undoubtedly, Piaget leads in the knowledge on these issues. He concludes (58).

"It is quite obvious that the perception of space involves a gradual construction, and certainly does not exist ready made at the outset of the mental development. The intuition of space is not a reading or an apprehension of properties of objects, but, from the very beginning, an action performed on them......"

2.3.4 Mental Schematization

Schema are defined as "typical and stereotyped reactions to a situation." Each individual develops a schema-system of his own, and, as Kelly states in his "Personal Constructs Theory", this process begins at birth and continues until death (59)(60)(61). The schema-system is not rigid. It is continually corrected and modified through
experience with objects and events. Any new situation requires either a slight or significant revision of the mental schematization. In the visual world, space-schemata construction begins with "proximity", "enclosure" and "continuity" relations. Further relationships are gained gradually. As Piaget states, the schemata develops through operation, manipulation and interaction with the environment. Attitudes towards the visual surroundings are affected by these "habits of perception", and new information is hardly recognized unless the new tradition is taken in and the schema-system modified accordingly.
3.1 Dimensions of Architecture

There is one set of processes whereby the individual modifies his surroundings, and another set of processes whereby the surroundings mould man's behavior. Such interac-
tion between people and the built-environment is made possible by "perception". The psychology of perception, however, is not readily applicable to the architectural context. With the exception of Ecological Optics, it studies the perception phenomenon as related to objects in space and pictures on paper. As a stimulator, Architecture is quite different from the experimental objects that perception-psychologists use in the laboratory. It describes an environment, surroundings which possess differing characteristics from "objects" of the psychology of perception (1). First, the architectural ensemble surrounds, enfolds, and envelops the human organism. This quality of architecture forces the observer to be a "participant" in it. Second, architectural surroundings provide simultaneously peripheral and foveal information. The participant integrates the visual information as his eyes move in or about the ensemble. Architecture is perceived through movement during which the successive inputs of information become mentally organized into a total experience. Third, architectural surroundings radiate more information that can be processed by human perceptual system. The relevant information is filtered by means of selective processes. Finally, architectural ensembles possess the ability of providing symbolic meaning, and emotional and motivational messages. They have an "ambiance", an aesthetic quality that is difficult to measure and analyze.

The inability of perception-psychology to provide a full account of the architectural stimulation stems from other facts, too. First, architects and psychologists do not
do not share a common terminology. Second, architects are trained in visual awareness and aesthetic sensitivity, while the others are normally not. Similar issues create a value-gap between the professional and people. For a better comprehension of the psychological and experiential nature of Architecture, distinction between its practical and artistic, physical and symbolic aspects is imperative.

The "room" is the basic unit of the architectural realm. It is the cell from which other building and space-organizations are generated. It is, in fact, the various horizontal, vertical, and diagonal adjacencies and articulations of individual room-cells that, eventually, give birth to our everyday built-environment. The genesis of any architectural ensemble is affected by the complex interplay of "cultural", "social", "practical", "aesthetic", "economic", and "technical" factors. Its solution is a matter of organizing and reconciling a substantial range of inputs. The experiential dimensions of the architectural ensemble are, however, to be distinguished from the above criteria. The experiential aspect of Architecture refers to those dimensions along which any built-ensemble would be experienced and conceived.

3.1.1 The Functional Dimension of Architecture

The function of the architectural ensemble is the control and regulation of the relations between the human organism and the surrounding conditions; it includes the totality of the tasks to be carried out for the optimal reconciliation of all the factors that, directly or indirectly, influence users', visitors', and beholders' activities, behavior and mental states. History reveals that the function of Architecture has gone beyond the satisfaction of mere practical needs (2). Although Architecture had arisen from a demand for the protection of man from geographical conditions, wild animals and enemies, the primitive habitats were also concerned with the protection from magical forces of nature.

In physical terms, the architectural ensemble engenders artificial surroundings that prevent unwanted organisms, energies and objects from causing discomfort to its users. In practical terms, architecture participates in human activities. Buildings are shaped and organized
in accordance with the sets of human activities that will be going on within or about them. Finally, the architectural ensemble conveys symbolic meanings, and social and cultural values. It is a symbol of its contemporary culture and society (3).

. **Architecture as a Physical Filter**

The building fabric is a filter between its exterior and its interior as well as between different parts of the latter. It performs its filter-role in terms of physical, thermal, acoustic, and light control. Rain, water, heat, cold, noise, dust, humidity, sun, odor, wind, snow, and radioactivity are among objects of such control.

. **Architecture as an Activity Frame**

Buildings are human activity containers. Most human activities take place within or about the architectural context. Architecture is expected to provide places, spaces, and other spatial elements whose size, shape, location, and relations allow the completion of everyday tasks and activities in optimal conditions. From the smallest unit of an architectural ensemble to its most encompassing geographical environment, there is a functional continuum. The ensemble has to respond to the practical needs imposed by this whole system.

. **Architecture as a Social Milieu**

Architecture may express a "role", a "status", a "togetherness", and similar social concepts. Werthman (4) noted that people select houses to bolster their self-image as an individual and as a person in a certain position in society. Moreover, architectural places may either discourage the formation of human relationships or enforce the development of stable interpersonal relations (5). The Greek "agora" as a meeting place for people, the "acropolis" as the habitat of Gods, and the "enclosed houses" for individual life exemplify the architectural expression of social hierarchy.

. **Architecture as a Cultural Symbol**

Art and Architecture communicate values through generations and time. They symbolize cultural values (6). The cave was the first shelter that human beings used. Natural
caves were followed by artificial ones. Primitive architecture exhibits symbolism with reference to the basic periods of human life, such as "procreation", "birth", and "death". Man of those times had to overcome the powers expressed by these phenomena, just as he had to master the climatic and other physical forces of Nature. Magic powers were controlled by offering them habitat. Then, fixed to a place, they could be reached by man.

The symbolism of Architecture has been gradually altered through the ages. In any context, buildings are symbolic and cultural objects, not simply in terms of the designer's intentions, but also in terms of the cognitive sets of people who experience them. In fact, Architecture has the faculty of exhibiting how human values and how the cultural tradition underlie people's everyday life. Life, then, acquires meaning and significance as part of the historical and cultural continuum.

3.1.2 The Technical Dimension of Architecture

The technical aspect of Architecture refers to construction skills and methods that make the ensemble rigidly stand upright on the earth surface in spite of gravitational and other geographical forces, and to techniques and procedures that allow an adequate and convenient assemblage of the constructive elements which envelop human activities and create the desired artificial surrounding.

"Structure" forms the skeleton of the architectural ensemble. It connotes a tendency towards "order" and serves three basic purposes: the erection of the bounding surfaces; the covering of the spaces defined by those surfaces; and the stability of the system so integrated. These tasks may be undertaken by an unified single structure or may be fulfilled through different systems.

- Homogeneous Structures

The homogeneous structures are characterized by their faculty of carrying loads and transmitting forces over their whole area in such a way that all elements or parts of the structure possess an approximate technical equivalence. "Massive construction" is an
early instance of homogeneous structure. It is obtained by the appropriate addition of isotopic masses such as bricks and stones. Domes made of stone blocks are such structures that cover relatively large spaces, the isotopic masses being subject only to compression forces. Massive structures may also be obtained by pouring a plastic material, such as clay or concrete, into a monolithic mass. "Shell" construction typifies this category. "Pneumatic membrane" and "shell" structures also exemplify the unification of bounding, covering, and supporting purposes into a single structural system. The surfaces and masses of those homogeneous structures are generally continuous, monotonous, and without articulation. (7)(8).

Non-homogeneous Structures

Non-homogeneous structures are those in which the loads and forces act within particular elements that are distinguished from those fulfilling a subdivising role. These structures may consist of several levels of sub-systems varying in their technical importance. In principle, the primary structure engenders a three-dimensional grid, and a secondary system becomes necessary when the primary has large dimensions. The secondary structure assures, then, the articulation of the main grid and supports the bounding, enclosing and covering elements. The structure, being independent from the partitions of the construction, enables the window and door openings of the building to be more freely handled and the size and shape of the space-cells easily manipulated. Due to their very nature, the non-homogeneous structures are traditionally called "skeleton" constructions.

The homogeneous and non-homogeneous structures may be combined together to complement their respective technical capabilities. Today, there is, however, no clear-cut boundary between these two structural categories. It is more appropriate to think that architectural structures vary along the "homogeneous - non-homogeneous" continuum.

The separation of the structure from the subdivising elements involves the issue
whether or not the structure is to be visually expressed. Homogeneous structures are usually open to visual experience. Yet, this is not always true for non-homogeneous systems whose support elements are functionally separated from the enveloping and subdivising surfaces. It becomes, then, necessary to make the distinction between the physical structure and the experiential structure. The former refers to the calculated structural system in its entire physical entity; the latter is the one which is perceived and conceived. They do not necessarily coincide with each other (9) (Fig. 1). Non-functional and ornamental elements are frequently used to alter and enhance the effect of the physical structure.

A quotation from Rudolph enlightens the point (10):

"Mies has handled the steel frame more eloquently than anyone else... The integral part, the steel frame is usually not exposed, but only an exterior symbol of structure, because he has no way of doing otherwise. He has to put concrete around the structural frame, and besides, the structural steel is possibly far too large for the desired visual effect. He superimposes another steel structure, very slender, which seems quite justifiable. The symbol of the structure, rather than the structure itself, is perhaps something we do not understand as well as we might."

Fig. 1 Chapel "Notre Dame du Haut" (Le Corbusier, 1955).
Difference between the physical and the experiential structure.
3.1.3 The Spatial Dimension of Architecture

The art of space, in actual three dimensions, appears with Architecture and Sculpture. A physical space, defined by its geometric and topological characteristics, comes into existence. In the sculptural context, the attention is oriented to the object, to the sculpture itself, and therefore, the emphasis is on the external space. Architecture generates co-existing internal and external spaces within and about which people move. This fact differentiates architecture from sculpture.

The space of architecture is accompanied by a physical form from which it is unseparable. The physical form is the "mainspring" of the space that it engenders. The space itself is rather a conceptual entity. The space may be obtained either by combination of surface elements or by excavation of three-dimensional masses (Fig. 2). In the latter case, internal and external forms can largely differ. Today's architecture falls in the first category, where the surface elements that define the inner spaces also define the outer ones.

![Fig. 2 Chapel "Saint Simeon" (Doruk, 1973).](image-url)

The experience of space does not require the existence of a perfectly close and non-transparent envelope or box. Invisible field forces operate between distant
spatial elements and give rise to the attainment of space experience. "Proximity", "closure", "good continuance", and "simplicity" are Gestalt factors which assist the activity of these forces: four dots organized as equidistant from a central point and from each other, immediately, evoke the experience of a square, the simplest possible visual organization, given the four dots. If four columns are erected over them, a three-dimensional space becomes apparent. The addition of a roof will strengthen the feeling of space and initiate the co-existence of an external one. Walls may be added to erect a hermetically closed room (Fig. 3).

The Physical Space

The physical space is the one that can be measured and defined in terms of geometric concepts. A cube, for instance, describes a space-unit equal to the cubic power of its edge. If, however, a hole is perforated into one of its sides, the physical space of the cube will become part of the exterior infinite space, and will, therefore, be less definite.

The Behavioral Space

The behavioral space refers to the way in which people move within the volume. The motions of people who operate in a space may define a spatial configuration totally different from the geometric organization. Referring back to the previous example, the circulation pattern of the users may describe a circular behavioral space in that cubic volume, due, for instance, to the addition of a miniature pool at the center of its floor.

The Experiential Space

The experiential space is the one which is perceived and experienced by the observer. Its phenomenological make-up arises from the simultaneous cooperative activity of the factors of figural and spatial organization of the visual field. It does not necessarily correspond with its physical and behavioral counterparts. The experiential space is a function of both the physical characteristics of the stimulus and the subjective variables of the perceiver.
3.1.3.1 Elements and Relations in Architectural Space

In this context, the term "element" connotes an unit which is a constituent part of the architectural space. Research in visual perception revealed that the built environment is experienced in terms of "surfaces". Architecture is conceived as a system of surfaces which exhibit different mutual relations (II). At one pole, the surface is reduced to a line; at the other pole, it extends to the infinity.

Surfaces may possess other sub-elements within themselves. Those may be "plastic", "perforative", and "pictorial" Gestalts. A plastic sub-element may be a pilaster that projects from the wall; a perforative one, a window or a door through the wall; and a pictorial one, a graphic essay on the wall.

The term "relation" expresses the way in which the elements are distributed and organized within the three-dimensional frame. Surfaces and spaces in architecture exhibit topological and geometric relations. **Topological relations** introduce the notion of "neighborliness". "Interpenetration", "superposition", "intersection", "adjacency", "fusion", "succession", and "division" are instances of topological relations. **Geometric relations** can be categorized in terms of the organization of elements with respect to a "point", a "line", or a "coordinate system".

The relationship between the elements of the architectural ensemble is more important than the elements themselves. The whole is primary while the parts are secondary. An hierarchical order prevails in the organization of elements and sub-elements. It is defined by the gradual scale ascending from the minute details to the dominant space. Greek architecture, with the overall envelope, then columns and entablatures or arcades, dominant floor lines and the groupings of windows, then on a lower scale, pediments and sills, and details of column heads and feet, spandril decorations and mouldings, demonstrate instances of this visual hierarchy.

Simple patterns are more easily and rapidly perceived as the first dominant step of the gradual organization. This first level will connote the meaning of the ensemble. Then,
individual elements will be gradually appreciated. Visual satisfaction will result if there is a hierarchical order consistent with the first meaning experienced. To achieve this coherence, the ensemble should exhibit a totality or a succession of unifying visual elements that harmoniously and gradually build up the overall meaning. The achievement of that order is necessary but not sufficient for the attainment of the visual satisfaction. An order that does not allow "variation" leads to "cliches". Opposed to the tendency for repetition and simple patterns is the need for variety and contrast. Contrast tends to disturb the expected succession and normality of visual elements without breaking the overall unity, the "oneness", and the meaning of the ensemble. It adds "controlled deviation" and dynamism into the visual field. However, if contrast is not properly handled and if, consequently, the variations are arbitrary, a "chaos" will arise, and the dictum "diversity within unity" will be threatened. Architecture, whatever its context, should produce order as well as variation.

The characteristics of elements and relations of architecture may be repeated and be widely spread so that a "style" becomes created. Style is a system of elements and relations that appears consistently, but with a changing degree of variance. "Originality", on the other hand, consists of intended deviations from the probable. The deviations will be meaningful if they vary within the overall system. The original creation is not therefore, intended, to break a style, but exploit its hidden probabilities. The expression "designed uncertainty" succinctly states this point (12)(13).

3.2 Man - Architectural Ensemble Relations

The functional, technical and spatial dimensions of the architectural ensemble are not independent of each other. Their relation, their delicate coordination and integration are of prime importance to the extent that the lack of harmony between them may devalue the ensemble and render it meaningless.

Today, building technology makes theoretically and practically possible the erection
of any desired form. However, the solution will be valid only if it generates the spatial properties needed for the optimal achievement of the total function of the ensemble.

The space, being a physical object, and thus having a visual form, radiates sets of visual stimuli. Those are sensed and perceived by the human organism as a function of the "factors of figural and spatial organization of the visual field". These sets do not reach the perceiver separately, but in terms of messages carrying more or less original and familiar information. They also possess a symbolic character, since, to a varying extent, each ensemble of spaces, each built form has a meaningful content, a symbolic character due to the learned conventional symbolic imports of things. These messages also transmit functional and technical information to the human receiver. The main dimensions of the architectural ensemble reach the perceiver's consciousness in the image of the "space-system", the "experiential space" (Fig. 4).

![Diagram showing the relationship between architectural ensemble, total function, physical space, structure, techniques, visual perception, and experiential space.]

**Fig. 4** Man-architectural ensemble interaction.

### 3.3 Aesthetics of Architecture

Art and Architecture create new objects. They "concretize" a new combination of known elements. They engender possible but not already experienced situations, and these gain meaning with reference to the existing world.
Aesthetic theories are neither eternally, nor universally valid. Otherwise, architectural aesthetics would have exhibited a consistent metamorphosis instead of periodical value-systems that have been sequentially devaluated and revaluated. Architectural styles have developed as reactions to their respective predecessors. During some periods, the essence of architecture has been thought to be governed by geometric rules or musical concepts. Other epochs have witnessed the dominance of the experiential aspects of the architectural product.

3.3.1 Aesthetic Evaluation

. **Formal Aesthetics**

Formal aesthetics refers to the formal aspects of the architectural ensemble. It deals with "pure" forms and spaces. It emphasizes the attributes that belong to the physical identity of the architectural object, and ignores the subjective experience of the perceiver. "Rhythm", "balance", "contrast", "order", "harmony", "cohesion", and "symmetry" are terms of its common vocabulary. The objective character of formal aesthetics leads to the concept of "eternal beauty".

. **Symbolic Aesthetics**

Symbolic aesthetics emphasizes the meaning associated with architectural space and form. Subjective processes and evaluation which go on in the mind of the interpreter are given priority over the physical properties of the stimulus. The advent of Gestalt Psychology amplified the popularity of this approach. Epithets such as "honest", "good", "terrific", "modern", "attractive", "disgusting", "exhilarating", "passive", and "mystic" are employed to qualify the experience of architecture.

The symbolic mode of aesthetic evaluation is rooted in meanings and values that certain spatial appearances have acquired for a particular society at a particular time. Accordingly, "beauty" is not a quality in things themselves, but exists in the mind which contemplates them. Each individual perceives a different beauty.
3.3.2 Architecture as a Symbol System

The architectural ensemble appears to be both a physical-mechanistic system that considers utilitarian and practical goals and a symbolic, informational system that conveys meaningful messages. The latter aspect leads to an analogy between language and architecture. The visual elements of architecture may be thought to correspond to words of the language, and relations of these elements to the grammar. Different styles of architecture are, then, to be considered as different languages. In fact, Langer (14) affirms that architecture is protolinguistic or a fundamental form of expression and communication outside of words. In protolanguages, significance is expressed with considerable redundancy, and explication is possible if one considers the context. The meaning is less succinctly expressed than in words, but the effect on human beings remains powerful (15). Ellis (16), in "The Dance of Life", establishes architecture as the second means of expression, the "dance" being the earliest one. Indeed, architecture affords a form of human communication between the ages.

3.3.3 Expression and Meaning in Architecture

In the architectural context, meaning may be conceived in terms of consecutive and interrelated stages (17). The first level is the representational meaning during which the stimulus is mentally represented as a percept or concept. The second level consists of the responsive meaning which is the internal reaction to the previously developed internal representation. These two levels may also be subdivided into distinct stages.

3.3.3.1 Representational Meaning

Presentational Meaning

In the presentational stage, the architectural stimulus introduces itself to the interpreter. The internal presentation is iconic and structurally analogous to the stimulus. It arises as a function of the factors of formal organization, both pictorial and spatial. The organism perceives and visually organizes the shape, color, size, and texture of the
stimulus, distinguishes it from its context, categorizes it according to his already known objects, and comprehends its attributes and qualities in the framework of his personal interests and prior experience.

. Referential Meaning

An architectural stimulus may bring to mind objects other than itself. The ensemble may be the symbol of other objects and concepts. The basic referential meaning in architecture consists of the recognition of the functional and technical aspects of the ensemble through its spatial identity. The genuineness of this semantic relation is a prerequisite for the art of architecture (Fig. 5). The distinction between the presentational and referential stages of meaning becomes apparent when professionals and laymen are compared. Architects mostly attend the former, whereas people experience the latter (Fig. 6)

![Architecture Diagrams]

Fig. 5 Which columnade has the right size (Woodworth & Marquis, 1953).

Fig. 6 Sidney Opera House.
While the architect is concerned with the geometric progression of the billowing roof, the spectator is struck by the feeling of "being propelled over water". (Architect: Utzon, 1956).

3.3.3.2 Responsive Meaning

. Affective Meaning

The internal representation of the architectural stimulus may result in exciting, pleasing, boring, or similar emotional states. The delight or the disgust that is experienced at this stage depends upon both the physical characteristics of the ensemble and
the subjective variables of the individual.

- **Evaluative Meaning**

  The evaluative meaning is an internal reaction to the internal representation, and possibly to the affective meaning. It also involves emotions and feelings. The observer can be initially pleased with a building due to its formal excellency, but find it unpleasant when he becomes better acquainted. Utility preferences come into play at this stage.

- **Prescriptive Meaning**

  Following the internal representation of the architectural stimulation, the organism will probably decide what to do. This response situation involves the prescriptive meaning. Architecture is prescriptive in the sense that something is made possible or convenient through the organization of space. The individual, for instance, is channeled as to his movement within the building. The organization of space provides him a disposition to respond.

The responsive meaning is dependent upon the representational meaning. In order to make reliable estimates of the probable effects of his future professional achievement, the architect must equip himself with an accurate understanding of the internal representation that the individual will actually develop. Then, more valid predictions about his prospective responses to the architectural work will be possible (Fig. 7).

![Diagram](image_url)

**Fig. 7** Architectural meaning (adapted from Hershberger, 1974).
3.4 Emotional Potentials of Architectural Stimulus

"At a moderate distance from the harbour on their coast lies an island, inhabited by many wild goats. Most of its area is wooded; there are also some mountains and some natural postures. All vegetation is natural, for the island has not been visited by man" (18).

"Not very far from the harbour on their coast, and not so near either, there lies a luxuriant island, covered with woods, which is the home of innumerable goats. The goats are wild, for man has made no pathways that might frighten them off, nor do hunters visit the island with their hounds to rough it in the forests and to range the mountain tops. Used neither for grazing nor for ploughing, it lies forever unsown and untilled; and this land where no man goes makes a happy pasture for bleating goats" (19).

Although the two paragraphs describe the same location and give the same information, the second possesses a quality that the first lacks totally: the emotional overtones (20). To make an architectural analogy, the first stands for a building, the second for a "chef d'oeuvre" of architecture, just as a poetry distinguishes itself from a prose. Indeed, the emotional qualities which are attached to meanings conveyed by the objects of art and architecture clarify the distinction between the artistic and the factual world. In that context, aesthetic feeling is thought to be equivalent to a feeling of "pleasantness", aroused upon the perception of the visual display.

Emotions are "excitement of the mind or feelings", aroused by external stimuli. They are involuntary, subjective and immediate evaluations of perceptual experiences. They basically vary along the "pleasant-nonpleasant" continuum, pleasant emotions referring to "joy", "gladness" and "like", and nonpleasant emotions to "anger", "fear" and "dislike".

Emotions may be directly associated with "pure" perceptions which are, by definition, free of meaning (21). Emotions may also be connected to perception by way of meaning attached to that perception (22).

3.4.1 Theories of Emotion

It is generally thought that the bodily changes which accompany an emotional state
are the outcome of the feeling of pleasantness or nonpleasentness caused by the emotion-producing stimulation. An opposite view, however, argues that the emotional state is the natural feedback of bodily changes. The theories of emotion derive from these two contrasting approaches.

- **Cannon's Theory**

  Cannon suggests that it is the "thalamus" in the brain which responds to the stimulation by sending signals to the cerebral cortex and other parts of the body. Hence, he assumes that the experience of emotion and the physiological activity of the body occur simultaneously.

- **James-Lange Theory**

  This approach sustains that the mental experience of emotion is the natural feedback of the physiological changes which occur during an emotion-producing stimulation.

- **Information-Integration Theory**

  Today, research has demonstrated that it is not the thalamus, but the "hypothalamus" which is the integration center of emotional inputs. Based on this finding, the information-integration theory presents a summation of the previous approaches: The mental experience of emotion results from the integrated information supplied by the external stimulation, the physiological bodily changes, and subjective cognitive factors. Prior experience appears, therefore, as a reference-criterion. So, personal interests, education, convictions and other subjective variables cooperate to shape one's emotional state (Fig. 8).

### 3.4.2 Aesthetic Emotions

As discussed earlier, responses to architectural stimuli depend on the representational meaning that the individual attends. Affective responses which derive from presentational and/or referential meaning constitute the core of aesthetic reaction-emotions. However, these tend to be indistinguishable from the "utility preferences" that are rather instrumental-practical evaluations.

**Pure aesthetic emotions** are responses to what is experienced through the recognition
Fig. 8 Schematic representations of theories of emotion (Hilgard et al., 1975).
of the formal properties of the stimulus. The decoded meaning is "presentative". Associational aesthetic emotions are responses to what is experienced through the recognition of other stimuli and events that are symbolized by the current stimulus. The decoded meaning is "referential". Utility preferences are responses to what is experienced through the recognition of existing and/or potential uses of the stimulus for practical and instrumental purposes. They are not aesthetic, but functional and pragmatic considerations.

Formal aesthetics studies "pure aesthetic emotions", whereas symbolic aesthetics deals with "associational aesthetic emotions". However, the distinction between formal and symbolic aesthetics is conceptual, for pure and associational aesthetic emotions are intimately bound up with each other. Architectural aesthetics is a coherent system of criteria which are simultaneously formal and symbolic (Fig. 9).

---

**ATTENDED MEANING**

PRESENTATIONAL MEANING ➔ FORMAL AESTHETICS ➔ PURE AESTHETIC EMOTIONS

PREFERENTIAL MEANING ➔ SYMBOLIC AESTHETICS ➔ ASSOCIATIONAL AESTHETIC EMOTIONS

FUNCTIONAL PRAGMATIC CONSIDERATIONS ➔ UTILITY PREFERENCES

---

*Fig. 9 Meaning-response relations in Architecture.*
CHAPTER 4

GEOMETRY IN ARCHITECTURE

The interpretations of Ecological Optics of space perception have revealed that the architectural ensemble can be best conceived in terms of "surface elements", their "relations", and their "properties". The surface is to be considered as the reference element of the visual experience, so that all other geometric entities are its functions. The "line" may be then defined as a surface one dimension of which tends to zero. In fact, forces acting between the visual elements of space create invisible, but felt surface elements which, through a process of "closure", delimit the spatial framework. In other words, we do not tend, phenomenologically, to decompose lines into dots, but rather to synthesize lines into surfaces (Fig. 1). In the light of these considerations, "surface" can be described as a bi-dimensional plane whose thickness is insignificant in comparison to its two defining measures. It has five visual variables whose interplay determines its essence. These are "color", "illumination", "texture", "size", and "geometry".

Fig. 1 Line as an unitary portion of surface.
4.1 Geometry

"The point of departure of my reflections is the following:
Every corner in a house, every angle in a room, every inch of secluded space in
which we like to hide, or withdraw into ourselves, is a symbol of solitude for
imagination.
To begin with, the corner is a haven that ensures us one of the things we prize
most highly: Immobility. It is the sure place, the place next to my immobility...
An imaginary room rises up around our bodies, which think that they are well
hidden when we take refuge in a corner. Already the shadows are walls, a piece
of furniture constitutes a barrier, hangings are roof...
To great dreamers of corners and holes nothing is ever empty, the dialectics of
full and empty only correspond to two geometrical non-realities. The function
of inhabiting constitutes the link between full and empty. A living creature fills
an empty refuge, images inhabit, and all corners are hunted, if not inhabited...
It is a poetic fact that a dreamer can write of a curve that it is "warm". But does
anyone think that Bergson did not exceed "meaning" when he attributed "grace"
to curves, and no doubt, "inflexibility" to straight lines? Why is it worse for us
to say that an angle is cold and a curve warm? That the curve welcomes us and
the oversharpen angles reject us? That the angle is masculine and the curve femi-
nine? A modicum of quality changes everything. The grace of a curve is an
invitation to remain. We cannot break away from it without hoping to return.
For the beloved curve has nest-like powers; it incites us to possession, it is a
curved corner, inhabited geometry..." (1)

A look to the architectural heritage reveals that Architecture and Geometry have
had much in common (2). In fact, geometry is the basic visual variable of the spaces
that constitute the everyday world. The infinite combinations of color, illumination,
texture, size and geometry define the visual form.

The father of "geometry" is Euclid. He has formulated its first concepts at the
beginnings of the 3rd Century B.C. Euclid's geometry was dominated by figures made up
of "straight lines", "angles", and "arcs of circumference". It was not long until Apollo de
Perga, performing different planar sections to the cone, discovered the "conic sections".
At this very moment, geometry escaped the hegemony of the ruler and the pair of compasses.
The non-circular curves, then, appeared and permitted the formulation of the exact traject-
tory of solar planets. It was Descartes who freed the curve from its dependence on fixed
figures and gave it the capacity of expressing variables. He combined the "geometry",
"algebra", and "arithmetic" to come up with the "analytic geometry": Within a system
of coordinates, the line is kept straight when it translates an equation of the 1st power.
The straight line can never have more than one intersection with another straight line. The curves of the conic sections correspond to the equations of the 2nd power. These curves can never intersect the straight line more than two times. Similarly, curves of the 3rd power, resembling the letter "S", and those of the 4th power, which describe the number "8", cannot intersect the straight line more than three and four times, respectively (3).

So, a bridge between the visual and the abstract world was being erected and liaisons between time and form initiated. Descartes was followed by Fermat, Bernouilli, Newton and Leibnitz who came on the scene to build the basis of the infinitesimal calculus, which, in turn, constituted the fundamental of the "derivatives" and "integrals". The mathematical basis of geometry then reached the point that works of art could be created by combinations of lines described by particular equations (Fig. 2). Nowadays, the equations of the 3rd power are being used to define the surfaces that envelop irregular volumes (3).

4.1.5.1 Basic Elements of Geometry

The straight line occupies an exceptional place in geometry. It is defined by a point which moves in an unchanged direction. In architectural terms, it comes into existence by the intersection of two planar surfaces. Although the straight line is very basic and, therefore, does not possess many geometric properties, it is involved in various cases of perceptual illusion that have also been encountered in the architectural realm.

A physically straight line, especially if long, appears to sag in the middle. The Greek Temples, the Parthenon and the Temple at Paestum have been lifted by 12.3 and 2.0 cm. at the middle of their bases, respectively, to avoid the curved appearance of the perfectly horizontal and straight lines. These temples do not possess, in the physical sense, absolute right angles and straight lines (5)(6). Such phenomena are probably due to some "Gestalt pressure" which disturbs the straight character of lines or destroy their parallelism (Figs. 3, 4). Similar illusions may affect the perceived length of straight lines (Figs. 5, 6, 7).

Straight lines contained by the same plane are either parallel or intersecting. If
"Cissoid"

\[ y = \pm \sqrt{\frac{x}{2a-x}} \]

"Strophoide"

\[ y = \pm x \sqrt{\frac{a+x}{a-x}} \]

Fig. 2 Aesthetic variations (Mallet, 1971).
Fig. 3  Hering's (a) and Wundt's (b) visual distortions. The straight lines appear bent in the middle (Hering, 1861 and Wundt, 1896).

Fig. 4  Zollner Illusion
Parallel lines are perceived as non-parallel (Zollner, 1860).

Fig. 5  Are the diagonals equal in length?
(Devised by Sander, in Hesselgren, 1969).

Fig. 6  The vertical is perceived longer than the horizontal (Thorn's trade mark, in Hesselgren, 1969).

Fig. 7  \( ab = ac = de \)
Do you agree?
(Hesselgren, 1969).
they are parallel, they never touch each other; if they intersect, an "angle" is obtained. A multitude of other relationships are possible when the tri-dimensional framework is considered.

The angle may be defined as a "discontinuity in a line or contour". A "dihedral" angle connotes the discontinuity in a surface. Angles vary between zero and 360 degrees. The 180-degree angle may be described by a straight line or planar surface. It is a special case in which no discontinuity is involved. The 90-degree intersection gives the pregnant angle according to which all others are visually judged. In fact, the right-angle is easily detected and slight deviations from it are immediately "caught". It acts as the turning-point of the angular range. Tachistoscopic experiments in which the exposure time of the stimulus is fully controllable reveal that angles with slight deviations from the right-angle are still experienced as right-angles. However, when the exposure time is increased, the 90-degree angle becomes sensitive to such deviations more than any other angle (7).

The angularity of a form or volume may be described by referring to the number of its sides. The series of equilateral polygons show that "angularity" and "roundness" are not phenomenological opposites, but the poles of a continuum (Fig. 8). In these continuous series, the "triangle", the "square", the "pentagon", the "hexagon", the "octagon" and the "circle" appear as points of the continuum where the visual character of the form exhibits a significant change.

As lines, angles are subject to illusory situations mainly due to Gestalt pressures. The properties of the lines or surfaces which define the angles as well as other neighboring stimuli may be the causes of such perceptual distortions (Fig. 9).

Curves are those lines which are expressed in terms of equations of the 2nd and higher powers. The most regular curve is the "circle", a succession of points equidistant from a central locus. The circle describes a cyclic movement. A family of other regular curves is obtained with reference to the planar sections through the "cone", a volume defined by joining the points of the circumference of a circle to a point belonging to the orthogonal erected on the center of the circle. All planar sections parallel to the base
Fig. 8 "Angular-Curvilinear" continuums (adapted from Hesselgren, 1969).

Geometrically different angles are perceived as equal (Hesselgren, 1969).

Equal angles are perceived as unequal (Hesselgren, 1969).

Fig. 9 Gestalt Pressures on angles.
of the cone are still perfect circles. Yet, as soon as the plane of section is freed from its parallelism to the base, "ellipses", "parabolas", and "hyperbolas" are obtained (Fig. 10). Nevertheless, the realm of curves does not end at this point. An infinity of other curves is found in Nature. The "spiral", for instance, is a fascinating dynamic curve (Fig. 11). More spontaneous ones are depicted by the trajectories of fireworks, the flight of mosquitoes, the sinuosities of rivers, and the undulation of waves. Curves may also be obtained by combination of other curves. The "supercircle" and the "superellipse" are examples of this case (Fig. 12).

The visual appearance of curves is affected by Gestalt pressures (Figs. 13, 14). These illusory phenomena, to which "line" and "angle" are also subject, are of importance for the architect. A correction may be necessary to obtain the desired visual effect.

Arnheim (8) compared the expressive qualities of the "semicircle" and "parabola". His conclusion states that the former appears rigid, static and contained, whereas the latter seems more dynamic. Arnheim indicates that the respective emotions they give rise to are a function of their defining conditions. The circle has only one defining condition: the locus of all points equidistant from a given point. The parabola possesses two: the locus of all points equidistant from a line and a point outside the line. Consequently, according to his view, the latter will be evaluated as more expressive.

There are also artistic opinions which suggest that shapes which can be described by analytical equations are more beautiful than the irregular configurations. Conversely, other views assert that curves composed of segments of other curves are more valuable in aesthetic terms (9).

4.1.5.2 Basic Directions

Among the infinite directions of the tri-dimensional Cartesian space, one is distinguished by the pull of gravity. In fact, the vertical direction dominates all other directions. Lowenfeld illustrates the preeminence of the perpendicular (10):

"The perpendicular line, the most absolute line which is neither influenced from the left nor the right expresses the same stability that a flag-pole expresses as the
Fig. 10 Conic sections (Huyghe, 1971).

Fig. 11 The spiral (Critchlow, 1969).

Fig. 12 Compound regular curvilinear figures (Hesselgren, 1969).

Fig. 13 In different surroundings, the same circle segment is perceived to have different curvatures. (Hesselgren, 1969).

Fig. 14 A quadrate with rounded corners. The sides are phenomenologically bent inwards (Hesselgren, 1969).
bearer of the symbol of the country."

Horizontal ground plane is the zero level for all vertical directions, and these two meet at right-angle. Some verticals seem to continue further below the ground plane, while others appear to rest on it (Fig. 15). Although no geometric difference is discerned between going upwards and going downwards, this distinction is justified in perceptual and psychological terms: going up is qualified as a heroic act associated with high values. While rising means "enlightenment, falling is "darkness" (11).

The pre-eminence of the vertical direction finds expression in architecture, too. The horizontal floor slabs, the horizontal accent of facade elements act against the dominance of the vertical. The repeated horizontal layers exhibit resistance to the spontaneous tendency to integrate them vertically. While the horizontal effect is enhanced when the width surpasses the height, elements such as buttresses, columns, vertically grouped window combinations, staircases, ramps and vertical shafts try to revive the pregnant character of the vertical direction. However, in certain cases, the dominant character of the architectural ensemble appears to be horizontal, and the verticality remains subordinate. In fact, easy mobility on the horizontal floor seems to be a natural property of architecture. The horizontal mode of living enhances free mobility and interaction, while vertical development emphasizes isolation, hierarchy and competition. The principal dimension of action is horizontal, while the principal terrain of vision is vertical. This explains why the buildings intended as visual monuments display their character in their verticality (12).

The directions lying between the vertical and the horizontal are called obliques. Obliqueness exhibits more dynamism and variety. Hesselgren expresses such feelings (13):

"... only when a moment of dramatic excitement is sought, such as a desire to give expression to the play of forces are deviations from the main directions felt to be justified".

The Parthenon, for instance, exhibits a conformity to visual main directions. However, the rock on which the complex rests possesses a chaotic character. A contrast between the natural and the built-form results (Fig. 16). A different attitude is adapted by Wright in his
Fig. 15 Buildings perforating into the earth or resting on the earth (Arnheim, 1977).

Fig. 16 Parthenon in Athens (Hurlimann).
Contrast between the complex and the landscape.

Fig. 17 Hotel Project (F. L. Wright, 1938-40).
Harmony between the complex and the landscape.
project for an hotel placed on the edge of a large crater. This time, the built-ensemble reflects the character of the shattered landscape. The obliques are dominant (Fig. 17).

The psychologist is interested in basic directions when studying man's self-orientation. He discerns "egocentric" and "exocentric" orientations. The former is inherent in the visual system. It is based on the retinal coordinates. The latter is built up from external references: gravity and visual framework. Experiments reveal that a subject tilted from the vertical is not able to judge accurately the physical verticality (14). An everyday instance of this situation can be experienced in a train which turns a curve: The verticality coincides with the plumb-line in the train which, itself, is influenced by the centrifugal force, and physically vertical stimuli seen from the window appear sloping.

4.1.5.3 Geometry of Solids

If a point moves in an unchanging direction from an initial position, the trace of its path describes a straight line. The first dimension becomes defined. If the line is moved in another direction off the original one, a planar trace is obtained. The surface adds the second dimension. The third dimension, different from the first two, yields the solid, the geometric equivalent of the architectural space-cell.

There are three basic ways in which these moves can be performed (Fig. 18). The "minimal movement" results in the equilateral triangle which, in the third dimension, yields the tetrahedron. The tetrahedron is the strongest of the solids, and is able to resist external forces from all directions. The "medial movement" describes the square which, in turn, generates the cube. The "maximal movement" that involves a cyclic development, results in the circle. The circle is the most resistant form to external forces.

The primary solid, the tetrahedron, is followed by the octahedron, an eight-faced double pyramid composed exclusively of equilateral triangles. The tertiary solid, the icosahedron is made up of 20 isosceles triangles. The tetrahedron, octahedron and icosahedron are three regular and stable triangulated solids. With the addition of the
Fig. 18 Basic moves of geometry (Critchlow, 1969).
dodecahedron, which is determined by 12 regularly assembled pentagons, the "Platonic Solids" are completed*. The Platonic Solids were considered the basis of the structure of the Universe. The tetrahedron was simulating the molecule of "fire", the octahedron the molecule of "air", the icosahedron the molecule of "water", the cube the molecule of "earth", and the dodecahedron the all-containing medium, the "ether" (Fig. 19).

When the five regular polyhedra are developed as divisions of the curved surface of a sphere, their five spherical counterparts are obtained (Fig. 20). The overall ten unit-set is thought to be the basis of the "Pythagorean Harmony"**.

The "all-space-filling" elements attract the interest of architects. These are units of volume which, placed adjacent to each other, completely fill the tri-dimensional space. The basic ones are the triangular prism, the cubic prism, and the hexagonal prism. Their packing grids are fully regular***. A multitude of them, however less regular, may be generated (Figs. 21, 22)(15).

---

* They were so called because of the emphasis that Plato placed upon them in expanding the Pythagorean cosmology in "Timaeus".

** It is believed that these patterns bear a relation to Pythagorean teaching.

*** The regularity of "packing grids" is expressed in terms of the sameness of the nodes. As different angles becomes involved, the regularity is lessened.
Fig. 21 "All-space-filling" elements (Critchlow, 1969)

Fig. 22 "All-surface-filling" grids (Critchlow, 1969)
4.1.5.4 "Pregnant" Geometric Forms

The account of the geometry of solids makes it clear that some forms possess priority over some others, due to their regularity and succinctness. All other forms derive from various alterations and variations of these basic geometric entities. In the context of the psychology of perception, such pre-eminent figural configurations are called "pregnant forms". A Swedish psychologist and the Gestaltists have performed a number of experiments to establish whether geometrically basic shapes are equally basic or "pregnant" in the perceptual experience of man. A number of criteria appeared as prerequisites for "pregnance" (pragnanz) to occur (16)(17).

. the stimulus should be easily and rapidly identifiable and recognizable,
. the identification and recognition of the stimulus should be accurate and precise,
. minute deviations from pregnant stimulus should be more easily and accurately discerned than those from non-pregnant stimulus, and
. under tachistoscopic exposure, pregnant stimulus and stimuli which deviate slightly from it should give rise to identical perceptual experience.

The study showed that three geometric configurations, the equilateral triangle, the square, and the circle meet these conditions, and therefore, are the "pregnant forms" of the visual experience.

4.2 Geometry in Architecture

Architectural spaces are described either by the continuous and inherent movement of a single surface or by the interrelations of a number of surfaces. In each case, a geometric relation is defined in terms of the organization of these surfaces according to a "point", to a "line", to a "coordinate system", or to any combination of them (Fig. 23).

If a surface or surfaces are organized relative to a point, a family of rotational symmetries results. The center is a locus of special importance (Fig. 24). The geometric organization relative to a line involves an axis. The axis may be of any configuration, but should preferably have a determined shape (Fig. 25). Axial organizations lead to "parallelism" which, in turn, introduces the "coordinate system". The latter comes into existence
Fig. 23 Geometric organizations:
(a) relative to a "coordinate system", (b) to a "line",
(c) to a "point" (Norberg-Schulz, 1965).

Fig. 24 "Point" oriented organization (Norberg-Schulz, 1965).

Fig. 25 "Line" oriented organization (Norberg-Schulz, 1965).
in the form of grids which consist of net-like reticulations (Fig. 22).

Topological relations constitute another realm of architectural organizations. Topology connotes a relation of elements that are equivalent in terms of "neighborliness". In other words, points which are near neighbors in the original layout remain near neighbors in its different variations (Fig. 26). Topological organizations have no particular shape. They are accidental and spontaneous (Figs. 27, 28).

Finally, the architectural world also exhibits traditional relations. These may be conceived as prescribed ways of combining elements. The classical orders and proportion systems are such relations.

Geometric and topological systems may be integrated. A topologically organized whole may be articulated through a dominant axis, or a topological enclosure may be geometrized by means of a "point", "line", or "grid" (18). However, particular elements may demand particular relations, and vice versa. Topologically defined elements may be organized both topologically and geometrically, whereas geometrically defined elements express affinity for geometric order. On the other hand, neither a topological system, nor a geometric organization, in principle, dictate elements of particular character. However, in the latter case, if the geometric order is not pronounced enough, elements of diffuse character will make it more imperceptible, while geometrically defined elements will enhance its organizational character.

Any urban or architectural ensemble is geometrically, topologically or traditionally laid out under the cooperative influence and concurrent action of geographical, social, cultural, economical, pragmatic, technological and other forces. The consequent architectural heritage exhibits a rich geometric vocabulary.

When the Mediterranean civilizations appeared from the depth of the prehistory, they made use of the straight line and its combinations for their architecture. Centuries later, Mondrian justified their geometric attitude (19):

"Immutable harmony is reached with the relation of positions depicted by straight lines and their rectangular opposition. In architecture, exact expression of the cosmic harmony is shown by the vertical and horizontal planes."
Fig. 26 Topological relations (March & Steadman, 1971).

Fig. 27 Topological relations in Architecture
Catal Hoyuk, Anatolia, Turkey
(March & Steadman, 1971).

Fig. 28 Topological relations in Architecture
Peublo Bonito, Chaco Canyon.
Egyptian culture introduced the diagonal when eternal pyramids were erected for the idols. Also, Egyptian architecture gives us instances of "canonic design" where a grid develops an authoritarian geometric order. These reticulations were even carried over the actual building. To predetermine the canonic system, Egyptian artists made use of "ostrakons", early versions of today's architectural drawings (20)(Fig. 29). Those reveal that curvilinear organizations were then in vogue as well (Fig. 30). To instance one, the focus of Ne-User-Ra's Sun Sanctuary was a circular offering table, all being directed towards this circle under the protection of the obelisk, symbol of the Sun's rays.

Greek architecture was fond of verticality and horizontality. Verticality has long been connected with religious aspirations, but in more primitive cultures it was associated with fertility cults, a link between the Earth and the Sun (21). The Greek Parthenon and the Temple at Paestum express a pronounced axial rectilinearity. However, the development of the Greek drama by Euripides, Sophocles and Aristophanes resulted in great amphitheaters, ultimate instances of rotational organizations. Greeks also introduced the triangle as a distinct architectural element, and managed to jump clear off the Cartesian grid towards a more topological organization of the public space: the corners of the buildings of the site are placed on the lines radiating from the entrance of the main sacred structure. In Doric order, the secondary buildings completely close the view, whereas in ionic order a single segment of the landscape is left open (Figs. 31, 32)(22).

A well-known circularly organized artifact is Stonehenge, in England (Fig.33). Hawkins (23) indicates its function as a "computer" and "observatory". Its relation to the rising and setting of the sun reveals the early knowledge about the motions of the planetary system. The oval configurations first appeared in Iberian peninsula, in Greece and Egypt. Along with the round and its derivative, the dome, these rotational forms have found their application in the pointed arches of Gothic churches, in Roman and Renaissance architecture, and in Ottoman mosques of Sinan. Art Nouveau attempted to express the emotinal tensions, the rapid unleashing of power, all characteristic of the life of the time, in
Fig. 29 Ostrakon
Proposal of a grove of tamarisk in front of a temple, 2100 B.C.
(Clarke & Engelbach, 1930).

Fig. 30 Ostrakon
Diagram from Saqqara, 2800 B.C.
(Clarke & Engelbach, 1930).

Fig. 31 Doric site: Asclepion
(Doxiadis, 1972).

Fig. 32 Ionic site: The Acropolis III
(Doxiadis, 1972).
spiral configurations and, in that respect, resembles Rococo (24)(25). Alberti (26) illustrates the place of the round:

"It is manifest that the Nature delights principally in round figures, since we find that most things which are generated, made or directed by Nature are round. Why need I instance the stars, trees, animals, nests of birds or the like parts of the Creation which she has chosen to make generally round.....?"

In spite of the rebellions of Baroque and Neoclassicism, the architectural realm, ranging from communities to alpine chalets, from monasteries to the courts of French royal palaces has been dominated for long periods by these forms described by the ruler and compasses. Even during the highlights of French Rococo, in the XVIII century, the dynamic curves have been saved for decoration, ornament and furniture. For the majority, the straight line and the orthogonal intersection have established a pronounced geometric hegemony on architecture that, for years, governed the work of modern pioneers.

It was by a reaction to the cubism of the Bauhaus that the geometry challenging the inertia could find a place for itself in the architecture of the XX Century. Structures were erected in form of continuous curvatures over which it sufficed to stretch a skin concrete. The tents of "Otto", Pavilions of "Saarinen", Notre Dame du Haut of "Le Corbusier", Sydney Opera of "Utzon", Berlin Philharmony of "Scharoun", houses of "Hering", cultural complexes of "Aalto", Observatory of "Mendelshon", Olympic structures of "Tange", fantasies of "Niemeyer", Guggenheim of "Wright" and utopianisms of "Archigram", to name some of them, introduced the dynamism and potential of the architectural geometry. During all the historical continuum, each geometric system expressed its own nature, its own particular aesthetics. DeSausmarez's sentences reflect this point (27):

"Horizontal and verticals, operating together, introduced the principle of balanced oppositions of tensions. The vertical expresses a force which is of primary significance, the gravitational pull. The horizontal contributes a primary sensation, a supporting flatness. The two together produced a deeply satisfying resolved feeling, perhaps because together they symbolize the human experience of absolute balance... Diagonals introduced powerful directional impulses, a dynamism which is the outcome of the unresolved tendencies towards vertical and horizontal... Where the line is used in relationships of curves, an entirely different rhythmical
Fig. 33  Stonehenge, England. 1500 B.C.
(Tyng, 1969).

Fig. 34  Flat, Napoli
Combination of different geometries
quality emerges..." (Fig. 34)

In fact, it suffices that we look at the houses of F.L. Wright to realize the echoes of DeSausmarez's impressions (Fig. 35). Three residences responding exactly to the same program adopt three different geometries and create quite distinct surroundings and particular experiential effects.

Fig. 35 Houses (Arch. F. L. Wright)
(a) House for a family of $5,000-6,000 income,
(b) Vigo Sundt House, Wisconsin, 1941,
(c) Ralph Jester House, California, 1938,
(d) Graph of space and room linkages for the houses.

key:
B: bedroom
B': extra bedroom
C: car port
D: dining room
E: entrance
F: family room
J: bathroom
K: kitchen
L: living room
O: office
P: pool
T: terrace
Y: yard
CHAPTER 5

COMPARATIVE ANALYSIS OF AESTHETIC RESPONSES
TO GEOMETRY IN ARCHITECTURAL SPACE

5.1 General Framework

5.1.1 Experimental Methods in Architectural Evaluation

Architects do not use systematic techniques to evaluate people's perceptual and emotional reactions to buildings. If attempted, however, such experiments are carried out in a casual manner, without sufficient rigor concerning the design and analysis of the research. In order to adopt fruitful experimental techniques, the architect is compelled to refer to the resources and methods of the social sciences.

Kling and Riggs (1) define "experiment" as an attempt to control the situation in such a way that meaningful relationships can be established between antecedents and consequences. The experiment should, therefore, be based on the scientific method: The results must be reached objectively and experiments reproducible by others. The research design refers to the determination of the procedures, methods and apparatus for the collection, measurement and analysis of the data. Man being both mentally and physically involved with his surroundings, the data to be extracted can either be those which are in his mind, or various aspects of his overt behavior, actions and activities. His physical involvement becomes manifest in his activity-patterns and visible actions within or about the given surroundings, while his mental involvement is manifested in his perceptions, mental images, emotions, beliefs and preferences. It, therefore, becomes quite apparent that the data-collecting technique is to be selected in accordance with the aim of the research. Basic techniques are the "observational", the "survey", the "correlational",

the "experimental, the "quasi-experimental", and the "non-experimental" methods (2)(3). The scientific approach is best accomplished by the experimental design. However, in some cases, other or mixed methods may yield more valid results and have practical advantages.

5.1.1.1 Basic Research Methods

The observation is fundamental to all other approaches. The aim of the observational technique is to describe the phenomenon under study. This technique is useful in gathering information as to how people behave within given surroundings. Its major weakness is the lack of explanation of the purpose and meaning of the observed behavior. The survey technique is one of the most convenient ways to obtain data regarding people's mental involvement with the physical surrounding. "Questionnaires" and "interviews" are easy, cheap and quick to use. The danger of the survey method is the possible intellectual inability of some respondents to handle the material. This disadvantage can however be compensated by simplifying the test-forms and by carefully selecting the subject-groups. The correlational method is used to specify the degree of relationship between variables. Once, through repeated observations or measurements, information on several variables is obtained, a correlational analysis can be performed on the data. The advantage of this method is that it makes possible predictions about past and future events. Yet, the relationship between variables does not allow one to infer a causal association. The experimental method uses techniques to manipulate, quantitatively or qualitatively, and control variables as a means to investigate causal relationships. Since strict control and manipulation of variables is very difficult within the architectural and urban context, the built-environment oriented research has rarely employed this method. The experimental method, by definition, requires that all the variables should be controlled and only one manipulated to deduce causal associations. The quasi-experimental method is referred to when it is not possible to control all the variables by external means. The non-experimental method possesses limited scientific validity, since it is difficult to determine whether or not and to what extent the dependent measure is influenced by the manipulation of the independent variable.
An experiment is said to possess "internal validity" if the manipulation has an effect in or on an experimental condition or activity. It is said to possess "external validity" if the manipulation can be generalized beyond the specific experimental situation (4). Usually, there is a trade-off between these two different validity concepts, since it is impossible to achieve both in a single experiment. Although the experimental method is best for establishing the internal validity, the quasi-experimental technique is better for external validity. There is no good way of experimental manipulation in a natural setting without disturbing the naturalness of the situation.

5.1.1.2 Experimental Designs

The aim of the experimental method is, therefore, to test whether or not a certain manipulation, quantitative or qualitative, has a certain effect on the dependent variable. In a between-subject design, each subject experiences only one level or condition of the independent variable. In a within-subject design, each subject experiences more than one or all levels or conditions of the manipulated variable. Within-subject designs possess several inherent advantages over between-subject designs: fewer subjects are necessary, since each subject is tested at several levels, and thus, generates more information. Furthermore, within-subject designs are more efficient, that is, they allow one to detect effects that cannot be deciphered when, instead, between-subject designs are used. The reason is that chance fluctuations within individuals tend to be less than between individuals. In other words, the performance or response of the same subject at two different points in time tends to be more alike than that of two different subjects at the same time. As within-subject mode of experimental design allow one to determine the effects of the manipulated variables on the basis of chance fluctuations within individuals rather than within groups, they possess higher efficiency.

When within-subject design is used, it becomes difficult to distinguish between experimental and quasi-experimental investigations. The best way for such distinction to be made is to consider the number of confounding factors. The experimental design
is achieved if there are no confounding factors. If one or more variables are suspected to confound the experiment, the method is classified quasi-experimental. Within-subject comparisons performed in controlled laboratory conditions can be considered as experimental manipulations, while those made in real-life situations are more likely to be quasi- or non-experimental research (5).

5.1.1.3 Confounding Factors

Variables that tend to affect the results of an experiment, although they are not manipulated, are the "confounding factors". As in most experiments subjects are tested on many items or in several sessions, "fatigue-effects", "practice-effects", and the "sequence of the administration" gain importance in terms of confounding. "Demand characteristics" are aspects of the experiment that allow the subject to make a good guess about what the experimenter wants to obtain as results. "Counterbalancing" refers to the use of procedures that distributes the effects of non-manipulated variables over the conditions of the independent variable in such a way that the differences can be attributed to only chance and to the conditions of the independent variable. Counterbalancing is accomplished by systematically varying the order of items, manipulations, sessions and other ordered steps of the experiment.

5.1.2 Techniques and Procedures

The problems of the experimentation with the phenomenological aspects of the physical surrounding, man-made or natural, stem from the complexity and the number of its variables as well as the lack of appropriate psychological dimensions along which these could be measured or scaled.

The relatively recent concern about the meaning and value of the built-environment has fostered an emphasis on the mental involvement of the people with the architectural artifacts. Verbal methods have gained importance in that context. Their use is based on the fact that man is aware of his visual environment and can generate appropriate verbal re-
sponses to it. The current status of environment-related research reveals that aesthetic issues, no less than others, can be attacked by means of experimental laboratory approaches, simulated conditions and contrived situations that had been conventionally utilized by the behavioral scientist. However, while measuring the attitudes, interests, values, feelings, perceptions and emotions of individuals in relation to their physical setting, there is a tendency to attribute more to the measurement than it can provide (6). Quantification is a central aspect of such research, but it cannot be achieved to the degree attained in the physical sciences. These measurements can only be approximated by the present techniques, and their validity and reliability are relatively lower when compared with those of physics.

There are, consequently, several issues to consider when such measurement is to be performed. One of them is the size of population (7). When the architectural design is for a single family, it is possible that a certain number of conversations remove ambiguities about the user’s probable responses to the prospective building. However, a lot of people who will share the visual experience of the ensemble remain ignored. Furthermore, if the population to be considered is that of a large architectural complex, a neighborhood or a town, the only approach is to keep an accurate and convenient record of people’s responses. A representative sample of that population should be drawn to simplify the questioning and measuring process into a manageable scale. Another issue to be considered along with the attitude and preference measurement is the appropriateness of the test instrument. To decide whether or not a certain instrument is appropriate, it is necessary to work over the questions and items of the instrument and to review the previous research literature in order to have a general idea about how the questions and items were intended, used and interpreted (8).

5.1.2.1 Techniques

"Interviews" and "questionnaire-surveys" are commonly used techniques when the data to be collected are about attitudes, preferences, opinions and beliefs (9). The
interview is a relatively quick and effective technique for the collection of a large amount of data. It can be carried out anywhere, can be "structured" or "non-structured" and contain "closed" or "open-ended" questions. The questionnaire is an alternative technique to the interview. It is inexpensive and easy to administer as long as clear and detailed directions and explanations are provided. It is more standardized, uniform, and thus comparable. The format of the questions differs from questionnaire to questionnaire. The responses can be short answers, checkoffs or scaled ratings. As these instruments are generally intended for the collection of standardized and measurable data, scaled ratings appear to be more advantageous, for they provide quantitative measures amenable to statistical manipulation and explicit interpretation on a given dimension. "Thurstone Equal Appearing Interval Scale" (10), "Likert Type Scale" (11), "Q-sort Descriptions" (12), "Thematic Potential Analysis" (13), "Symbolic Metamorphic Equivalents" (14), and "Adjective, Activity and Mood Checklists" (15)(16)(17) are some of the attitude and personality assessment tests and scales suggested as applicable to the environmental analysis. The "Semantic Differential Technique" (18), a derivative of Likert Type Scale, utilizes sets of bipolar adjectival scales. Initially designed to assess human objects, this technique appears as the most useful and efficient instrument for the investigation of psychological reactions, feelings, and preferences for the architectural surrounding.

The research concerning the comprehension, description of, and reactions to the built-environment of any scale exhibits four main components: people or subjects of the research; the architectural or urban ensemble of interests; the media of presentation of this ensemble to the subjects, and the nature and format of the responses. In a research design where the stimulus, the response formats, and the media of presentation are held constant, individual and/or group differences of given sections of the population are investigated. In turn, when the research design keeps constant the respondent-groups, the media of presentation, and the format of responses, but changes the architectural stimulus, the research becomes focused on the characteristics of the stimulus itself. Factorial designs allow one to study these variables simultaneously.
5.1.2.2 Selection of the Subjects

The architect tries to accomplish better surroundings not by altering the values of the individuals, but by manipulating physical spaces and structures. He is, therefore, interested with the relation that exists between the ensemble experienced and its geometric entity. Each person possesses a different impression of the given visual object. This is due to the differences in respective "mental schematizations", "personal constructs" of the individuals, which are, in turn, a function of their particular social position, education, culture and all other prior experience. The physical surrounding will achieve different attributes depending on the individual or group who is decoding the incoming perceptual information.

If the experimenter is interested in general findings, it would be more appropriate to gather data from a representative sample of the general public. Yet, for case studies and specific purposes, data collected from particular groups of the general population should warrant investigation.

5.1.2.3 Presentation of the Stimulus

The problem, here, is how to present the independent variable to the group of respondents within a reasonable period of time and in an efficient way so that full perceptual information radiated by the display is transmitted to them. Craik (19) has tabulated most of the media of presentation that can be used in the context of environmental research.

Direct experience consists of looking at the actual surrounding, and walking or driving through or around it. The free exploration has external validity, for the situation is natural and the information received is multimodal. Yet, it is very difficult, if not impossible, to control all the variables in order to arrive at some causal relationship. Moreover, the way subjects observe and experience the given surrounding is diverse.

Different people use different exploratory and observational strategies, therefore rendering indeterminate the precise aspect of the surroundings which has been attended. The equi-
valence of presentation is, therefore, difficult to achieve. Other practical limitations of of direct mode of experience are the money and time needed to transport the group to the selected surrounding.

The simulative experience techniques try to approximate the free, in-site, observation while controlling the specific exploratory strategy of each subject. These techniques are much less expensive and more standardized. A general limitation of the simulative presentation of the environmental display is the possible degradation of the perceptual richness of the original display or surrounding. However, such techniques generate higher internal validity, and hence, allow the establishment of causal relationships between variables. "Photographic slides", either color or B/W are frequently used. The "cinematic and televised representations" possess the advantage of continuous movement (20)(21).

The popularity of "sketches, maps and drawings" stem from their traditional use in the disciplines of architecture, planning and geography. "Models" are one of the powerful simulation techniques, for they possess the additional advantage of the third dimension. The observer is able to make full use of the informational cues for space perception. Models can be observed from different angles. Besides, they allow the construction of hypothetical spaces, and easy control and manipulation of the variables. The development of miniature television cameras allow the exploration of scale-models from natural viewing positions. Other special techniques of simulation or presentation of the experimental stimulus consist of "tachistoscopic views" and "laser beam holograms". The latter almost allow full dimensional presentations (22). Finally, "computer graphics", although rudimentary today, possess the potential of systematic simulation of the built-form (23).

Given that simulative techniques fit better to the experimental conditions, further focus on their various aspects appears beneficial. Simulations allow pre-construction evaluations by representing the alternative solutions to a design problem. A prior assessment of people's reactions is, therefore, possible, and this would be of substantial help to the architect. In that context, a number of researchers have attempted to compare
responses to real architectural and natural scenes with responses to their simulative representations in terms of the connotative meanings they communicate. The validity of "slides" was investigated by Hershberger (24); Howard, Mlynarski and Sauer (25) and Peterson et al. (26); of "televised image" by Bonsteel (27) and Hershberger (28); of "models" by Lau (29) and Seaton and Collins (30). Seaton and his colleague compared simultaneously the tri-dimensional, color and B/W photograph simulations with the actual displays. Shafer et al. (31) studied the differences between reactions to actual scenes, to their color slide projections and to their color photographs. Nagase (32) compared color and B/W photographs of buildings taken from various distances. Wool's (33) compared color and B/W photographs of scale models with line drawings made from the photographs. Canter (34) and Wool's (35) also performed similar analyses. All these researchers found that simulations were related or closely related to each other and to the original display.

5.1.2.4 Nature and Format of the Evaluations

The nature of the responses, evaluations and ratings of the respondents are primarily determined by the measurement and scaling techniques (36):

. Descriptive Evaluations

Descriptions provide clues about the way in which people, internally, represent the given scene or surrounding. They are generally of a spontaneous nature and allow the development of a terminology whose accumulation would lead to an environmental vocabulary. Kasmar and Vidulich (37) developed the "Environmental Descriptive Scale" where a final set of 66 bipolar adjectives were selected from an initial list of 500 items. The scale, tested in three different rooms and on two different occasions, showed itself to be sensitive, reliable and stable.

. Global Evaluations

In order to elicit more global, unusual and subtle responses to the built-environment and landscape, techniques that had been traditionally employed for personality assessment
have been used. "Emphatic Interpretations Method", "Thematic Apperception Test", and "Symbolic and Multisensory Equivalence Tests" are such techniques. Another way of obtaining global responses consists of graphic methods in which the subject is asked to represent graphically his image and comprehension of given surroundings (38). Major disadvantages of such techniques are the differing skills of the respondents in making sketches, maps and drawings, and the individually varying capacity of visual memory.

. Inferential Evaluations

People make continual inferences about the social as well as physical surrounding in order to build theories and hypotheses about their structure and functioning. "Gough Adjective Checklists"(39), and "Guilford Consequences Test"(40) explore such inferential concepts and belief-systems about the given milieu (41).

. Attitudinal Evaluations

These are evaluations in which attitudes towards a certain concept of physical surroundings, be they architectural or natural, are more outstanding than other evaluations. Affects of the environment such as mountain scenery, urban versus pastoral values, architectural styles, air and water pollution, and aviation and freeway noise have been objects of investigations. When attitudinal reactions are studied comparatively, the research becomes transformed to measurement of preferences.

. Preferential Evaluations

Preferences are obtained by having the subjects rate an array of possible alternative or hypothetical solutions or actual surroundings. Such studies were performed for landscapes (42), residential neighborhoods (43) and camping facilities (44). Respondents either select between paired alternatives, rank in order of preference, or rate the scenes. The present study used such evaluations.
5.1.3 Standardized Adjectival Scales for Aesthetic Preference Measurement

5.1.3.1 Verbal Responses

To study the ways in which people behave or perform in some activities and tasks in or about a given architectural or urban ensemble is not of much help to the architect, since the "why" generally remains unknown. Apparently, the easiest and most direct way of deciphering the roots of people's involvement with their surroundings is to ask them what they experience, feel and think about the given aspect of the given ensemble. The advantages of the verbal mode of response are, in fact, numerous (45). First, in everyday life, words are the most common way of assessing architectural milieus and scenes. Second, words are predictors of action, precursors to subsequent behavior. People can express definite opinions about buildings, but effects of buildings on behavior are not readily observable. Third, verbalized descriptions and ratings not only help to understand nonverbal behavior, but also its actual causes. They allow insight into people's internal and subjective selves. Finally, words can be easily turned into measuring scales that allow quantification and comparison which are not possible with many other measures of human behavior.

5.1.3.2 Adjectival Vocabulary

Adjectival descriptors are the most common way that architects and laymen prefer for verbal communication about the built-environment. Such vocabulary may be compiled from architecture, design, decoration, art magazines, from related books, papers, dictionaries, advertisements, from the everyday language of painters, sculptors, real estate and building realtors, from other visual artists, specialists and art critics. Vielhauer (46) made a search for those adjective-pairs which were appropriate for the description and evaluation of the architectural space. In addition to the above sources, she used questionnaires and arrived to a final list of 197 pairs. Today, given the work of several other researchers, an exhaustive list of those adjectives applicable for architectural-meaning evaluation is available.
5.1.3.3 Scales

In order to develop verbal techniques to assess the architectural meaning, the aesthetic preferences, it becomes necessary to decipher the psychological dimensions of the architectural experience. If one can discover the interrelations of adjectives on the basis of their use in architectural evaluations, those descriptor-adjectives can be clustered to represent respective experiential dimensions of the architectural ensemble. The semantic measurement technique of Osgood and his colleagues has established the fundamentals for such methods (48). The device was presented in the form of a set of bipolar scales whose end-points were defined by adjectives of opposite meaning. The continua were transformed to a simple measure by segmenting them and assigning numbers to the segments. A 1 to 7 scoring system appears to be consistent with the number of items which a person can comprehend and compare at the one time. Besides, this division allows a half-way point for neutral judgments.


In fact, the scores obtained from a number of people on an extensive set of adjectival pairs give information about the similarities in the way that the adjectives are used. If, for instance, every time a certain architectural milieu scored "7" for how "beautiful" it was, it also scored "7" for how "friendly" it was, it can be asserted that there is a high similarity on the way these two adjectives are being used. On the other hand, if there is no such relationship, it might be said that whatever element or relation that makes a given architectural object beautiful, it does not make it friendly. If, therefore, words are being used in similar ways across a large number of situations, then the architectural meaning that underlies them tends to be the same. These lists may be used to establish the mental dimensions of the meaning of architecture (49). The approach is also theoretically supported by Kelly's "Personal Constructs Theory" (50) whose corollary states that people's construct system is composed of an infinite number of bipolar dichotomous constructs,
running from one pole to another.

Evidently, in each individual effort for the isolation of the psychological dimensions of architecture, the resulting "adjectival clusters" or dimensions depend upon the initial set of adjectives, the stimuli, and the sample of respondents on which the analysis is carried out. This fact makes it necessary for such studies to be developed in terms of threads of unity found among multiple samples of respondents, various procedures and different sets of architectural stimuli.

5.1.3.4 Adequacy of Semantic Measurement

Provided that the type of measurement is adequate for the purpose for which it is to be used, the way in which the results will be interpreted and the confidence that will be accorded to that interpretation depend upon the properties of the measuring scale. Therefore, the imperfections of the instrument should be known to avoid inadequate conclusions (51).

The validity of measurement refers to the degree to which the instrument measures what is intended. In fact, it is often difficult to be sure whether what is being measured is what the respondent actually thinks, or instead, what he thinks he has to say. The validity of the measuring instrument is also a function of the representativeness of its items. The latter can be verified by reference to other instruments whose validity is already ascertained or by comparison of the results to an external criterion. Osgood et al. (52) and Seaton and Collins (53) have investigated the validity of semantic ratings and found them to be acceptable.

The reliability of the measurement is the indication of the degree to which the scale gives consistent results. Low reliability in semantic measurement arises mainly from the fact that each respondent probably possesses slightly different understanding of the meaning of the items. To establish the reliability, measurements have to be repeated on separate occasions, but under identical conditions. The relation between results indicates the degree of reliability. Seaton and Collins (54) reviewed the reliability of seman-
tic ratings and reached positive conclusions.

The precision of the measuring device refers to its sensitivity. The precision of the judgments that human can make when using a measuring instrument is limited. Therefore, it is not logical to make the scales too precise if the user is unable to discern the intervals. As mentioned earlier, "semantic differential" has traditionally used "seven-point" scales, and this precision level was also adopted in the present research.

The convenience of use refers to the easiness and rapidity of use of the scales. Besides, the cost and the complexity of the analysis of the measuring device should be compatible with the value derived from its use. The semantic scales conform to these concepts.

The objectivity is the general requirement of the scientific approach. The way in which the instrument measures should be explicit and the way in which the respondent comes to a decision clear. Standardized questionnaires are more fruitful in this respect, for the way that the wording is presented, scored, and analyzed is apparent and consistent. With careful determination and identification of the variables to be measured, accurate selection of items, and clear and complete instructions that accompany the test-form, the adjectival semantic scales reach acceptable objectivity.
5.2 The Experiment

5.2.1 Introduction

The gradual loss of the aesthetic quality of the architectural and urban surrounding and the consequent extinction of aesthetic sensitivity have occasionally been mentioned in previous chapters. Also, Vigier (55), Stea (56), Craik (57), Canter (58), Hesselgren (59), Prak (60), and many other critics of art and architecture have, on various occasions, expressed the need for greater perceptual richness of today's visual environment. In fact, the necessity, for the architectural profession, to meet people's needs, values and expectations and provide them with aesthetic satisfaction cannot be overlooked. The achievement of such goals requires the determination of people's affective responses to buildings.

The aesthetic behavior characterizes virtually every level of human activity, so constantly and closely that we are even unconscious of its existence (61). Yet, it is commonly supposed that "aesthetics" is not amenable to measurement. Indeed, the idea of quantification in the aesthetic field has been always skeptically regarded. Architects, artists and scientists traditionally have desired to separate "questions of value" and "questions of fact". That has been, perhaps, a consequence of the romantic thought of the early XIXth century. The beginning of the present century is marked by aesthetic considerations and investigations. Drought (62) performed aesthetic experiments in 1929, Chandler and Barnhart (63) compiled a bibliography of "experimental aesthetics" in 1938, Norman and Scott (64) reviewed the effect of color in 1952. Many studies focused on the aesthetic effects of surroundings. Deutsch (65), Goldstein (66), Pierce & Weinland (67), Pressey (68) have accomplished research on the effect of the environmental "color" on the human organism. Faulkner (69) cites numerous studies centered on formal properties of "rhythm", "style", "color" and "contour", "color preference and personality", and "art therapy". Hogg's (70) work is also rich in similar topics. In the context of research related to architecture, Maslow and Mintz (71) showed that an aesthetically "pleasing" room has an effect on people's judgment of human faces that is different from the effects
of an "ugly" room. Edge (72) demonstrated that Le Corbusier's "Modular" proportion system was not essential for buildings to be aesthetically preferred.

Aesthetic studies can be segmented as those referring to "physical measurements", and those to "subjective judgments". The former approach has basically dealt with the amount of information emanating from the stimulation-pattern. Berlyne and his colleagues (73) established the importance of "complexity" and the function that links it to aesthetic preference. Wolhill (74) demonstrated the existence of some curvilinear relationships between the "judged complexity" and "aesthetic preference". Maaloe (75) related aesthetic preferences to objective mathematical variations expressed in terms of "entropy".* Although concepts like "complexity", "order", "variation", "symmetry", and "chaos", which constitute the physical parameters, are not yet adequately specified and defined, these studies appear promising. The latter approach, as in the present research, attempted to link different physical forms and visual variables to "attitudes" and "preferences". The fact that the distinction among "judgment", "attitude", "perception", "emotion", "cognition", and "preference" is not readily possible without rigorous controls gave rise to two complementary research fields: the study of the nature and dimension of the psychological response, and the investigation of the relationship between a particular psychological dimension and a particular physical correlate.

Such research possesses the potential of generating valuable information and findings before detailed architectural design is started, when different design solutions are being considered, or after the completion of the construction. The advantage of *before* design research is the possibility for providing the design with valuable information. Yet, given that what people want is dependent upon what they already have, this type of information-input runs the danger of ossifying the existing surrounding, and therefore limiting novel solutions that a creative architect could produce. In *during* design type of contribution, the alternative solutions are subjected to comparative assessment by appropriate samples of people. One alternative is selected and further developed.

* Entropy: mathematical measurement unit of order and variation. Its continuum goes from "monotony" to "chaos".
After construction efforts have the advantage of being able to use actual buildings. However, given the uniqueness of design problems, the information obtained by such studies runs the risk of being irrelevant for other cases. The present research exemplifies a "during design" type contribution.

5.2.2 The Problem

It has been established that the theories of perception adopt two contrasting but complementary views: On the one hand, the subjective variables such as socio-cultural and educational differences, and prior experience are believed to be the major factors which assist and shape the perception of and the corresponding response to the surrounding; on the other hand, the physical variables of the environmental stimulation-pattern are considered to be the main determinants of perception. The latter view also that the optical array radiating from the surrounding contains in itself the complete visual information for an adequate perception, and therefore negates any additional subjective information sources.

The implications of these two basic standpoints are incorporated in the body of the "information-processing approach" to perception. This one advances that the perception and resulting aesthetic responses are not only a function of the physical variables of the visual world, but may depend on the subjective characteristics of the perceiver. Moreover, the simultaneous and complementary roles of both physical variables and inner subjective factors have been expressed by the modern theories of emotion which consider the aesthetic-emotional response as an integration of information from both physical and cognitive sources.

This research oriented itself to the experiential qualities of the architectural stimulus and aimed to investigate possible relations between physical and qualitative dimensions of the architectural ensemble. The independent variable consisted of the "geometry of the architectural space" while the dependent measure was its possible aesthetic emotional effects. The experiment varied the geometry of the stimulus in a controlled
manner and held constant all other perceptual variables to detect a possible causal relationship. A 2 x 3 "A N O V A" (within-subjects) factorial experimental design was used. On the one hand, conditions of the "geometry" variable were manipulated; on the other hand, subject-groups having different professional backgrounds were employed to generate the data. The experiment was partially duplicated a week later. This experimental design allowed the simultaneous testing of two hypotheses:

- the aesthetic-emotional appeal of the architectural space is influenced by its geometric organization,
- professional background modifies and shapes the aesthetic experience.

Also, an account of aesthetic responses to different geometric organizations of the architectural space was obtained. The use of such research-models is believed to facilitate the decision-making task of the architect and offer him a reasonable degree of accuracy in predicting the consequences of his aesthetic manipulations.

5.2.3 Previous Relevant Research

The research relevant to the particular context of the present investigation is only 15-20 years old. Hershberger (76) focused on the issue of whether or not the architects do internally represent and respond to the architectural surrounding differently than the laymen. He compared graduating-, pre-, and non-architect students. Architects and non-architects were found to possess differences in their comprehension of the architectural surroundings, and furthermore, since pre-architects were similar to non-architects, it appeared that professional education had influenced the way of internally representing and responding the built-environment. Hershberger also established that major geographical and hence cultural differences accounted for variances on the attribution of the meaning and expressive qualities to an identical group of buildings (77). Sanoff asked two groups, one constituted of experts in design and architectural research, the other of planning students, to describe an ideal environment and rate a given visual scene on the same standardized scales. A dichotomy appeared among architects' conception of ideal
environment and their preferred ratings. A stronger relationship was seen between their 
description of "ideal" and their "least preferred" architectural scenes. Sanoff also showed 
that planning students did not substantially differ from architects when both rated existing 
environments. In general terms, architectural students were more neutral than those of 
planning; the latter responded with more varied ratings. In a different research, Canter 
(78) concluded that the variation in satisfaction-responses decreases as the individual's 
sensitivity on the given aspect of the built-environment increased. Heider and Simmel (79) 
and Michotte (80) had the subjects report their experiences with simple geometric shapes 
that had been animated. Shapes having particular movements were constantly described 
in terms that indicated "expressive qualities". Small triangles were experienced as "angry" 
or "afraid" depending upon their perceived movements. Wools (81) studied the influence 
of selected features of a room on its "friendliness" character. In the first experiment, 
"windows" and "room shape" had a significant effect while "seating arrangement" had none. 
The room shape was manipulated in terms of roof angle. The sloping ceiling was judged 
as being more friendly than the flat ceiling. In a follow-up experiment to decipher any 
interaction, only roof angle and seating arrangement were manipulated. It was found 
that the seating under the higher part of the roof was slightly more friendly than under 
the sloping half, and the interaction was found insignificant. In the second experiment, 
with student-architects as subjects instead of housewives, the seating arrangement appeared 
to be the most powerful feature in variance of judgment. The research continued in terms 
of intergroup comparisons and 1st year student-architects and 1st year student-psychologists 
were found not to differ in their ratings. At the end of the overall experiment, it was 
concluded that the "seating arrangement" was the most powerful variable for the groups 
with the exception of the housewives who, apparently, were more affected by the varia-
tions of the "roof-angle". This variable ranked second for both student-groups; it was last 
for the professional architects. The latter group was the only sample being significantly 
influenced by the "window" parameter.
5.2.4 Theoretical Basis

A need appears to construct a theory in which the inputs are various aspects of the built-environment and outputs are verbal behavior. Lee (82)(83) suggests that during the process of growing-up objects and events are mentally coded in terms of what they are and where they are. Each individual has to learn the value to himself of different stimuli he encounters and as well as their location. The storage mechanisms that guide learning and remembering do not process the information in a simple form of static accumulation of bits of knowledge. The memory has the ability of sorting so that recent information is allocated to existing material of the same sort. The information, if necessary, is duplicated and dispatched to relevant locations of the system. Each individual, therefore, possesses a unique bundle of information about aspects of the world, including the built surroundings. The inner representations, which are constructed gradually in the central nervous system, become more and more accessible as the individual develops. For each person, there must be relationships between the physical surroundings and the "mental maps" or "schemata" he has built, and a further set of relations which link the schemata to behavior. In fact, Lee shows that much behavior is consistent with these schemata which can be thought of as summaries of man's experiences with the relationships between things, activities and places. However, in order to be able to summarize these patterns of relationships, it is necessary to codify the constituent parts in some way. Yet, this appears to be a relatively complex process and it is very likely that these categories are formed along several dimensions. These relationships can be deciphered if people are asked to externalize their schemata by converting them into pictorial or verbal description (84)(85)(86).

Kelly's "Personal Constructs Theory" exhibits a similar reasoning (87)(88)(89). People possess alternatives or choices in the way they "read" their surroundings. The understanding of the environment is, therefore, dependent upon the way in which people translate it for themselves. In other words, we are in a continuous process of attempting to make sense of our surroundings, built or natural, human or non-human. We try to translate
our life and its environs into a form which we can understand. Kelly suggests that man, rather than being a physiological system, is a "scientist". His processes and intellectual behavior are psychologically channelled by the ways in which he anticipates events. Man is a predictive and a forward-looking creature whose primary interest is to search for better interpretation and understanding of events and surroundings that he experiences. He is, therefore, not inert, nor does he need to be motivated to act. He is active and the initiative is with him. He checks the sense he has made out of the world by noting how the outcome of a particular experience is useful for predicting the next one. When the prediction does not succeed, a revision needs to be made. In such a way, gradually, predictions become more anticipatory and less dogmatic. Like the scientist, man formulates theories by deduction and induction, and the recurrence of patterns evolves and begins to make sense for him, and eventually becomes his "constructs". He relies on them for his attitudes towards events and surroundings (90)(91).

Stringer (92) strengthens the present thesis's position by suggesting that people endeavour to make architectural sense of their built surroundings in the same way in which they do with the various aspects of life and world in general. Just as for the schemata, the constructs people establish internally about architectural and urban places and ensembles can be externalized by verbal and pictorial techniques. One of the corollaries of Kelly's theory states, as mentioned earlier, that person's construct-system is composed of an infinite number of dichotomous sub-constructs. Those can be conceptualized as bipolar continua. For instance, such a dimension for "color" would be "hot-cold", red hue relating to hot pole and blue hue to the cold pole.

Hinkle (93) notes that constructs possess hierarchical relationships with each other. Some constructs, hence, include others as components contributory to their overall context. The graduate of Beaux-Arts tradition, he says, might construe an architectural ensemble as being a "fine piece of architecture". The basis on which he considers it so might be due to its "balanced proportions" or "delicate detailing" or some other quality. Each of these would be subordinate constructs within the overall context of the super-
ordinate construct "fine architecture in Beaux-Arts tradition." Similarly color will have
an infinite number of other continua such as "dark-light", "active-passive", or "calm-
brutal" along which it can be internally represented.

Studies aimed at discovering the underlying experiential dimensions of architecture
are, therefore, a search for superordinate and subordinate constructs. Vielhauer (94),
Hershberger (95)(96), Collins (97), Craik (98), Black (99), Cass & Hershberger (100),
Brittell (101), Janiskee (102), and Sanoff (103) in America; Canter (104)(105), Woolf (106),
Kuller (107), Acker (108), Walters (109), and Building Performance Research Unit (110)
in Europe made use of factor analytic statistical procedures to analyze the adjectival
ratings of groups of respondents and to decipher the clusters of adjectives representing
distinct constructs. These efforts stem from the work of Osgood et al. (111) who developed
the "semantic differential" as a measuring instrument of meaning. The validity of the
elicited dimensions was tested in Swedish by Acker (112), in Japanese by Ichikawa (113),
in German and Spanish by Canter et al. (114) and in Turkish by Krampen et al. (115).
The majority of these studies have shown that, within the architectural context, the most
powerful construct or phenomenological dimension was an "aesthetic/pleasantness"
one, the rest maintained an evaluative flavor. A total of 20 dimensions are now estab-
lished (Table I).

Table 1 Hierarchy of Psychological Dimensions of Architecture

<table>
<thead>
<tr>
<th>1. Aesthetic Appeal</th>
<th>11. Lighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Friendliness</td>
<td>12. Privacy</td>
</tr>
<tr>
<td>3. Organization</td>
<td>13. Shape</td>
</tr>
<tr>
<td>5. Space</td>
<td>15. Noise</td>
</tr>
<tr>
<td>6. Ornate</td>
<td>16. Rigidity</td>
</tr>
<tr>
<td>7. Coloring</td>
<td>17. Formality</td>
</tr>
<tr>
<td>8. Neatness</td>
<td>18. Texture</td>
</tr>
<tr>
<td>10. Temperature</td>
<td>20. Utility</td>
</tr>
</tbody>
</table>

Source: Hershberger, 1972
5.2.5 Method

5.2.5.1 Subjects

Thirty-four graduate students of Rice University, Texas volunteered for the experiment. The subjects were in two groups. The first group was composed of 17 students whose undergraduate and graduate major was "chemistry", and the second group of 17 students whose undergraduate and graduate major was "architecture". All the subjects were native white Americans. There were four females and 13 males in each group. The average total years of professional education was 6.88 for Chemists and 6.09 for Architects. The subjects were between 22 and 35 years of age and the mean ages were 25.6 and 25.2 for the Chemists and the Architects, respectively. Major geographical and social differences were avoided. All the subjects were fully informed about the nature and purpose of the experiment.

5.2.5.2 Measuring Instrument

The crux of the construction of the measuring instrument was to decipher the list of adjectives which represent and describe the aesthetic dimension of the architectural meaning. "Aesthetic appeal" had appeared as the most easily identifiable and powerful psychological dimension of architecture in a significant majority of the previous researches. Measurements performed on the aesthetic as well as other dimensions were found to possess "reliability", "validity", and "comparability". Canter (116) adds that a certain fuzziness may exist on ratings made by the same person on different occasions (Fig. 1).

![Diagram]

pleasant :________:________:________:________:________: unpleasant
good :________:________:________:________:________: bad

Fig. 1 Fuzziness of adjectival ratings (Canter, 1967).

Yet, having admitted that the fuzzinesses are normally distributed, the errors will balance
each other when the ratings of several scales are added together. Therefore, the more adjectival scales that are used to represent a certain dimension, the more likely are the fuzzinesses to cancel out.

The scales used in the present research were compiled from those that previous studies had established as representing the aesthetic dimension of the built-environment (Table 2). Scales with significantly low loadings on factor analyses, those which shared significant loads on other dimensions, and those with rare occurrence among different studies were eliminated and a final list of 26 adjectives was obtained (Appendix 1). Instead of using bipolar scales where two contrasted, opposite or antonym adjectives delimit the end-points, single adjectives were employed to represent each scale. This was done to avoid any possible confounding that might be due to the appearance of parasite-scales which, in turn, are due to the indefiniteness of antonyms. In fact, while scales, such as "light-dark", used to describe the perception of physical properties appear to lie on a linear continuum, this may possibly not be the case for emotive scales, such as "kind-cruel", that seem to define several latent scales such as "kind-not kind", "cruel-not cruel" (117). The use of the findings of various researches done in different places, with different subjects and different environmental displays, contributed to the establishment of a cross-culturally and cross-architecturally validated aesthetic dimension structure.

The test-booklet was composed of four sections. The first section included an explanation of the nature and purpose of the experiment as well as the general instructions about the use of the measuring instrument. The second section consisted of "personal identification and background" questions. The third part comprised the rating scales and additional instructions and information concerning the sequence to be followed during the ratings. The final part of the test was made up of two questions in which the respondents were asked to rank the stimuli, respectively, according to their "overall aesthetic impression" and their "inclination to move into them" (Appendix 1).
Table 2. "Aesthetic" Scale—Structure of II Researchers (summarized)* (see p. 116 for references).

<table>
<thead>
<tr>
<th>Walters</th>
<th>Vielhauer</th>
<th>Canter</th>
<th>Craik**</th>
<th>Collins</th>
<th>Janiskee</th>
<th>Brittell</th>
<th>Hershberger</th>
<th>Kuller**</th>
<th>Sanoff***</th>
<th>BPRU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impressive</td>
<td>Appealing</td>
<td>Interesting</td>
<td>Different</td>
<td>Interesting</td>
<td>Inspiring</td>
<td>Unique</td>
<td>Beautiful</td>
<td>Stimulating</td>
<td>Interesting</td>
<td>Pleasant</td>
</tr>
<tr>
<td>Interesting</td>
<td>Stylish</td>
<td>Characterful</td>
<td>Inviting</td>
<td>Beautiful</td>
<td>Attractive</td>
<td>Exciting</td>
<td>Secure</td>
<td>Exhilarating</td>
<td>Lively</td>
<td>Beautiful</td>
</tr>
<tr>
<td>Live</td>
<td>Attractive</td>
<td>Uplifting</td>
<td>Dynamic</td>
<td>Exciting</td>
<td>Inspiring</td>
<td>Interesting</td>
<td>Interesting</td>
<td>Stimulating</td>
<td>Impressive</td>
<td>Lively</td>
</tr>
<tr>
<td>Good</td>
<td>Cheerful</td>
<td>Fine</td>
<td>Interesting</td>
<td>Dynamic</td>
<td>Unique</td>
<td>Amazing</td>
<td>Interesting</td>
<td>Novel</td>
<td>Impressive</td>
<td>Interesting</td>
</tr>
<tr>
<td>Sophisticated</td>
<td>Fashionable</td>
<td>Active</td>
<td>Characterful</td>
<td>Expressive</td>
<td>Unique</td>
<td>Attractive</td>
<td>Secure</td>
<td>Sensuous</td>
<td>Impressive</td>
<td>Good</td>
</tr>
<tr>
<td>Pleasant</td>
<td>Inviting</td>
<td>Unique</td>
<td>Expressive</td>
<td>Unique</td>
<td>Bright</td>
<td>Exciting</td>
<td>Idyllic</td>
<td>Stimulating</td>
<td>High</td>
<td>Interesting</td>
</tr>
<tr>
<td>Vibrant</td>
<td>Tasteful</td>
<td>Bright</td>
<td>Expressive</td>
<td>Unique</td>
<td>Lively</td>
<td>Exciting</td>
<td>Good</td>
<td>Novel</td>
<td>Sensuous</td>
<td>Intimate</td>
</tr>
<tr>
<td>Beautiful</td>
<td>Sparkling</td>
<td>Lively</td>
<td>Expressive</td>
<td>Interesting</td>
<td>Pleasant</td>
<td>Interesting</td>
<td>Gentle</td>
<td>Stimulating</td>
<td>Intimate</td>
<td></td>
</tr>
<tr>
<td>Subtle</td>
<td>Beautiful</td>
<td>Happy</td>
<td>Interesting</td>
<td>Unique</td>
<td>Unique</td>
<td>Expressive</td>
<td>Good</td>
<td>Dynamic</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Unique</td>
<td>Elegant</td>
<td>Distinctive</td>
<td>Consolating</td>
<td>Interesting</td>
<td>Consoling</td>
<td>Expressive</td>
<td>Pleasant</td>
<td>Intimate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Colorful</td>
<td>Glamorous</td>
<td>Unique</td>
<td>Unique</td>
<td>Interesting</td>
<td>Consoling</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Repetition of the same author refers to different studies.
** Adjectives appeared in negative form are converted to positive form.
*** Scales appeared in other form than adjectives are converted to adjectives.
5.2.5.3 Stimulus - Conditions

The independent variable consisted of three conditions of the "geometry" of the architectural space, rectangular, circular and angular. The experimental manipulation was accomplished by means of 1/20 (metric) scale-model simulations. Hence, there were three models, one for each condition. The models simulated fictitious office-spaces. Offices were selected, for their space and furniture arrangements have acquired a certain standardization. Each accommodation consisted of three interrelated spaces, one major and two minors, corresponding to the rooms of the boss, secretary and visitors, respectively. The ceilings were left open to allow light in the spaces. Although bird's-eye contemplation was possible, the respondents were encouraged to make natural eye-level observations using the window openings at the perimeter walls. All the physical and perceptual variables, with the exception of the manipulated one, were kept constant across the conditions (Fig. 2). The simulation-models, including their furniture, were built by the same craftsman using the same material. "Color" and "texture", and the quality of the craftsmanship were, therefore, identical for all the conditions. The "illumination" was equivalent for each model. Artificial upper fluorescent light was used. Each model was receiving the same amount of light from the same direction, and was consequently subject to equivalent "shadow" effects. The "size" variables such as "floor surface", "perimeter", "height", and "volume" were approximately the same for all the conditions. Furthermore, the furniture elements were equated in all aspects, except their geometry which conformed with the geometry-condition to which they were appertaining (Appendix 2).

The simulations were generated from "pregnant" forms. Hence, the circular model consisted of three interlocked circles, the angular condition of three equilateral triangles, and the rectangular condition of three squares. The use of pregnant forms aimed at the control of confounding effects that might possibly result from differing visual complexity of the respective conditions. The pregnant forms are demonstrated to be perceived easily and rapidly, and to possess the same degree of visual information and complexity. The inter-relations of the three spaces of each display were also identical. Therefore, the indepen-
Fig. 2 Stimulus-conditions
(See Appendix 2).
dent variable conditions were equated on all "Gestalt factors of formal organization". The pregnant directions, the vertical and the horizontal planes, both for the spaces and the furniture, were left intact. Hence, the geometric manipulation was made only in two dimensions.

The representativeness of scale-model simulations was thoroughly investigated by Lau (117). He compared full-scale make-ups and scale-model simulations in a study on "pleasantness and gloom elicited by the lighting quality of bedrooms". The analysis indicated that the observers tend to be even more constant on assessments of scale-models than full-size rooms. High correlations were found between the two modes of presentation.

5.2.5.4 Experimental Room

Experiments were run in a room at the School of Architecture, Rice University, Houston, Texas. The displays were placed on the top of three similar black tables \((26'' \times 26'' \times 50'')\) high enough to allow the subjects to observe and experience the stimuli at the natural eye-level. The perimeter of the tables was free to permit the subjects to move around and look at the displays from different angles and directions. Each table was visually isolated from the others by means of black partitions so that the displays could not been seen simultaneously. Additional partitions were provided to separate the rating-area from the rest of the room where the subjects were admitted and waited for the test. Except the desk and chairs for the experimenter and waiting participants, no other visual and non-visual stimuli were present in the room (Fig. 3).

![Fig. 3 Experimental room (Scale: 1/120 metric).](image)
5.2.5.5 Experimental Manipulation

The experiment comprised two groups of respondents and three conditions of the independent variable. A 2x3 factorial "within-subject" design was used. The administration of the experiment lasted a day for each group. The first session was run with the Architects, and the second, the following day, with the Chemists. The respondent who was taken into the experimental room was presented with the test-booklet and allowed enough time to fill in the personal information, read the instructions, and familiarize himself with the rating-scales. Additional verbal instructions were provided if necessary. The subjects were also encouraged to ask questions in case of hesitation during the experiment.

The subjects entered the rating-area one at a time and performed the experiment in accordance with the sequence described within the test-booklet (Appendix I). The sequence in which each respondent rated the displays was changed in order to accomplish a complete "counterbalancing". After completing the rating and ranking of the stimuli, the subject left the rating-area. He was then asked not to communicate any information concerning the experiment to the rest of the participants. The time used by the subjects to accomplish the rating and ranking tasks ranged from 10 to 20 minutes. A week later, the Architects repeated the experiment under similar conditions.

5.2.6 Results

The rating instrument had 26 adjectival scales, each one with a weight from 1 to 7. Thus, a minimum score of 26 and a maximum score of 182 was possible for each subject on each geometric condition (Figs.4,5)(Appendix 3).

A 2x3 factorial ANOVA was performed on the data (118)(119). The condition-effect was found very significant (p < .001), whereas the group-effect was not. The results indicated that Architecture and Chemistry students did not significantly differ in their overall evaluation, while the geometric manipulation was very effective, the groups being taken together (Table 3). The results of ANOVA also showed a significant interaction (p < .025)
Fig. 4 Three-dimensional representation of group-totals.
<table>
<thead>
<tr>
<th></th>
<th>architects</th>
<th></th>
<th></th>
<th>chemists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensuous</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>01</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Impressive</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>02</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Interesting</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>03</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Sophisticated</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>04</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Pleasant</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>05</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Beautiful</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>06</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Subtle</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>07</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Unique</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>08</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Appealing</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>09</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Stylish</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>10</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Attractive</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>11</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Cheerful</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>12</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Fashionable</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>13</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Inviting</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>14</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Tasteful</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>15</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Elegant</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>16</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Uplifting</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>17</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Peaceful</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>18</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Bright</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>19</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Lively</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>20</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Exciting</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>21</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Expressive</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>22</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Inspiring</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>23</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Idyllic</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>24</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Exhilarating</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>25</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Lovable</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>26</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

Fig. 5 Group profiles (scores averaged on each scale).
Table 3. Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>ms</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>91,148.70</td>
<td>101</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Between S</td>
<td>35,012.70</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Groups</td>
<td>84.80</td>
<td>1</td>
<td>84.80</td>
<td>nonsignificant</td>
<td>-</td>
</tr>
<tr>
<td>Error (b)</td>
<td>34,927.90</td>
<td>32</td>
<td>1091.47</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Within S</td>
<td>56,136.00</td>
<td>68</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Geometry</td>
<td>20,195.10</td>
<td>2</td>
<td>10097.55</td>
<td>20.48 &lt;.001</td>
<td></td>
</tr>
<tr>
<td>Geo x Group</td>
<td>4,381.30</td>
<td>2</td>
<td>2190.65</td>
<td>4.44 &lt;.025</td>
<td></td>
</tr>
<tr>
<td>Error (w)</td>
<td>31,559.60</td>
<td>64</td>
<td>493.12</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

between factors. Therefore, further analyses for simple effects were performed on the means.

The significant main-effect for "geometry-condition" signaled that of the three geometric conditions, at least two differ significantly. The purpose of the first step of the supplemental computation was to determine which specific pairs differ when the data from both groups were taken together. The "Newman-Keuls' Test" was applied to analyze these possible differences (Table 4). All pairs were found significantly different from each other, however with differing levels of significance. In fact, it appeared that "▲" versus "■" and "▲" versus "●" conditions yielded more significant differences (p < .01) than "▲" versus "●" conditions (p < .05). Inter-condition differences were, therefore, all significant, and the circular space-system ranked first, the triangular second, and the rectangular third*.

The next computational step analyzed again the inter-condition simple-effects, this time the groups being taken separately (Table 5). The "Newman-Keuls' Test" was used and significant differences were obtained between "▲" versus "■" and "●" versus "■" conditions for Architects (p < .01), while "▲" versus "●" conditions appeared to be nonsignificant. The Architects equally preferred the "▲" and "●" conditions whereas the "■" condition was attributed significantly lower ratings. The Chemists' means were significantly different

* ▲ angular, ■ rectangular, ● circular.
Table 4. Simple Inter-condition Effects
(both groups taken together)

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Difference of Means</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;▲&quot; versus &quot;■&quot;</td>
<td>22.77</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>&quot;▲&quot; versus &quot;●&quot;</td>
<td>11.03</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>&quot;■&quot; versus &quot;●&quot;</td>
<td>33.80</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

Table 5. Simple Inter-condition Effects
(groups taken separately)

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Difference of Means</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>A R</td>
<td>&quot;▲&quot; versus &quot;■&quot;</td>
<td>23.17</td>
</tr>
<tr>
<td>C H</td>
<td>&quot;▲&quot; versus &quot;●&quot;</td>
<td>3.12</td>
</tr>
<tr>
<td>H I T</td>
<td>&quot;●&quot; versus &quot;■&quot;</td>
<td>20.05</td>
</tr>
<tr>
<td>C H</td>
<td>&quot;▲&quot; versus &quot;■&quot;</td>
<td>22.35</td>
</tr>
<tr>
<td>E M I S</td>
<td>&quot;▲&quot; versus &quot;●&quot;</td>
<td>25.18</td>
</tr>
<tr>
<td>M I S</td>
<td>&quot;●&quot; versus &quot;■&quot;</td>
<td>47.53</td>
</tr>
</tbody>
</table>

from each other for all conditions (p < .01). The circular space was attributed the highest score, while the rectangular one was again the least preferred.

Further F tests were performed to find whether Architects and Chemists differ significantly on any of the geometric manipulations. A separate test was computed for each condition (Tables 6, 7, 8). It was found that the group means were suggestively different for only the "●" condition (p < .1). Chemists rated the circular space organization higher than Architects.

In order to have a measure of the validity of the rating-scales, the data of each subject were transformed into rank format, and then compared with the rankings obtained from the first question of the Section 4 of the test. This question consisted of ranking the
Table 6. Simple Inter-group Effects
Condition "△"

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>ms</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>24,099.53</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Between S</td>
<td>1,129.87</td>
<td>1</td>
<td>1,129.87</td>
<td>1.57</td>
<td>nonsignificant</td>
</tr>
<tr>
<td>Within S</td>
<td>22,969.66</td>
<td>32</td>
<td>717.80</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 7. Simple Inter-group Effects
Condition "□"

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>ms</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>21,933.77</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Between S</td>
<td>974.24</td>
<td>1</td>
<td>974.24</td>
<td>1.49</td>
<td>nonsignificant</td>
</tr>
<tr>
<td>Within S</td>
<td>20,959.53</td>
<td>32</td>
<td>654.99</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 8. Simple Inter-group Effects
Condition "○"

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>ms</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>24,920.27</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Between S</td>
<td>2,388.97</td>
<td>1</td>
<td>2.388.97</td>
<td>3.29</td>
<td>&lt; .1</td>
</tr>
<tr>
<td>Within S</td>
<td>22,531.30</td>
<td>32</td>
<td>704.09</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

displays in terms of "overall aesthetic preference". Twelve Chemists yielded a perfect positive correlation \((r = 1.00)\) between their two different rankings, one subject's rankings were negatively correlated \((r = -1.00)\), and the rest exhibited moderate correlations. These results indicated that the validity of the rating-scales was acceptable. However, the rankings of the Architects did not yield any significant relation. Nevertheless, this outcome was rather expected, architects being conditioned by various and contradictory aesthetic considerations.

In order to see the degree to which the aesthetic appeal influences one's decision to move into an architectural space, "Spearman Rank Order correlation" was also computed
between the rankings obtained from the first and second questions of the Section 4 of the experiment. The second question consisted of ranking the displays according to the "inclination to move into them". The rankings of 10 Chemists showed a perfect correlation (r = 1.00), the others being moderately correlated. No negative correlation was present. As expected, no significant relation was detected between two different rankings of Architects.

To obtain a measure of the reliability of the scales, the data of the architectural group generated in two different occasions, but in identical conditions, were analyzed. For that purpose, the experiment was readministered to the Architects a week later. The "Pearson Product-Moment correlation" coefficients for all three conditions were found very significant (p < .001) (Table 9), indicating that the scales were reliable.

Finally, the average standard deviations of the groups were computed. The Architects (s = 23.46) appeared more neutral than the Chemists (s = 28.80), who exhibited more variance in their adjectival ratings.

Table 9 Pearson Correlation Coefficients Obtained from Two Different Rating-Sessions (Architects)

<table>
<thead>
<tr>
<th></th>
<th>&quot;▲&quot;</th>
<th>&quot;■&quot;</th>
<th>&quot;●&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>.93</td>
<td>.83</td>
<td>.91</td>
</tr>
<tr>
<td>p</td>
<td>&lt; .001</td>
<td>&lt; .001</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>
SUMMARY & CONCLUSION

The present dissertation investigated the aesthetic arousal in function of both subjective variables of different groups of people and various geometric organizations of simulated architectural spaces. Moreover, substantial material was included for a comprehensive account of the topics which appear to relate to and constitute the reference-frame of aesthetic-psychological-experiential considerations in Architecture.

Three geometric conditions, that is "triangular", "rectangular" and "circular" space-systems, were made equivalent in all aspects. A group of Architecture, and another of Chemistry graduate students rated these model-displays on adjectival scales which were designed to represent the aesthetic dimension of Architecture. The main-effect elicited by the different geometric conditions was significant at very high levels, indicating that the geometry variable of the architectural form and space possesses a pronounced aesthetic potential. On the other hand, the main inter-group effect was absent. Although the groups differed in terms of their professional education, the values they each held were not divergent enough to yield significant differences on their overall averaged evaluation of the geometric conditions. However, the appearance of a significant interaction-effect indicated that, still, the groups possess slight differences to elicit simple-effects. Although the difference was suggestive rather than significant, Chemists rated the circular condition higher than Architects. The intra-group results paralleled this outcome. While Architects did not show any difference of aesthetic preference between the triangular and circular conditions, Chemists appeared to prefer the latter significantly more than the former. For both groups, the rectangular space organization
was the least preferred one.

The comparison of the scores yielded by the adjectival ratings and those generated by aesthetic preference rankings revealed that Chemists exhibit consistent relations between the two modes of measurement, while that was not the case for Architects. Apparently, the cause of that outcome was that Architects were conditioned by their professional education during which they have been fed with contrasting aesthetic concepts. Parallel results were found when the adjectival ratings were compared with the scores obtained from the second ranking question that consisted of ordering the displays according to the inclination that one has to move into them. These findings support Sanoff's (1) conclusion stating that what architects indicated as "ideal" turned out to be substantially different from their "preferred" environmental scenes. A stronger relationship was detected between their "ideal" and "least preferred" scenes. The results of both my own and Sanoff's researches show the value-gap that exists between the professional and the section of people he serves.

The standard deviations averaged across the overall ratings of each group indicated that Chemists were more variable than Architects. This outcome is in accordance with Canter's (2) finding which established that variations in responses of groups of people decreases as the "sensitivity" of the group members increases. The implication of this particular outcome is that using insensitive people for such measurements will complicate the demonstration of significant differences between different conditions of the experimental manipulation.

In the context of the present research, the conclusion was reached that both the geometric organization of the architectural space and the professional education of people interplay to shape the aesthetic response, the effect of the former being much more pronounced than that of the latter. The unfamiliar geometric organizations, that is to say curvilinear and angular layouts, were aesthetically preferred over the right-angle intersection, a result which implies that people, including architects, adopt to the famil-
iar configurations, and consequently, are willing to attend unexperienced, original and novel spatial relations. The study also showed that, all other things being equal, layman's aesthetic preference for an architectural place was a significant predictor of his decision to buy, rent, use or frequent this place.
DISCUSSION

This and similar researches cannot yield absolute findings. In the context of the present study, a multitude of other subject-groups could be used; different subject-variables could be focused on; and a number of other geometric manipulations could be made. Furthermore, the simultaneous effects of several visual variables could be investigated to arrive at a more global estimate of the aesthetic appeal. Generally, the particular manipulation will be dictated by the unique character of the problem under study. However, additional follow-up studies may possibly enlighten other general issues. Were the results obtained short-term effects? Would the subjects adapt to the displays and would therefore the initial effects be altered? Would the most preferred geometric organization still be so after it became familiar? Or should the architectural structures be made flexible and versatile so that they could be geometrically altered from time to time?

The present study yields implications for establishing the degree to which the professional and the layman agree or disagree on experiential issues concerning Architecture. Also, it demonstrates that even the most conjectural aspects of Architecture are amenable to scientific research whose results may be of significant value in effecting a more satisfactory perceptual impact of Architecture. Finally, it shows a new way of comparing architectural products and generating "during-design" information to facilitate the decision-making task of the architect. However, it should not be expected that the information collected by the application of such models will drastically determine the architectural design decisions. The goal is rather to guide, to equip the architect with a new bundle of information which will give him an idea of the nature of the reaction of the
prospective users, visitors, observers and by-standers to the prospective architectural product. In fact, the role of the architect in the contemporary society is in a process of change. The profession should recognize the preferences, needs and desires of its clientele, be it a single family, be it a whole town. It is by gradual accumulation of researches paralleling the one presented here that chains of cause-effect relationships can be generated, unified, and put at the service of architects and the people they design for.
REFERENCES

Introduction


(5) Walter, E. V. "Dreadful Enclosures: Deoxifying an Urban Myth" (Paper), City University of New York, June 1972.


Introduction (cont'd.)


(20) Vielhauer, J. A. "The Development of a Semantic Scale for the Description of the Physical Environment" (PhD thesis), Louisiana State University, 1965.


(29) Craik, K. H. ibid.

Chapter 1


(3) Sargent II, F. ibid.
Chapter 1 (cont'd.)


(10) Yucel, A. Tasarlama ve Cevre Sorunlari, Istanbul Technical University, Department of Architecture, 1971, p.32.


(12) CIB Bulletin, No 1 and 2, 1966. (Congrès International du Bâtiment)


Chapter 1 (cont'd.)

(26) Sargent II, F.  ibid. p.2.


(40) Canter, D.  "Should we Treat Building Users as Subjects or Objects?", Architectural Psychology: Dalandhui Conference, Glasgow, University of Stratchlyde, 1969.


Chapter 2

Chapter 2 (cont'd.)


(8) Lang, J. "Theories of Perception and Formal Design", in Designing for Human Behavior, J. Lang et al. (Eds), Stroudsburg, Penn., Dowden, 1974, p.99.


(10) Boring, E. G. ibid.


(21) Gibson, J. J. ibid.

(22) Breitmeyer, B ibid.


(24) Haber, R. N. & Hershenson, M. ibid. pp.177-183.
Chapter 2 (cont'd.)


(28) Hochberg, J. E. ibid. p. 58.


(30) Rubin, E. Visuell Wahrgenommene Figuren, Copenhagen, Glyndandske, 1921.


(33) Lang, J. ibid. pp. 102-104.

(34) Haber, R. N. & Hershenson, M. ibid. pp. 188-191.


(38) Haber, R. N. & Hershenson, M. ibid. pp. 153-175.


(41) Haber, R. N. & Hershenson, M. ibid. p. 204.


(45) Haber, R. N. & Hershenson, M. ibid. p. 279.


Chapter 2 (cont'd.)

(49) Breitmeyer, B. ibid.


(52) Haber, R. N. & Hershenson, M. ibid. pp.266-272.


(60) Piaget, J. & Inhelder, B. ibid.


Chapter 3


Chapter 3 (cont'd.)


(8) Norberg-Schulz, C. ibid. p.163.


(19) Homer The Odyssey, (translated by E. V. Rieu), IX, Middlesex, Harmondsworth, 1948, p.144.

(20) Prak, N. L. ibid.


Chapter 4


(4) Huyghe, R. ibid.
(6) Krauss, F. *Paestum, the Greek Temple*, Berlin, Mann, 1941.
(7) Hesselgren, S. ibid.
(16) Breitholtz, N. *Swedish Psychological Pedagogic Dictionary III*.
Chapter 5


Chapter 5 (cont'd.)

(6) Proshansky, H. M.  "Environmental Psychology and the Design Profession", in Designing for Human Behavior, J. Lang et al. (Eds), Stroudsbourg, Penn., Dowden, 1975, pp.77-78.


(9) Goodrich, R. J.  "Surveys, Questionnaires and Interviews", in Designing for Human Behavior, J. Lang et al. (Eds), Stroudsbourg, Penn. 1974, p. 234.


(19) Craik, K. H. ibid.

(20) Rose, S. W.  "A Notational- Simulation Process for Composers of Space", University of Nebraska, 1966.


Chapter 5 (cont'd.)

(24) Hershberger, R. G. "Predicting the Meaning of Architecture", in Designing for Human Behavior, J. Lang et al. (Eds), Stroudsbourg, Penn., Dowgen, 1974, pp. 147-156.


(28) Hershberger, R. ibid.


(40) Christensen, P. R. Consequences Test, Calif., Sheridan, 1958.

Chapter 5 (cont'd.)


(47) Kasmar, J. V. ibid.

(48) Osgood, C. E. et al. ibid.

(49) Canter, D. ibid.


(52) Osgood, C. E. et al. ibid.

(53) Seaton, R. W. & Collins, J. B. ibid.

(54) Seaton, R. W. & Collins, J. B. ibid.


(57) Craik, K. H. ibid.


Chapter 5 (cont'd.)


Chapter 5 (cont'd.)


(85) Lynch, K. ibid.


(87) Kelly, G. ibid.


(94) Vielhauer, J. A. ibid.


Chapter 5 (cont'd.)


(103) Sanoff, H. ibid. pp.244-260.

(104) Canter, D. ibid.


(109) Walters, D. (Unpublished study carried out at Birmingham School of Architecture)

(110) BPRU (Building Performance Research Unit) (Unpublished studies), Glasgow, University of Strathclyde.

(111) Osgood, C. E. ibid.

(112) Acking, C-A. (Unpublished studies), Lund Institute of Technology, Dept. of Theoretical and Applied Aesthetics.


Conclusion


APPENDIX I

TEST BOOKLET

Section 1: General Instructions

This experiment is part of a doctoral dissertation in Architecture. Its purpose is to study systematically the aesthetic appeal elicited by three architectural space-systems, each having different geometric organizations.

Each display is a 20 times reduced model-simulation of a portion of a fictitious office building. Each of them is constituted of three interrelated spaces, a large office and smaller secretary and waiting rooms, respectively. You will rate separately each of the displays on seven-point adjectival scales. Each adjective defines a scale on which you will evaluate the display by encircling the number that best indicates your judgment. For instance,

![Scale Diagram]

It is known that subjects are hesitant to give extreme ratings at the end-points of such scales. This bias tends to move all the ratings towards the middle of the scales. Hence, do not hesitate to use the ends of the scales if such judgments reflect your true reactions. Raters are also seen to possess an inclination of responding either at the high-end or low-end of the adjectival scales. Do not be afraid to use both sides and do not limit yourself to use only a few of the numbered categories. All seven steps are to be used. Rate each scale individually and do not be concerned about how frequently you use a particular number as long as it is your true judgment. Make only a single rating on
each scale and do not omit any. Also, do not skip from one scale to another out of order.

The adjectives are selected as representing the aesthetic dimension on which people internally represent and describe the built-environment. Be aware, therefore, that you are required to rate the displays only according to your aesthetic preferences. Do not pay attention to functional, technical and economic suitability.

The Section 2 is composed of some routine questions about you and your background. As soon as you finish them, go on to Section 3 and read its instructions. Then, look at the rating-scales in order to check whether or not you know the correct meaning of the adjectives defining the scales. If not, refer to the dictionary available in the room.

Before beginning the ratings, go back to Section 1 and to the instructions of Section 3 and read them over until you are sure that you fully understand the procedure of the experiment. A study that has taken years will partially depend upon your ratings. Therefore, your attention and collaboration are strongly needed. Please, be careful and feel free to ask questions to experimenter during the experiment. Do nor forget to complete the Section 4 before returning the booklet.
Section 2: Subject Identification and Background

Name, Last name: ____________________________
Age: ____________________________
Sex: M F (encircle one)
Race: ____________________________
Place of Birth: ____________________________ (State only)
Citizenship: ____________________________

Undergraduate Major: ____________________________
College/University (undergraduate): ____________________________ (name and State)
Graduate Major: ____________________________
College/University (graduate): ____________________________ (name and State)
Total Years of College/University Education: ____________________________

If, after 7 years of age, you have spent, for any reason, more that a year in States and Countries other than those of your birthplace and undergraduate and graduate studies, please list them below:

<table>
<thead>
<tr>
<th>Place (Country or US State)</th>
<th>Date (year) from to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section 3: Aesthetic Preference Ratings

A separate rating-scale sheet is provided for each display-model. Be sure to match the display-symbol (□, △, and ○) printed at the upper right corner of each rating sheet with those posted on the respective tables on which the models are exhibited. The order you will follow to visit and rate the displays is, therefore, determined by the sequence in which your rating-sheets are inserted in this booklet. However, just before the rating session, you are allowed to visit the display in any order you desire. Do not spend more than 30 seconds per display during this first acquaintance.

While rating the models, move around them and observe them from different angles and directions. Adjust your eye-level in order to experience them from natural angles as in real rooms. Make your ratings fairly quickly, but do not be careless. As soon as you complete the rating of a display, check if you have omitted any scale or made double-marks on a single scale. Do not forget to review Section 1 and the above instructions before beginning to rate the models.
| 01 | SENSUOUS       | 1 2 3 4 5 6 7 |
| 02 | IMPRESSIVE     | 1 2 3 4 5 6 7 |
| 03 | INTERESTING    | 1 2 3 4 5 6 7 |
| 04 | SOPHISTICATED  | 1 2 3 4 5 6 7 |
| 05 | PLEASANT       | 1 2 3 4 5 6 7 |
| 06 | BEAUTIFUL      | 1 2 3 4 5 6 7 |
| 07 | SUBTLE         | 1 2 3 4 5 6 7 |
| 08 | UNIQUE         | 1 2 3 4 5 6 7 |
| 09 | APPEALING      | 1 2 3 4 5 6 7 |
| 10 | STYLISH        | 1 2 3 4 5 6 7 |
| 11 | ATTRACTIVE     | 1 2 3 4 5 6 7 |
| 12 | CHEERFUL       | 1 2 3 4 5 6 7 |
| 13 | FASHIONABLE    | 1 2 3 4 5 6 7 |
| 14 | INVITING       | 1 2 3 4 5 6 7 |
| 15 | TASTEFUL       | 1 2 3 4 5 6 7 |
| 16 | ELEGANT        | 1 2 3 4 5 6 7 |
| 17 | UPLIFTING      | 1 2 3 4 5 6 7 |
| 18 | FINE           | 1 2 3 4 5 6 7 |
| 19 | BRIGHT         | 1 2 3 4 5 6 7 |
| 20 | LIVELY         | 1 2 3 4 5 6 7 |
| 21 | EXCITING       | 1 2 3 4 5 6 7 |
| 22 | EXPRESSIVE     | 1 2 3 4 5 6 7 |
| 23 | INSPIRING      | 1 2 3 4 5 6 7 |
| 24 | IDYLLIC        | 1 2 3 4 5 6 7 |
| 25 | EXHILARATING   | 1 2 3 4 5 6 7 |
| 26 | LIKEABLE       | 1 2 3 4 5 6 7 |
Section 4: General Preference Ratings

This final section consists of two preference ranking questions. You are now free to visit the booths in the order you desire and as many times as you want.

Question 1:
Rank the displays according to your overall aesthetic preference. The first rank stands for the most preferred, the second for the moderately preferred, and the third for the least preferred. Encircle your choice for each rank.

<table>
<thead>
<tr>
<th>Rank</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>■</td>
<td>●</td>
</tr>
<tr>
<td>2nd</td>
<td>■</td>
<td>●</td>
</tr>
<tr>
<td>3rd</td>
<td>■</td>
<td>●</td>
</tr>
</tbody>
</table>

Question 2:
Rank the displays according to your inclination to move into them. The first rank stands for the one you are most inclined to move into, the second rank for the one you are moderately inclined to move into, and the third rank for the one you are least inclined to move into. Encircle your choice for each rank.

<table>
<thead>
<tr>
<th>Rank</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>■</td>
<td>●</td>
</tr>
<tr>
<td>2nd</td>
<td>■</td>
<td>●</td>
</tr>
<tr>
<td>3rd</td>
<td>■</td>
<td>●</td>
</tr>
</tbody>
</table>

End of the test
### APPENDIX 3

The raw scores, totals, means and standard deviations of adjectival ratings.

<table>
<thead>
<tr>
<th>Stimulus Subjects</th>
<th>△</th>
<th>□□□</th>
<th>Y*</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>S₁</td>
<td>72</td>
<td>51</td>
<td>58</td>
<td>6</td>
</tr>
<tr>
<td>S₂</td>
<td>107</td>
<td>76</td>
<td>120</td>
<td>6</td>
</tr>
<tr>
<td>S₃</td>
<td>126</td>
<td>90</td>
<td>122</td>
<td>6</td>
</tr>
<tr>
<td>S₄</td>
<td>123</td>
<td>89</td>
<td>96</td>
<td>6</td>
</tr>
<tr>
<td>S₅</td>
<td>90</td>
<td>89</td>
<td>117</td>
<td>6</td>
</tr>
<tr>
<td>S₆</td>
<td>114</td>
<td>96</td>
<td>146</td>
<td>5</td>
</tr>
<tr>
<td>S₇</td>
<td>138</td>
<td>137</td>
<td>83</td>
<td>7</td>
</tr>
<tr>
<td>S₈</td>
<td>106</td>
<td>78</td>
<td>114</td>
<td>5</td>
</tr>
<tr>
<td>S₉</td>
<td>110</td>
<td>94</td>
<td>90</td>
<td>9.5</td>
</tr>
<tr>
<td>S₁₀</td>
<td>121</td>
<td>64</td>
<td>148</td>
<td>6</td>
</tr>
<tr>
<td>S₁₁</td>
<td>80</td>
<td>102</td>
<td>83</td>
<td>5.5</td>
</tr>
<tr>
<td>S₁₂</td>
<td>110</td>
<td>104</td>
<td>114</td>
<td>4.5</td>
</tr>
<tr>
<td>S₁₃</td>
<td>139</td>
<td>100</td>
<td>98</td>
<td>7</td>
</tr>
<tr>
<td>S₁₄</td>
<td>94</td>
<td>103</td>
<td>107</td>
<td>4.5</td>
</tr>
<tr>
<td>S₁₅</td>
<td>132</td>
<td>119</td>
<td>129</td>
<td>4.5</td>
</tr>
<tr>
<td>S₁₆</td>
<td>150</td>
<td>114</td>
<td>118</td>
<td>6.5</td>
</tr>
<tr>
<td>S₁₇</td>
<td>141</td>
<td>53</td>
<td>157</td>
<td>5</td>
</tr>
</tbody>
</table>

**architects**

<table>
<thead>
<tr>
<th></th>
<th>(\Sigma x=1953)</th>
<th>x=114.88</th>
<th>(\Sigma x=1559)</th>
<th>x=91.71</th>
<th>(\Sigma x=1900)</th>
<th>x=111.76</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(s=22.15)</td>
<td></td>
<td>(s=22.56)</td>
<td></td>
<td>(s=25.69)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>S₁</th>
<th>S₂</th>
<th>S₃</th>
<th>S₄</th>
<th>S₅</th>
<th>S₆</th>
<th>S₇</th>
<th>S₈</th>
<th>S₉</th>
<th>S₁₀</th>
<th>S₁₁</th>
<th>S₁₂</th>
<th>S₁₃</th>
<th>S₁₄</th>
<th>S₁₅</th>
<th>S₁₆</th>
<th>S₁₇</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>108</td>
<td>82</td>
<td>148</td>
<td>57</td>
<td>126</td>
<td>105</td>
<td>102</td>
<td>117</td>
<td>123</td>
<td>83</td>
<td>158</td>
<td>122</td>
<td>72</td>
<td>124</td>
<td>48</td>
<td>112</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>97</td>
<td>113</td>
<td>41</td>
<td>53</td>
<td>100</td>
<td>65</td>
<td>78</td>
<td>93</td>
<td>95</td>
<td>140</td>
<td>112</td>
<td>80</td>
<td>52</td>
<td>93</td>
<td>43</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>167</td>
<td>144</td>
<td>134</td>
<td>67</td>
<td>145</td>
<td>118</td>
<td>148</td>
<td>159</td>
<td>129</td>
<td>133</td>
<td>160</td>
<td>106</td>
<td>98</td>
<td>140</td>
<td>92</td>
<td>142</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>6.5</td>
<td>7</td>
<td>6</td>
<td>5.5</td>
<td>5</td>
<td>10</td>
<td>5.5</td>
<td>5.5</td>
<td>7.5</td>
<td>8</td>
<td>10</td>
<td>6.5</td>
<td>9</td>
<td>6</td>
<td>6.5</td>
<td>5.5</td>
</tr>
</tbody>
</table>

**chemists**

<table>
<thead>
<tr>
<th></th>
<th>(\Sigma x=1757)</th>
<th>x=103.35</th>
<th>(\Sigma x=1377)</th>
<th>x=81.00</th>
<th>(\Sigma x=2185)</th>
<th>x=128.53</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(s=30.74)</td>
<td></td>
<td>(s=28.30)</td>
<td></td>
<td>(s=27.36)</td>
<td></td>
</tr>
</tbody>
</table>

* Total years of professional education
VITA

Ahmet Vefik Alp was born in Istanbul, Turkey, on May 31, 1948, the only child of Dr. and Mrs. Cavit Alp. After completion of Saint-Joseph French High-School, he attended Istanbul Technical University from 1967 to 1973. In 1971 and 1973, he was awarded the Diplomas of "Architect" and "Dipl.Eng. Architect", respectively. In June 1973, he joined the Faculty of Istanbul Technical University, Department of Architecture. The same year, Mr. Alp began his doctoral studies, and, in 1977, the University accorded him permission and support for a two-year stay in USA for the completion of his dissertation.

Ahmet Vefik Alp has designed and supervised the construction of several buildings, eight of them are completed and in service. He has also participated in several national competitions of architecture and received, in 1973, a special award for his scheme for the "Headquarters of the Central Bank of Turkey, in Ankara. Mr. Alp is the author of several articles appearing in Arkitekt. In addition to his native language, he speaks French and English.