COLOR AND SCALE IN ARCHITECTURE

by

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A THESIS
SUBMITTED TO THE FACULTY
IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER IN ARCHITECTURE

accepted and approved,

Andrus Toda.

Houston, Texas
April 1958

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To the
memory
of my father
COLOR AND SCALE IN ARCHITECTURE

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Acknowledgement

I would like to express my indebtedness to Professor Anderson Todd of the Architectural Department of the Rice Institute for his guidance and his considerate assistance during the course of my thesis.

I would also like to thank the Department of Architecture and the Rice Institute for enabling me to undertake the work through the grant of Assistantships and Fellowships, and the Fulbright Foundation for the Travel Grant which enabled me to come to the United States.
"In essence and by destination the art of architecture exerts itself in a true space, one in which we walk and which the activity of our bodies occupies."\(^{1}\)

Everything existing in this "true space" -- and this includes architecture -- manifests itself visually; and, this manifestation is not only the expression of its existence in space but also the expression of what its existence means.

For this reason it seems that the basic problem of architecture is this expression.

What is the manifestation of architecture and how does it become known to us? What are the qualities which give to this manifestation the property of being architecture? How are they expressed?

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\(^{1}\)H. Focillon, *The Life of Forms in Art*, p. 20.
What are the basic and primary materials of the architectonic expression and what are their basic relationships which are interpreted as indications of architectural significance?

When I started planning this work the above questions indicated my problem but the field of inquiry seemed vast and extended.

My purpose was to study architectonic expression and particularly to examine the fundamental relationships involved in its visual "structure." This is because it seems to me that knowing the basic "mechanism" of architectonic expression is an elementary prerequisite of the creative part of architecture -- its composition.

For architectural composition is the use of all the available "materials" of expression in order to achieve a certain objective, and the main objectives of architecture are to express: a) its existence; and, b) its purpose.

This can be done only when we know what "materials" we have in hand, how they can be used and what are the results of their interrelations.

Moved by the desire to approach the center of this field of inquiry as closely as possible, I started a series of preliminary thoughts in order to find an
indication of what might be the basic "materials" of expression whose relationships could have a fundamental importance in the articulation of the architectonic expression.

In the following pages I will try to give an account of these preliminary thoughts. This account will serve as an introduction to the main part of my work and it will also help the reader to apprehend why, in searching for basic values of the architectonic expression, I concluded to study color, scale, and their relationship.

An architectural work is a manifold unity; it is a unity not added to our universe as something new and absolute; it is not a different universe with new original laws and elements, but an integral part of a system of immeasurably complex relationships — our universe.

Furthermore, it is an attempt for the expression of something which is unique, something which is an affirmation of the perfect whole of the universe and this cannot be expressed anywhere else but within this universe whose main characteristic is space.

Architecture finds its expression in space, and space is the realm of sight. Architecture is an art which appeals to the sense of vision, because sight is the medium of communication between man and architecture.
Therefore, the main experiences that man has from architecture are visual experiences — appearances.

What are these "appearances"? Are they the main objectives of architecture or are they merely symbols of its manifold unity?

It seems that they are neither. They are not the main objectives, because architecture "exerts itself in a true space" where it establishes an order for certain utilitarian, technical and aesthetic purposes, and "appearance" is only the visual expression of that order. By comparison, for example, "appearances" are the main objectives of painting. Also, they are not the "symbols" of its unity because architecture cannot exist in space without its visual elements actually participating in the conditioning of the space itself.

As we have said before, space exists in the realm of sight which means that we do not become aware of any transformation whatsoever of space unless it is manifested visually.

Thus a house is not only the "appearance" of a house (or an arrangement of solids). It is also the spatial expression of every meaning that the notion of "house" implies in serving certain human activities in a suitable way and based on certain utilitarian and technical requirements.

The fact that the visual expression of architecture is not an abstract image nor a symbol signifies

2 Ibid.
that this visual expression has meaning; by this
criteria, it becomes a form and, particularly, a
visual one.

This form is something which does not exist in-
dependently of man because it is based on visual
phenomena, that is, phenomena depending on human
sensation. Mainly, it is because the meaning given
to the simple visual manifestation, in order to become
"form," is the result of human interpretations.

My problem now begins to be more specific, since
I have found two elements which seem to be important
for the architectonic expression. The first is the
visual manifestation of the architectural work. The
other is man, who is the purpose and the justification
of the existence of this work.

It would be a difficult task to begin searching
for relationships existing between these two elements
without trying to limit them to a more specific view,
because these relationships extend over a wide field
which covers many sections of knowledge.

It is not the scope of this work to enter
all those sections of knowledge and to
attempt an exposition of an empirical
theory of reality.

Therefore, I continued my preliminary thoughts,
searching for two things:

a) the simplest component elements of
the visual manifestation;
b) the elementary, but basic, human factors partaking in the expression of architecture.

The fact that architecture can be manifested visually is due only to light, for light creates the sensation of vision.

Light is a continuous vibration existing within space. If we abolish light we also abolish the work of architecture. Painting, sculpture and architecture would not be able to exist without light. Space is full of light rays which we do not see. We only have a notion that light fills up space with its vibrating existence. We realize this intangible notion when a ray of light goes through an atmosphere of dust or smoke; then, small particles reflect the light and it appears as being a material substance which fills up space.

But, it is mainly as color that light can be perceived, because prior to any manifestation light is analyzed in colors.

The color of an object is nothing but an expression of the light it reflects and "... the sensations we meet with as elements of all vision are colours and nothing but colours."

It appears to me now that I have found what I was searching for: a basic element of the architectonic expression — and this must be "color." For, color is the simplest component element of the visual manifestation of architecture.

It has been noted in a previous page that the visual form of architecture does not exist independently of man. This is further intensified by the fact that color — the component of this form — is not an intrinsic property of the objects. Color is a visual sensation and "... a color sensation — like sound, taste and smell — exists not in the outside world but inside ourselves."

This idea is illustrated by the old question: "is there any color on the South Sea Island if man is not there to see it?"

Let us now turn our interest to the search for the other element of architectonic expression, the basic human factors which partake this expression.

As previously stated, in the realm of the actual space, any "appearance" is nothing but the visual manifestation of objects which have a material entity. The difference between the random material objects and the ones of architecture is that the latter added together constitute something which is more than the mere sum of their material entities. They constitute a unity which is specially made with the purpose of serving human functions. What distinguishes it from other unities which "accidentally" supply similar functions is its property of being made by man.

The objects which constitute architecture exist in space in an actual state, but the fact that their...

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4N. Graves, Color Fundamentals, p. 10.
unity is an architectural work can be apprehended only by man.

For anybody else -- for an ant or an elephant -- the five pieces of wood which make the unity we call "chair", are nothing but the sum of five pieces of wood with no particular meaning.

We can therefore say, that this "unity" is the meaning of the architectural work, or it is its "form."

Through this reasoning we have been led once more to the "form." This time we have approached "form" starting our reasoning not from the "appearances" of architecture, but from the actual material objects which constitute architecture.

Considering both ways of approach to the "form" we are led to a further thought.

The visual manifestation of the architectural work does not acquire any meaning, or in other words, it is not able to become a "form" unless it is referred to the objective human presuppositions of the architectural work -- namely, the utilitarian and technical factors which I mentioned before. It is mainly these factors that define the order which gives to the material objects the property of being architectural unities.

This order is the cause that produces the form. Both the needs of man and the technical prerequisites on which he bases his works have an infinity variety. This is the reason why so many different buildings exist, each one having a different form. Actually, the various
buildings have many things in common. Their forms may vary, but their variations are developed on a network of similar laws. This fact becomes evident when we analyze the various forms proceeding from the whole to the parts. Then, we see that the parts do not only follow similar laws for the formation of the whole, but also that many of them are independent forms existing simultaneously in different buildings which serve completely different purposes. Doors and windows are more or less invariable forms, existing in every building.

Let us assume now that, in reference to architecture, man has properties of "quality" and "quantity."

The assumption of "quality" signifies his general condition or status when he satisfies his need for one of the requirements which characterize the life of all men, namely, the physiological, social and intellectual prerequisites of his existence.

Satisfying his vital need to sleep, man has the "quality" of the "sleeping" man; he can also have the "quality" of the "working" man, or of the "praying" man.

The second assumption, the "quantity," signifies the physical, physiological, psychological and spiritual entity of man. His "quantity" depends on the fact that he is a human being having certain dimensions and certain weight, occupying certain space, following certain order in his existence — being born, living, thinking and dying.
Man's "quality" varies and each variation of "quality" defines a building with a different character.

In one building he has the quality of being a "sleeping" man, hence the building is defined as a dormitory; in another he is the "working" man and the building is a factory; in another he is the "praying" man and the building is a church.

But the "quantity" of man never changes, because none of the properties which make him a human ever changes. His dimensions and his appearance, his weight and his physical strength have never changed, nor the natural order of his existence has ever changed.

The forms of architecture change for every different "quality" of man, but every form is made for the same man, with the unchangeable "quantity."

Therefore, all forms in architecture must have something in common since they serve a common purpose.

This universal "quantity" of man must be the reason for the existence of the similarity between the works of architecture which have been mentioned above. This must be the fundamental for the common laws on which the organization of the forms is based. It must also be the reason why all architectural wholes are comprised of common partial forms.

"The civilization of every age has the tendency to render different values to man. Therefore, man's idea about his "quantity" changes, though actually his "quantity" remains the same."
The fitness of a building to a certain human "quality" defines its particular architectural meaning as to whether it is a church or a factory or something else.

But fitness to the universal "quantity" of man is the basic and general meaning of architecture since man has the same "quantity" no matter what "quality" he has.

How can a building be a church or a factory if it is not primarily made for man? Even the words "church" or "factory" have no meaning without the implication of man.

We cannot give architectural meaning to the visual impressions we have from a material unity, that is, we cannot define it as an architectural form unless we can apprehend this "fitness."

When the comparison between the human bodily dimensions and the dimensions of a building does not show a proper relationship, or, when the building gives the impression of being made for a being which is proportionally smaller or bigger than man, we usually say that the building is not made for man and, it is not "in human scale."

But is the dimensional relationship the only criterion which shows whether a building is made for man or not?

Do the bodily dimensions only constitute the unchangeable "quantity" of man?
There must be something more because (1) apprehension of the dimensional relationship between man and architectural form is not the only fundamental meaning of architecture, and (2) common fitness to the human dimensions is not the only basic similarity between the various architectural forms.

To demonstrate this, I will use once again the example with the "chair" which I used before.

Even if we diminish proportionally the dimensions of the five pieces of wood which constitute the chair and we make a chair relative in size to the size of an ant, this "chair" would not be for the ant anything more than the man-sized chair was to it; that is, the sum of five pieces of wood.

That means that man's "quantity" must be something more besides his dimensions.

Therefore, if "scale" is a notion showing whether a building is made for man or not, it must involve the notion of every unchangeable factor of that man; in other words, it must involve the complete "quantity" of man.

Imagine having a bridge which is in perfect dimensional relationship with man but which is built of straw. Can we say that this bridge is in human scale when it can be crossed only by ants?

I shall not try to define these unchangeable factors here. This is to be done in the main part of my work and it will serve to examine "scale" from a wider point of view.
What is important to be noted here is that scale in its complete aspect is a fundamental factor for the apprehension of the architectural work. Because when a building is in "human scale," it means that it has a human origin and a human purpose; therefore it is "architecture."

The thoughts which have been recounted to this point give us the indication that there are two basic elements of architectonic expression: "color" and "scale."

Therefore, the question now is: Does a problem of a relationship between color and scale exist in architecture? And, furthermore, is this problem vital for the creative part of architecture or just a theoretical way of criticizing architecture?

Our inquiry up to now indicates that a relationship between these two elements must exist since one depends on the other as it is shown by the facts that:

a) Scale is nothing but a basic apprehension of the architectural work.

b) The apprehension of the architectural work depends on the apprehension of its visual expression whose basis is the sensation of sight and the elementary stimulants of sight are nothing but colors.

In other words, "color" seems to be the "structural material" of the architectural form and "scale,"
the evaluating factor of its "structure." This "structure" is a complex unity, in which the combinations of the elementary "material" (color), form qualitative relationships such as proportions, harmony, rhythm, contrast, emphasis and the like, which are basic values of the architectonic expression. Therefore, the problem of color and scale is a problem concerning the composition of architecture, since these qualitative relationships are compositional elements of the architectural form.

Under the aspect of composition, this problem has a particular importance for the architecture of our time.

One can say that our age is, at least, a superficially humanistic age. It is humanistic from the point of view that man and his potentialities are its ultimate measures. However, this is limited only in material and practical aspects. Characteristic of this age is the tendency to investigate all the possible ways with which matter can serve man. Everything within nature, which is found to be of value for man is systematically organized and used. We never stop this quest and every new thing made by man has to display a new, "advanced" way of exploitation of the matter, before even the potentialities of the older ways are completely examined and exhausted.
This head-long pursuit for the "new" is one reason for the tremendous technical progress of architecture within the past few years but it also has brought architecture to a critical point.

The unlimited possibilities of modern technology lead to the creation of new forms which are completely new concepts for the human experience. Up to now man has lived among architectural forms more or less unchanged for many centuries. The transition from known forms -- correct or not -- to absolutely new ones, makes the establishment of relationships between man and the new architecture difficult.

"Acceptance of the inevitable change is slow because new designs demand intellectual effort while conventional patterns possess the advantage of familiarity beset on habit."5

Man's universal "quantity" naturally has not changed but our idea about this quantity has changed.

One hundred years ago a building with 80 stories or without any windows would have been considered as something beyond any human purposes and possibilities for many reasons which do not exist now.

Meanwhile, the conception about color has also changed.

Of course, it is not the fundamental property of color -- to be a stimulant of the sensation of sight -- that has changed, but the ideas about its use.

Today, color introduces new morphological problems in architecture due to many reasons. In my opinion the most important of those reasons are the following:

1) The appearance of the buildings does not depend any longer on the few known materials — such as brick, stone, stucco and the like — which have been dominant in the architecture of the past. Modern technology produces a wide variety of new architectural materials which have changed the appearance of the buildings not only because they allow the development of new structural systems, but also because they offer a completely new and wide selection of finishes, colors, textures, and generally, surface-qualities. But, very little is known about the expressive values of all these new elements of architectural composition and the designers have to explore them, since there are no previous examples of, or principals relating to, their expression.

2) The concept of functionalism has had a great influence on modern architectural thought, and it is a fundamental concept in modern architecture. One may appropriately call it the characterizing tendency of modern architecture. Adherence to the principle that architectural form must be intensely functional is now general, at least in so

*In the sense of, the development of form.*
far as lip-service is rendered to it, and a large number of buildings are actually being created in the spirit of functionalism.\(^6\)

Under the influence of that spirit, colors are serving now many utilitarian requirements of the building. The color schemes are very often defined by pure practical purposes such as the marking of hazards in factories and industrial plants,\(^7\) or the productivity of the workers, or the efficiency of the pupils.\(^8\) This practical use of color led to the, so-called, theory of "Functional Color" which has been developed recently.\(^9\)

However, the spirit of functionalism in modern architecture did not only turn the attention of the designers to the use of color according to the simple practical needs of man. It also led to a wider interpretation of architectural color which under this functional aspect has to serve man's aesthetic and emotional needs, as well.

3) The last, and very important, reason is the


revolution in the aesthetic expression which reached its climax in the first decades of this century and led to new "theories of vision" which contained new concepts about the expressive qualities of color. The new architecture, being at its birth, was an open ground for every suggestion of aesthetical content.

With architects objecting to every mimicry of style, even the idea of a style, they needed a new aesthetic background or theory although they declared with the "functionalistic approach" that their forms had to come out of "... technical and utilitarian requirements only."10

This background for the aesthetic developments of architecture was provided, in a large measure, by contemporary painting. Its new theories of vision have had a character of general inquiry about the visual properties of every existing form.

These theories have not been limited in scholastic interpretation of the descriptive means of painting, such as the theories of pointillism and impressionism. They have had a wide field covering every value of the manifestation of the form in its surrounding space. Thus we can say that this inquiry had an architectonic character.

Cubism studied the expression of the form in relation to space — to which rendered for the first time a fourth dimension: time.

The artists of "De Stijl" were studying the aesthetics of free asymmetric equilibria by means of inter-penetrating rectangles and the "constructivists" exploited the intangible beauty of the industrial textures and surfaces and the aesthetics of volume without mass.

These movements in painting exercised a great influence on the new architecture. We find, around 1920, schools of Cubism, Expressionism, Neoplasticism, Purism, Constructivism and Futurism in architecture.12

Though all the various "isms" were temporary mannerisms and they did not survive too long, their influence in the evolution of architecture has been evident until the present time.

We can find the traces of them in contemporary architecture, but fortunately none of the architects has been restricted exclusively to the dogmatic development of any of those theories of vision.13

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11 Ibid.
13 Le Corbusier's architecture has traces of "Cubism" and "Functionalism."

Dudok's works were suggestive of Van Dongen's paintings.

Oud made a Mondrian-like composition of the whole facade of the small "Cafe de Unie" in Rotterdam.

In various house projects by Mies Van der Rohe in the early '20s the influence of Van Doesburg is evident in the pattern of the floor plans. And even in his works in Chicago the arrangement of the extremely simple elements of his facades often seem to approach very closely the rigid discipline of Mondrian. (Continued)
Color has been extensively studied by all the new theories, since it is the main expressive medium of painting and it has an important part in the formulation of the principles which, according to these theories, govern the organization of form and space — the main objectives of all of them.

The new architecture was using, as I have said, similar principles in the organization of form and space within the frames of its objectives. And, it borrowed and introduced, as it was natural, the new concepts about color in its work.

However, the important thing was that color again found an outstanding place in architecture and became a necessary element of its expression.

The reasons mentioned above show clearly that with color becoming such an important medium of architectural expression, it is a factor which must be always taken under consideration and be in close relation to all the other expressive values of architecture.

The problem of the work in hand is now clear. However, I want to add here, that this work is not an effort to establish aesthetic rules or to explain the aesthetic problems of architecture, on a basis of color and scale relationships.

13(Continued)
The architects of Bauhaus have been influenced by the works of Kandinsky and particularly of Klee.

(According to: H. R. Hitchcock, op. cit.)
In examining the relationships of color and scale as a basic part of the architectonic expression, I do not intend to give practical "recipes" for a poor architectural "expressionism" similar to the one which Zevi describes as following:

"... to express the content of a building symbolically through an exuberant arbitrary plasticism within a literary and mystico-romantic atmosphere. A factory for the production of optical apparatus was designed with two large openings like gigantic eyes."14

I only consider this work as an effort to establish the validity of the idea that color as an element must be intrinsically related to the architectural form; it must not be a secondary element which is used to cover the surfaces of the building with something which is considered as "pleasant" for reasons of passing whims, personal taste or fashion.

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14 B. Zevi, op. cit., p. 31.
The meaning of "scale"

SCALE is a particular relationship between man and his physical environment.

What is the character of this relationship in architecture is shown by the following remark by G. Gromort:

"Everywhere man must feel that the building is made for himself; we do not say that the building is in scale unless this condition is fulfilled." 1

We have seen in the previous chapter that:

To be "made for man" is the primary purpose for the existence of all architecture.

This purpose implies the fitness of any architectural work to the fundamental characteristics of man which have been described as his unchangeable and universal "quantity."

Man's idea and consciousness of his "quantity" serves as a unit for the evaluation of this fitness. This evaluation concerns the visual form of architecture and its outcome is the feeling of whether the building is made for man or not.

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What does "fitness" of the building to man's "quantity" mean?

"To enclose a space is the object of building; when we build we do but detach a convenient quantity of space, seclude it, protect it and all architecture springs from that necessity."2

The purpose of this space is to contain man, the living organism whose physical characteristics are his body and his activities.

Even a tomb serves that purpose. Because actually it is not made for the dead man. It is made for the living man whose spiritual or religious activities concerning the mystery of death, contains.

Therefore: (1) In order to contain man's body this space must have dimensions relative to the dimensions of his body. (2) In order to contain man's activities, this space must be offered to the human movement since movement is the primary human activity in space.

Movement means transformations in time, and according to Kant the sense of space is bound together with the sense of time; both of them exist a priori.3

(3) The only way for this space to be "enclosed," or -- in a wider sense -- to be defined, is to be surrounded by solids. An arrangement of solids forms


the boundaries of the "defined" space; hence, this arrangement must have dimensions relative to the dimensions of human body and also allow the flow of the human movement within that space. But in order to fulfill its purposes, the arrangement of solids must form a balancing whole, providing the security and the stability necessary for man's physical existence.

This is basically the architectural whole: The "defined" space and the defining solids; both adjusted to the living man.

We can say that this whole is nothing but an extension of man and his activities; just as -- in a simpler manner -- clothes are the extensions of his body.

Man is the nucleus around which this whole is formed. His dimensions, the laws of his movement, his vital need for equilibrium, all are unchangeable elements and inseparable parts of his existence. Those elements form the pattern on which all architecture is developed.

How does man experience the "fitness" of the building to this pattern?

"The size of our body (of which we are always conscious) serves as a yardstick when we perceive our surroundings. Our body is the scale unit which enables us to establish a finite framework of relationships within the infinite space."

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Gropius, Scope of Total Architecture, p. 29.
The size of man's body is the unit for the definition of the relationship of size existing between man and the building; in other words, the size of man's body serves to "examine" how the human dimensions are related to the dimensions of the building.

But man is not only conscious of the dimensions of his body.

He is also conscious of the activities of his body, the laws and the character of his movement, because he exercises that movement every moment. This consciousness serves to him as a criterion for the evaluation of the articulation of space and solids.

Furthermore, man's sense of movement implies the sense of a natural equilibrium which is not only a necessary requisite of movement, but also a continuous state of himself, coming from the fact that he has certain physical properties of weight, pressure and force resistance of which he is conscious.

Man "projects" his bodily dimensions visually against the architectural form in order to establish the dimensional relationship between himself and the building.

In a like manner the consciousness of all the other properties of his self is projected against this form, with the purpose to establish the full relationship concerning the building and his unchangeable characteristics.
"Through these spaces we can conceive ourselves to move; these masses are capable like ourselves of pressure and resistance, these lines, should we follow or describe them might be our path and our gesture."\(^5\)

This relationship is a composite one; it involves the relationships concerning the three unchangeable elements of man -- dimensions, movement and equilibrium -- and their expression by the architectural form.

The following pages will deal with the examination of each of those relationships separately.

The relationship between man and architectural form concerning dimensions.

Man's apprehension of size is his self.

"Measure-mensurate-mens-mentality menschen-mind-man, mind is the symbol of man; man is not merely the measure but the measurer."\(^6\)

He qualifies every existing form as being either smaller or larger than himself.

Man's ability to measure is derived from this simple relationship; then he extends it:


\(^6\) Entwistle, "How to Use the Modulor," Plan No. 9, Birmingham, 1951, p. 12.
Smaller, smaller, smaller -- until the non-existing.

Or:

Bigger, bigger -- until the absolute whole. (Non-existing)

Thus, man establishes a "gradation" of sizes with himself as its standard and known unit.

Once a dimension is set, it corresponds with a certain position on that "gradation" of sizes. Therefore, it has a certain relation with the dimensions of the man, with every other dimension and with the whole too.

That is to say: this "set dimension" is correlated to the universe through the man.

"Beyond the satisfaction of physical functions the chief purpose of a major work of architecture is to awake in the viewer, the realization that man can have a real relationship with the whole of which he is the unknown product. In other words, a great work of architecture is the physical witness of the possibility of a man's conscious comprehension of aspects of the absolute." 7

Man comprehends every form as the part of the whole.

To be so, every form must reflect the standard unit, the man, as well as the notion of the whole.

7Ibid., p. 13.
Therefore, it must be a whole itself.

By the same process, every individual element of the building is itself a unity but it is also a part of the whole, while it is related to man.

"To awaken this sensation of wholeness it is necessary that every component element be related to every other and to the containing envelope."[8]

This mental process which follows the analysis of the whole in its component parts is the process of "measure."

All the resulting relationships are known to man, since they start from the known reference, man himself. Therefore, in order to comprehend the form, man has to examine the relations between the parts of the form, the relations between them and the whole, and finally he has to refer all those relationships to the basic unit --- human dimensions.

There are certain parts in the whole (building) about which we have an indisputable knowledge of the relationship between their dimensions and the human dimensions. These are elements coming from direct and necessary associations of man with the building, such as the dimensions of the stairs (adjusted to the human pace), the dimensions of the doors (adjusted to man's height and width), the dimensions of the hand-
rails (height of the hands above the ground). German writers call them "übertragene Maastäbe"; in translation: "figurative scales."

When the "figurative scales" of any architectural form are not correctly related to the human dimensions, and the proportional evolution of its sizes is based on those "figurative scales," then the dimensions of this form do not belong to the "gradation of sizes" mentioned above (the only one related to human dimensions); the whole architectural form is "out of scale." Dimensionally, man does not "fit" to this form.

The relationship between man and architectural form concerning human movement

As we have said before, the purpose of Architecture is to serve man as a living organism whose external characteristics are his body and his activity. (Activity implies the notion of movement). Particularly, in the actual space every human activity starts from a bodily movement.

The contour formed by any bodily movement defines a certain volume of void.

In space, a volume of void is constantly occupied by man. This is not equal to the volume of his body as we may think.

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9P. A. Michelis, Αrchitectoniki as Techni (Architecture as an Art), p. 124.
It contains both the volume occupied by the body and the volume of void required for the free movement of that body.

Basically, a space, whose purpose is to contain man's activities, must be capable of containing the volume of void defined by the contour of all the successive bodily movements implied by such activities.

This volume of void is not experienced through actual bodily movement. It is experienced visually as a potentiality to move: to turn around, to dance, or to stretch our arms. Man transcribes his bodily movements in terms of visual transitions. The capacity of space to contain the volume of void required for his movements is interpreted as the freedom which he enjoys when he feels that the volume of void which his visual transitions define, fits comfortably within the limits of the visual forms.

This sense of freedom is a physiological demand of man's nature. It is a necessary requirement of his environment and it satisfies his need for "expansion" which is implied by the consciousness of his ability to move. Lack of this freedom produces the feeling known as "claustrophobia."

G. Scott says that man possesses in himself a physical memory of "just the movement" and he expands every time he breathes, "... the need to expand, felt in all our bodily movements ... is not only profound in every individual but obviously of infinite antiquity in the race."10

10G. Scott, op. cit., p. 170.
The above conditions can be found only in the space which has the property of being "defined." Such a property has been described as a basic requisite of the space of architecture.

These conditions do not occur in the open and formless space, though it is an infinite volume of void and it seems that it should be capable of containing every finite volume of void and allow man to enjoy this sense of freedom. Such an infinite space does not have any meaning for man's movement. Movement means change of position in space and there is no change unless there is something in relation to which this change is occurring.

We can say that in the infinite space no movement exists.

Only in the "defined" space, the volume of void suggested by the contour of any bodily movement has a meaning because it can be referred to the arrangement of solids which define space.

Solids are the means of definition of space. Space becomes known to man as a relationship between solids, because space itself is not intelligible. This means that man becomes aware of his environment only when he experiences its visual definition.11

In a "defined" space, man's visual movement has a meaning since the transitions involved have a meaning

11A. I. T. Chang, The Existence of Intangible Content in Architectonic Form, p. 52.
only as long as they are transitions from one visual element to another. And the visual elements define the contour of the volume of void implied by this visual movement.

The necessity for visual definition, being a requisite for the apprehension of our visual environment, is a strong feeling—a common experience of all human beings.

"Imagine sitting on a balcony twenty stories high above the ground, the balcony having an open railing made of vertical bars. Though the railing gives you physical protection, you will have a sensation of giddiness if you look down. Giddiness, however, stops immediately if the railing is covered with cardboard or paper, for this enclosure then gives support to the eye. Our equilibrium is re-established through the illusion of safety although nothing has been added in fact for greater physical safety. The eye does not know, it reacts automatically.

The equivalent phenomenon in horizontal direction is the so-called agoraphobia, i.e. the dread of open spaces which seizes sensitive persons crossing a large open square. They feel lost in a space the size of which is not in keeping with the human scale. But if some vertical planes were erected on that open space like wings on a stage, such as shrubs or fences or walls, the illusion of safety would be reinstated, and the dread would disappear; for the eyes of the person groping in space now find a frame of reference to support them; when
they hit a solid in the field of vision they register its outline just as radar does.  

This search for safety and for a visual support is nothing but the demand for a definite and clearly limited space. Only in such a space human activities can take a concrete form.

Each condition of visual definition is experienced differently, it produces different feelings. Variations of such conditions are experienced as visual movement as well as actual one.

Visual movement always contains a suggestion for actual movement or it comes from the experience of an actual one.

Furthermore, these variations imply variations of feelings, that is: a mental or intellectual movement.

The whole purpose for the existence of architecture is to serve human functions; those functions are nothing but movement -- mental, visual and actual. Organizing this movement architecture serves its purpose; this is achieved by the qualitative organization of various conditions of visual definition.

We can say that architecture is the purposive qualitative arrangement of various conditions of visual definition to give a sensation of order and to direct human movement.

This "visual definition" suggests that what in

\[\text{\cite{Gropius:20}}\]
the beginning of this chapter has been called "freedom" of man's movement in architectural space, does not mean dependency on nothing. (Dependency on nothing cannot exist in architectural space; for movement is annihilated.) The condition of non-existence of movement is a property of infinite space only.

Freedom of movement in definite space means correct direction and organization of movement. It is the reference to the defining solids that gives meaning to the movement; and this meaning is the "freedom" of the movement. Correct organization of the solids allows the flow of human movement and makes the architectural space capable of containing man's activities.

It is evident now that the fitness of an architectural work to man's activity is experienced as the satisfaction of his need for clear definition and freedom of his visual movement.

Those two things are bound together. "Freedom" is the outcome of "definition" and "definition" is the outcome of "freedom."

A lot, on which a small neighborhood is going to be built, is already a definite space as long as it has its boundaries set. Movement -- either actual or visual does not have any meaning within this space. Establishing a system of roads we give meaning to movement. It is now organized, it is "free."

This "freedom" results in the definition of smaller spaces -- the blocks -- within
The space of the neighborhood lot. Within the defined space of the blocks movement again does not have any meaning unless we trace the boundaries of the individual lots of the houses. Successive interchanges of definition and freedom of movement lead "downwards" to the house, rooms, arrangement of furniture, individual furniture and finally to the minor spaces which have an importance for human movement such as arrangement of books, utensils. Upwards, this procedure leads to the community, the town and the whole human environment. (Plate 3).

The successive experiences of definition and freedom of movement relate all space in a chain of relationships. This chain starts from the smallest space where definition and freedom of visual movement begin to have a meaning -- i.e. an arrangement of books, a lavatory, a small piece of sculpture -- and continues to bigger spaces, to the whole of our visual environment.

This way, man is related to every part and to the whole of the space of his environment through the consciousness of his movement.

The relationship between man and architectural forms concerning equilibrium.

Solids are the means for the realization of the space which is the object of architecture. They are the permanent element which gives meaning to the passing flow of the human movement in space.
Being material entities, solids are subject to the universal law of gravity and they have certain physical properties of strength and of force resistance.

An arrangement of solids, a building, presumes a balanced structural organization which is a necessity for the realization of the architectural form. The stability of this structural organization is based on the "provision of the minimum of available material to resist the maximum of possible loads."13

This is not valid only for the structures of architecture, but it is a universal law of nature, which can be noticed in the structure of nearly all natural forms such as plants, animal skeletons, shells, etcetera.

Physical balance and stability of the solids has the meaning of firmness and security for man. The dependence upon such properties of our environment is fundamental to our nature.14

Man cannot have an actual experience of the properties of weight and force resistance of the solids, and it is not possible to examine directly their state of physical balance from their visual appearance.

It is through an indirect way that he evaluates visually the properties of balance. Man has a consciousness of the weight; he lives in the universal

13I. T. Chang, op. cit., p. 43.
14C. Scott, op. cit., p. 171.
field of gravity. He also has a consciousness of the various physical forces such as pressure, tension and the like. He interprets visual conditions in terms of his own consciousness of weight and force resistance.

"Weight, pressure and resistance are part of our habitual body experience and our unconscious mimetic instinct impels us to identify ourselves with apparent weight, pressure and resistance exhibited in the forms we see."15

This remark by G. Scott is based on a certain characteristic concerning man's apprehension of his environment which has been observed by the German psychologist T. Lippe, who has given to this characteristic the name "Einfühlung," usually translated in English as "empathy."

According to H. N. Lee:

"... empathy is the tendency to regard kinaesthetic reactions and incipient reactions that are a part of observers bodily conditions as if they were perceptual aspects of the object. Thus we speak of the rising mountain and undulating lines. The mountain, however, manifestly does not rise. It remains unmoving. It is our eyes and heads that are raised. And the lines do not undulate."16

Because of this feeling of "empathy," what is important for man's experience is not the physical

15Ibid.

16H. N. Lee, Perception and Aesthetic Value, p. 91.
balance of the solids but the balance of the phenomenal forces that he transcribes to the building as a result of his visual experiences.

Man is convinced that a building balances only when it appears to him that it balances. Such a condition satisfies his instinctive need for physical firmness and security.

How does man experience this phenomenal equilibrium of the solids of architecture?

He cannot "see" the physical forces themselves.

Size and the visual expression of the material serve as a basis for their comparative evaluation. What counts more in such a comparison is usually the apparent density of the solids rather than the visual indication of their material.

This way, a vertical arrangement of solids is experienced generally as balancing when elements larger in size and of a comparatively greater apparent density are closer to the ground while smaller elements and of a lesser degree of density are on top.

In an horizontal arrangement, man always projects an imaginary vertical axis. He examines how solids balance by comparing their distances from this axis as well as their sizes and their apparent densities.

The apparent stability of a structure is not only a problem of balance of apparent weights but it
implies also the evaluation of the strength of the various structural elements, which is again a matter of comparison between sizes and physical properties of the materials.

Due to the law of "minimum material for maximum load," size and visual manifestation of the material of a structural element, express its potential in force resistance.

This is not valid for every structural element, but through experience and association man knows what are the potentials of force resistance, of practically all materials employed in building.

This way, a certain size of an element having the appearance of steel, is considered adequate of supporting a certain load, but if the same element has the appearance of wood, its size must change in order to convince us that it is strong enough to carry the same load properly.

Structural arrangements of solids which exhibit a different equilibrium than what is expected from the appearance of their materials, the size and the order of their elements, are not accepted visually as properly balancing. They produce a feeling of instability because man is not satisfied with miracles of equilibrium. His sense of stability and balance is satisfied only when he experiences a logical structural organization.

But, as it has been said before, the logic of the "eye" is not necessarily in agreement with the
logic of the structure. It has been shown that what is important for man's apprehension is not the physical but the phenomenal equilibrium.

However, phenomenal equilibrium of the physical forces (weight, pressure, resistance) implied by the solids does not completely satisfy man's instinctive need for balance. It seems that the "eye" itself has an innate need for balance and symmetry.

This balance -- which we can call visual equilibrium -- is not implying only physical forces and their visual expression.

The logic of the "eye" concerning that matter is not something which can be determined easily.

"... the precise relations of the component factors in visual balance is beyond analysis."17

However, there can be an analysis about the general principles of visual equilibrium.

The instinctive need of the eye for such an equilibrium seems to be a consequence of the visual movement which has been already described.

According to the phenomenon of empathy, visual movement, being associated with actual movement, suggests an action of forces.

"Symmetry" is used here, with its broad meaning. It does not mean repetition of the same form on both sides of an axis, but rather a uniform distribution of visual impressions.

17A. I. T. Chang, op. cit., p. 47.
Any movement must have a motive in order to have meaning. A movement without motive is experienced as a restless action leading to nowhere but producing fatigue.

The motive of any movement is always static in character.
We walk in order to arrive somewhere, in order to stop.
We think in order to establish an idea which then stays.
We follow a line visually not for the sake of the line, but looking for its end.

The purpose of the visual movement as it has been described, is not movement itself but the definition of the space, and this definition is nothing but the establishment of a restfulness; it is the establishment of a static order within which the potential of the human activity can be developed. This restfulness represents the definite space and in order to be established it demands a mutual neutralization of all forces which are implied by the visual movement.

To analyze all visual movement which gives the definition of space and to define the acting and reacting forces is a problem concerning each particular case of visual environment.

These forces do not all come from direct visual experiences. Previous experiences, suggestions of certain conditions, expected meanings, all supply additional forces which complement the forces which are implied by the visual movement and the phenomenal

\[18\textit{Ibid.}, \ p. \ 42.\]
equilibrium.

The following examples illustrate a few simple conditions of visual equilibrium.
The ridge of the roof suggests strongly a vertical axis.

Visual equilibrium requires similar actions on both sides of this axis (the same amount of visual movement).

The form of the monument "points" upwards; it suggests a visual movement towards this direction. However, this is the purpose of that monument: to "move" us upwards and this way to establish its symbolism. Correct visual expression of the physical balance suggests a movement downwards, the direction of gravity.

Thus visual forces are neutralized and visual equilibrium is established.

One may say that the upwards-force is greater than the downwards-force. The reaction to that exceeding amount of upwards-force is supplied by the viewer itself; and this is the whole purpose of the monument. (It leaves a certain amount of uprising force for each individual viewer to carry with him.)

The suggestion of the footing supplies the reacting force.

No suggestion of reacting force. No visual equilibrium.

The counterbalance establishes the visual equilibrium.
The visual movement suggested by the strong rhythm on both sides implies a force which is balanced only by our expectation about the space where this rhythm leads. If this space fails to satisfy our expectations, the equilibrium is destroyed. It is easy to see in the lower example that there is a lesser feeling of space.
The complete aspect of scale

Scale in architecture is the result of the simultaneous existence of the three partial relationships which have been described separately only for the sake of analysis.

Scale is not simply the property of the building of being "made for man"; neither is it simply the satisfaction nor the feeling which man feels when he experiences this property.

Scale is a relationship between man and architectural form which involves both the property of being "made for man" and the corresponding feelings of man; but, in a final analysis, scale is also a relationship concerning all the functions of man as well as of architecture which basically give meaning to the forms of architecture. The latter being non-natural forms they acquire their meaning only through their relation with man.

However, "scale" is not merely a perceptual relationship between man and architectural forms, although it is primarily based on the laws of perception similarly to any other relationship concerning the apprehension of our visual environment.

Furthermore, we must not make the mistake of assimilating the relationship of scale with the "aesthetic experience." The pure aesthetic experience
sees the object "per se."

"Beauty is the form of finality in an object, so far as perceived in it apart from the representation of an end." 19

"Scale" differs on that point; its meaning is intelligible only as long as the architectural form is referred to its end, man, whose spatial relations it represents.

However, scale can be considered as a first step towards the aesthetic evaluation of the architectural form since it involves man's satisfaction from the appropriateness of this form to serve its given end; satisfaction is synonymous to pleasure and:

"Pleasure is the measure of the aesthetic interest; ... (it) is the evaluating factor for aesthetic value." 20

The three component aspects of scale are not independent relationships.

Each one of them depends on the others and their common dependency is a factor for the establishment of scale. This is already evident in the separate examination of each of those relationships.

We have seen that the procedure of measure and the apprehension of the dimensional relationship imply


20H. N. Lee, op. cit., p. 80.
necessarily visual movement; also, that visual equilibrium is a consequence of visual movement.

Furthermore, the apprehension of the various conditions of balance depends on the comparison of the sizes of the various architectural elements and forms.

The following examples should illustrate the fact that the establishment of one of those relationships depends on the establishment of the others and, finally, the whole circle of relationships leads to the establishment of scale.
1) Apprehension of the dimensional relationship between man and the architectural form depends on the conditions of definition and freedom of visual movement.

In the Greek urban compositions, the various buildings were arranged on a free pattern so as to allow the visual movement to follow a sequence of forms. The continuity of the visual transition from one form to another creates a definite space; the dimensional relationship between man and the various architectural forms can be easily apprehended since man is able "to locate" the various forms within this definite space.
2) Apprehension of the dimensional relationship existing between man and an architectural form depends on the conditions of visual equilibrium.

"Imagine a gothic tower or for reasons of simplicity, a prism of masonry whose weight loads the base to its extreme limit. Double all the dimensions. The weight (proportional to the cubes of the dimensions) becomes eight times as heavy; on the other hand the area of the base (proportional to the squares of the dimensions) becomes only four times as large. The conclusion is evident. If in the first case, the base was loaded to its limit, in the second case it will break. In other words, given the design of a building with the condition that its masonry is taxed to its limit of resistance, then the scale is determined. Such is the case of the great gothic buildings. By the very fact that the stone is exerting its maximum effort, the absolute size is not an arbitrary thing; the eye, the most accurate of all instruments of calculation establishes at once the scale,* which it may be checked afterwards by calculation." 21

**Scale** here means dimensional relationship only.

3) Apprehension of the definition and freedom of movement (visual or actual) depends on the apprehension of dimensional relationship between man and the architectural form.

Saint-Peter's, Rome. Only when man is present -- as an indication of size -- the conditions of visual definition and freedom can be apprehended fully.
4) Definition and freedom of visual movement depends on the conditions of visual equilibrium.

An apparently heavy ceiling gives the feeling of confinement and suppresses freedom of visual movement.

In a Japanese rock garden, the whole composition of space is based on conditions of visual equilibrium.

"It could be that what this garden is trying to express is the islands that show themselves here and there on a vast expanse of ocean. The islands that are scattered on the quiet sea are paradise for the peaceful lives of the people and seem to be the embodiment of the actualities of Paradise surrounded by the halo of Buddha's mercy." 22

5) The apprehension of various conditions of equilibrium depends on the dimensional relationship between man and the architectural form.

We can apprehend the tremendous forces implied by this structure only when we have a means to apprehend its size. The handrails, the lamp posts, the automobiles, all have a known dimensional relationship to man; through them, the whole form is dimensionally related to our body and its conditions of equilibrium are apprehended.
6) The apprehension of equilibrium (phenomenal or visual) depends on the definition and freedom of visual movement.

The building of the "Palazzo Ducale" appears as a gracefully balancing whole, without any apparent heaviness. This effect is given by the relationships existing between the solids and the voids of each one of the three superimposed parts. Solids and voids define the human movement and allow it to flow on each part in a differently regulated way.
The fact that each architectural form implies different conditions of sizes, movement and balance (whose apprehension is mutually dependent) shows us that the relationship of scale is unique for every individual architectural form.

This does not mean that the basic character of scale differs from one building to another, because — as we have already said — this character is based on common and universal criteria.

We may say that each architectural work has its own characteristic "scale"; and this is a property which differentiates all architectural works while, at the same time, it correlates them, through man, the common criterion.

If one of those partial relationships concerning size, movement and equilibrium changes, the whole relationship of scale changes, and, unless all of them are adjusted to the new situation, the architectural form is not correctly related to man; it is "out of scale."
Changing only the dimensional relationship between man and an architectural form.

...the smaller looks frivolous.

...the larger looks grotesque.

Both of them are not in correct relationship with man.
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Architectural form and color

It has been already said in this work, that architecture basically is the shaping of space according to human characteristics and needs, by means of solids, or, more generally speaking, by means of mass.

Mass and space are two inseparable elements. One penetrates where the other withdraws. One contains or is contained by the other.

We may say that architecture is the art of organizing the relationships between mass and space.

But how does man become aware of those relationships?

Space itself cannot be seen; mass itself can be seen only when it is transparent.

Existence of space alone or mass alone would not have any meaning for our vision.

What we actually see is the common limit of space and mass which is the visual expression of their relationship.
What we call architectural form is nothing but this visual limit which represents the organized relationships of space and mass and it belongs to both of them.

The fact that we "see" this form is due to the light.

It is the light which produces this limit common to space and mass. It stands between them and it separates and joins them by means of the lines which frame the surfaces, the surfaces which form the volumes, and the volumes which enclose the mass.

Without light this common limit — and, hence, the architectural form — visually would not have existed.

At night, when we look at a building from a certain distance, we only see a volume standing within the formless void of space and outlined by its contour. The prevailing impression is one of an outline suggesting only a formless mass and not of an organized unity. Under the daylight, the same building acquires its form, because the order of the relationships of mass and space is manifested. The contour of the building is not framing a formless mass any more, but an organized and self-sufficient unity.

But, as a stimulant of vision, light is nothing but colors.

"The sensations we meet with as elements of all vision are colours and nothing but colours." ¹

¹W. Ostwald, op. cit., p. XVII.
This means that color is the elementary source of visual experience. However, our apprehension of any visual form is not simply a sequence of chromatic sensations.

"Sensation is the conscious response to the stimulations of a sense organ or nerve receptor."²

We do not merely "sense" the visual form but we "perceive" it; and "perception" has to be distinguished from "sensation."

"Perception is the organization of the perceptual materials according to those structural and qualitative relations which are given in immediate apprehension."³

Basically, those perceptual materials are colors.

We may say that the simplest condition of vision is that of a continuous and uniform field of color (very rarely existing in actuality). This individual color does not have much, if any, meaning by itself.

It is capable of acquiring a meaning only when it is related to previous experiences and only through its relationship to other colors.

Then, it can produce a feeling (pleasure, joy, vividness), an impression of a certain condition (warmth, coldness, spirituality) or a suggestion of something (fire, water, sky).

Seen on a particular object, the same color involves a range of different appearances caused by the

³Ibid., p. 48.
light and shadow. There is not a continuous and uniform field of one color anymore and what we see now is a combination of related colors.

Now, the object of our visual experience is not an undifferentiated sensuous stimulation, not even a mere juxtaposition of several colors, but it is a new visual condition, resulting from the relationship of those colors. This new condition of visual experience is a "visual form."

It is evident now that though the individual color stimulation is not capable of producing a visual form, it is, however, the primary component element of this form.

In order to have "relationships" — and hence: form — more than one of those component elements are required. Then, the relationship of one color to another becomes a source for the creation of new, purely formal elements. Thus, the boundaries of the color-fields produce lines and shapes and because those new elements constitute definite units which can be compared mutually, once again another element is created and introduced — size.

It is not the purpose here to follow the evolution and sequential creation of visual form from its primary components to its full meaning. What can be noted now is that as soon as its primary components
are related, new elements appear whose interrelations introduce also new elements. This means that a major property of the colors is to increase the number of the potential relationships which become indispensable parts of the "construction" of the visual form.

Color, as the primary potential element of the visual form, is the only one that can be conceived independently of any other element or relationship — except of other colors. However, color is not only a kind of visual alphabet; its combinations produce relationships, but its action does not stop there.

The case of color is not similar to the case of letters in the formation of written, intellectual forms. The combinations of letters constitute the words and the words produce the ideas, but the way the letters are written — large or small, black or red — does not have any important influence upon the intellectual form which is expressed by the written ideas.

Color is something more than mere embodiment or descriptive element of the visual form. It is an integral part of it; it is an inseparable part of the governing context of the relations.

In every color combination by which a new element of the visual form is produced, the colors involved are not only the components of it but also they condition the quality of this element.

"A pattern of colors in red and purple is not the same aesthetic form as the same pattern (defined in terms of space alone) in red and green and the reason for this is that the given qualitative relation between red and purple is
not the same as that between red and green. 

From what has been described up to now, it is evident that the apprehension of architectural form — like any visual form — involves a mental procedure in which colors are the primary data given to our senses.

This procedure is not simple. It implies the whole problem of the perception of our physical environment and its center is not the external world but man himself.

It begins with physical phenomena (radiant energy in the form of electro-magnetic waves, absorption, transmission and reflection of light), it continues with physiological phenomena concerning the structure and the functioning of the eye and the nervous system and, finally, it involves complex, physiological, psychological and aesthetic reactions which are related to the whole psychic and spiritual world of man.

Generally, visual form and its perception has been recorded as a major problem since the time of Aristotle. It has occupied philosophers as well as physicists, physiologists, psychologists and artists. Yet, there is no theory that gives a complete solution to the problem. What those theoretical inquiries have shown

Ibid., p. 61.
is that:

"Physical-energy distributions are essentially different from the resulting conscious responses; it is the dependability of the correspondences in ordinary circumstances which give rise to the illusion of reality."5

This means, that we do not see things as they originally are or as they are related to each other; only one part of what we "see" comes from the object, the rest comes from within ourselves.

But, the examination of the problem of perception is not within the scope of this work. However, the examination of scale involves inevitably the examination of perceptual phenomena, since every relationship concerning man and his visual environment is basically a perceptual one.

The problem of man's attitude towards his visual environment is the main problem of architecture since architecture is the art of organizing the relationships between mass and space which, in a final analysis, are nothing but relations of visual elements.

"I consider the psychological problems in fact, as basic and primary, whereas the technical components of design are our intellectual auxiliaries to realize the intangible through the tangible."6

5Committee on Colorimetry, Optical Society of America (Ed.), The Science of Color, p. 152.

6W. Gropius, op. cit., p. 20.
It seems apparent now what the character of the relationship between color and scale is. Color is the beginning of all perceptual activities and scale is based mainly upon such activities.

In order to define this relationship we will have to examine briefly the characteristic properties of color which are involved in the apprehension of the architectural form and which contribute to the establishment of scale. These are properties which have often been observed and studied. Therefore, their examination in this work, based on already known principles, is concerned only with their value as elements of the visual manifestation of architecture.

Properties of colors

By reference to the physical or psycho-physical conditions under which colors are commonly experienced, they have various "modes" of appearance. According to the Science of Color, the modes of appearance of colors are the following:

**Illuminant mode.** When the color is perceived as belonging to a source of light.

**Surface mode.** When color is perceived as belonging to a surface, that is: when it comes from a light reflected by a physical surface.

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8Com. on Colorimetry, Opt. Soc. of Am., op. cit., p. 146.
Volume mode. When light passes through the bulk of a more or less uniform and transparent substance and gives the impression of one color.

Illumination mode. When in the field of view there are illuminated objects which reflect light and cast shadows or when reflecting particles exist in the atmosphere. (Whether the source of light is present or not.)

Film mode. When we see a reflecting surface through an aperture in a screen capable of masking a small area of this surface. The colors of spectrum are also film colors.

The illuminant, surface and volume modes are classified as "object" modes and the last two as "non-object" modes, because the first group is commonly associated with objects, and the second group is not.

Regarding those two groups of colors, D. Katz, comparing a spectrum color (non-object) and the color of a piece of paper (object), remarks that one can feel that his eye is capable of penetrating more or less deeply into the spectral color while in the colored paper its surface appears as a barrier which the eye cannot pass. 9

"We have here a phenomenon of visual resistance which in its way contributes to the structure of the perceptual world as something existing in a actuality." 10

When a spectral color is directly before our eyes, the field on which it is seen appears always

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10Ibid.
perpendicular to the direction of vision while the
color of an object can assume any orientation whatsoever with reference to the direction of vision.\textsuperscript{11}

What has particular importance for the perception of our environment and therefore for the organization of visual relationships is not the modes of appearance of colors themselves, but two facts about them:

"Under ordinary conditions, the modes of appearance are remarkably stable and dependable: surfaces remain surfaces; illuminations remain illuminations; volumes remain volumes; and so on. Because of this stability, the modes make a major contribution to the perceptual frame of reference which permits the individual to respond effectively to his physical environment. The external conditions are sufficiently potent that each individual is perceptually consistent with every other individual as well as with himself. On the other hand, the fact that the modes do depend upon the external conditions of viewing means that they do change in reaction to changes in the external conditions. Moreover, very simple or seemingly trivial changes in external conditions are occasionally sufficient to cause a shift or conversion from one mode to another. Though the modes are qualitatively different and do not lie along a continuum, they do seem to exhibit differences in degree, and these help to account for more or less easy shifts from one to another."\textsuperscript{12}

\textsuperscript{11}Ibid.

\textsuperscript{12}Com. on Colorimetry, Opt. Soc. of America (Ed.),\textsuperscript{\textit{op. cit.}}, p. 146-147.
The "shiftiness"* of the modes can be easily noticed in actual architectural situations.

i.e. When the illumination behind a perforated screen wall is strong the openings on the wall show a color which does not have a definite surface and it allows the eye to penetrate in it; in other words there is a film-color effect.

By placing strong illumination in front of the screen wall, its solid parts become bright and instead of openings we see black surfaces which look like they were painted on the wall. This means that the effect of film-color has shifted to an effect of surface color.

Shifting from one "mode" to another it is not only the result of external factors — such as changing of illumination — but it may also be produced by a change of mental set or interpretation.

One may interpret this figure as representing a cube which means that the colors of this figure are seen in an illuminant mode of appearance.

Another may see a simple two-dimensional design with three different colors — white, gray, dark gray; for him these colors have a surface mode of appearance.

Generally, both external and internal factors are involved in the apprehension of the modes of appearance of colors. It seems that the internal factors are stronger because when the mode is doubtfully or ambiguously determined by the external factor, the

*Word used in ibid.
The internal factor of "set" becomes especially important. We may say that man usually apprehends colors as having the mode which is more pleasant or more meaningful for him and not the mode which is more natural for the colors to have.

i.e. in the previous example very few people would perceive the colors of the figure in the "surface mode," though they actually are in this mode.

In our daily association with the things of our environment we never experience a pure color "sensation." What happens is that we give a meaningful interpretation to the color stimuli which means that we "perceive" color.

The various "perceptions" of color come necessarily from an appearance of color in one mode or another. What is important for the phenomenal description of those "perceptions" are the attributes which we render to the various modes of appearance. With those attributes we describe colors as they appear to be for human apprehension and not as physical phenomena.

Hue (distinguishing color, tone), Value (shade, lightness) and Chroma (saturation, intensity, purity).

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"Term meaning: readiness to respond in a specific way.


**"sensation," see p. 59.

***"perception," see p. 59.
tint) are the three major attributes of color. They
"... describe any color as accurately and as readily as
the three dimensions of a box describe its length, breadth
and thickness."\textsuperscript{14}

These terms have been established by the Munsell
system of color notation which gives the following
definitions:

\begin{align*}
\text{Hue:} & \quad \text{Colours can be defined as achromatic (i.e. white, gray and black) or chromatic (all the others). Hue is the attribute of a chromatic colour by which, for example, red is distinguished from blue, blue from yellow, etc.} \\
\text{Value:} & \quad \text{A term used to compare by means of a uniform scale ranging from ideal black to ideal white, the varying degrees of lightness of different colours.} \\
\text{Chroma:} & \quad \text{A term used to describe by means of a uniform scale the quality by which a colour is distinguished as weak, moderate or strong.}\textsuperscript{15}
\end{align*}

According to M. Tscherning:\textsuperscript{16}

\begin{align*}
\text{Hue depends on the wave length alone or in other words, hue is the position of the color on the spectrum.} \\
\text{Value depends on the quantity of light.} \\
\text{Chroma depends on the white which is found in all existing colors.}
\end{align*}

\textsuperscript{14}F. G. Cooper, \textit{Munsell Manual of Color}, p. 25.
\textsuperscript{15}"Colour on School Buildings," \textit{loc. cit.}, p. 4.
Insistence is another important attribute of colors.

D. Katz, who was the first to study and describe this attribute, gives the following definition:

"We shall call that one of two colors the most 'insistent' which seems to possess the power of catching the eye more readily and of holding it more steadily." 17

According to the Science of Color, the insistence of colors is associated with the value of the achromatic colors and the chroma of the chromatic colors.

"Especially bright or strong sensed colors in general rank high in insistence." 18

It is obvious that an object color cannot be "insistent" by itself. The insistence of colors depends on contrast.

Maximum contrast is obtained by the use of colors of extremely strong chromas if they differ sufficiently in value from black and white.

A yellow of extreme chroma on a black.
A strong dark blue on white.
A strong yellow on dark blue.

Size is another attribute of color.

A color which might be objectional or not interesting in large areas can be significant and stimulating in small areas and the reverse.

17D. Katz, op. cit., p. 108.
18Com. on Colorimetry, Opt. Soc. of America, op. cit., p. 150.
The apprehension of a color depends on the size of its area because the degree of its insistence (chroma and value) change with a change in area.

For this reason a contrast between two colors suggests an apparent difference in size. Two identical areas of black and white when they are compared show apparently a significant difference in size. The same thing happens between yellow and blue or red and green, and, generally, between cool and warm colors.

Though many believe that the difference in apparent size is a matter of hue as well as luminosity, it seems that luminosity is the main factor. For this reason and as a general rule, a light colorant appears larger than a dark colorant of identical area.

According to Moholy-Nagy:
"... the 'largest' color is white, followed by yellow, red, green, blue and black." 20

Kandinsky, who examines colors intuitively, believes that yellow and orange have the property of an eccentric movement; this makes them expand and appear larger. The reverse happens with blue and violet which have a concentric movement and therefore they contract and appear smaller. 21

See p. 78.

"The "luminosity" of a color depends on the amount of light it reflects.


20L. Moholy-Nagy, Vision in Motion, p. 155.

21W. Kandinsky, Concerning the Spiritual in Art, p. 60.
It seems that luminosity gives to color a property of expanding in space and this makes its area appear larger.

This can be noticed in a simple tungsten lamp whose wire looks much thicker when the lamp is on than when it is off.

Relative, also, is the phenomenon of irradiation, in which a light area projected visually on a dark background appears as having its boundaries expanded, while a dark surface projected on a luminant background is "devoured" by the light and it appears smaller.

For the same reason that two colors show an apparent difference in size they also show an apparent difference in location.

This way, a darker color seems as being farther than a light one, even if both of them are actually on the same surface.

It is known that warm colors have the property of "advancing" while cool colors are "retreating."

Apparent location of colors depends again on their luminosity. This explains the reason why warm colors are "advancing" and cool colors are "retreating" since the first usually reflect a greater amount of light than the latter.

Another attribute for the phenomenal description of color is the shape of its area but, generally, shape does not influence the apprehension of color. However, many artists have seen a relationship between color and its shape.
Kandinsky says that:
"Generally speaking 'sharp' colors are well suited to sharp forms (e.g. yellow in the triangle) and soft deep colors to round forms, (e.g. blue in the circle)." 22

Faber Birren believes that colors suggest and therefore suit to certain shapes.
- red - square, cube
- yellow - triangle, pyramid
- orange - rectangle
- green - hexagon, icosahedron
- blue - circle, sphere
- purple - oval 23

Those remarks are not within the limits of the simple perception of color and even if such properties of color are valid, they are not pure "plastic" properties but they involve thoughts and symbolisms which are beyond the immediate apprehension of the visual forms.

As we have already said, electromagnetic energy (light or the color stimulus) is the cause; color sensation is the effect. The spectrum has an infinite range of wave lengths and it is estimated theoretically that the number of the various color sensations, that is, the number of colors which the human eye is capable of distinguishing ranges between a few thousand and ten millions. 24 However, the various systems of color notation do not show more than 150 simple colors.

Concerning Architecture, researches in England (British Building Research) resulted in the issue of the British Standard

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22 W. Kandinsky, op. cit., p. 47.
23 F. Birren, op. cit., p. 40.
2660:1955 (Colours for Building and Decorative Paints) which contains 101 colors as the colors that are sufficient for architectural use.25

Though we can distinguish all the colors of a visual form, their number does not have a great significance for the apprehension of this form since we have a tendency to see them not as many individual colors but as groups of similar colors.

"We resolve them into six to ten primary colors, following the psychological law of the threshold of optimum discrimination. This means that while innumerable gradations of color exist we tend to react to simple but strong sensations and often we simplify what we see to prevent its throwing us into confusion."26

Various colors do not have the same aesthetic appeal on man.

Color preference tests27 have demonstrated that reds, blues and violets are liked much more than oranges, yellows and greens.

There is also difference in preference between two values or two chromas of the same hue which is often greater than between two different hues.

In addition to the specific value of the hue, color preference is conditioned by the area the color


27M. Graves, op. cit., p. 80.
occupies,* by the object or condition with which the color is associated** and especially by the presence of other colors.

The last remark shows that it is not the preference of the individual colors that counts in a color composition but the aesthetic effect of the combinations of colors.

The basis of the pleasing sensation is measured relationships or order, and, therefore, combinations of color based on such relationships are pleasant.

The problem of defining the principles of order in the relationships of color is based on the well-known fact that the appreciation of color depends on psychophysical reactions and the most important of them is that man answers to every color with its contrast.28

"Color harmony is the perfectly balanced condition of the complementary energies whereby the complementary to every color is the result of the physiological function of the eye."29

All theories of color organization have been developed upon this basis. They have defined objective rules for the orderly arrangement of color in pleasant

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*See p. 70.
**See p. 77.
29Ibid.
relationships and they have established color circles in which every color has its complementary.

The first step was done by Newton (1642-1727) who analyzed the light and organized the first color circle using seven colors. Goethe (1749-1832) used six primary colors for his circle and defined the basic complementary pairs as yellow-red blue, blue-red yellow, purple-green.

Two color theories and systems of harmony have been comparatively the best and they form the basis for the study of colors in our time.

One has been developed by the German scientist W. Ostwald. Ostwald's basic complementaries are: yellow-ultramarine, ice blue-orange, red-seagreen, violet-leaf green.

The other has been developed by the Boston artist A. H. Munsell. His basic complementaries are: yellow-purple blue, blue-yellow red, red-blue green, red purple-green, purple-green yellow.

Black and white can also be considered as complementaries.

The Science of Color notes that the unsaturated complementaries provide the best

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30W. Ostwald, op. cit., p. 7.
31Ibid., p. 15.

*Ostwald's theory appeared in 1916 with the publication of his book Die Farbenfibel (The Color Primer).
32W. Ostward, op. cit., p. 80.

**Munsell published his first color chart in 1905.
33M. Graves, op. cit., p. 136.

34Com. on Colorimetry, Opt. Soc. of America, op. cit., p. 162.
harmony of complementaries and that strong or saturated complementaries are unpleasant because they produce a kind of vibration caused by the continuous and different ocular accommodation.

The relations of colors whose hues are in sequence in the chromatic circle are also considered as harmonic. The monochromatic relationship of color can also be harmonic; that is, the relationship between colors which have the same hue and chroma but different value. This is the simplest harmony of colors.

The use of the academic rules of color harmony does not solve the problem of a color composition. However, those rules are valid tools for the proper relation of the composition to man, since their principles of color harmony are based on unchangeable psycho-physical human properties.

It has been said before* that in reference to previous experiences and in relation to other colors, a color or a relationship of colors are capable of producing a certain feeling, impression or suggestion. Colors, being inseparable elements of our environment, are commonly associated with objects or conditions of our daily experience. This way actual conditions related in a color and interpreted through association become a means of suggesting conditions not at the moment.

*See p. 59.
actually experienced.

Through association, colors acquire various meanings which not only become an element for the apprehension of the visual form but they also serve as attributes for the phenomenal description of them.

Best known are the properties of color to suggest warmth, coolness and weight.

Depending on their hue, colors are classified as warm or cool colors.

Yellows and reds are warm colors.
Blues and greens are cool colors.

Although coolness and warmth depend on hue, value and chroma contribute also to such impressions.

As a general rule deep colors tend to appear heavier than pale colors. It seems that the apparent weight of colors depends on their luminosity. Therefore, colors with weak chroma and high value appear as lighter than colors with strong chroma and low value.

E. Bullough explains this characteristic of colors as an association with the fact that a dark color appears as having more "quantity" than a pale one and therefore it is heavier.
He says that when we have a red and a pink, red appears to have more substance; if pink were added to the pink it would eventually become red.\footnote{E. Bullough, "On the Apparent Heaviness of Colour," \textit{The British Journal of Psychology}, Vol. II, 1906-1908, p. 111-152.}

Through association with material objects, colors can express properties such as softness, hardness and
strength or weakness in force resistance.

This way warm and earthen colors usually suggest the soft and not so strong nature of organic materials (wood).

Cool and metallic colors suggest the hard and strong nature of the inorganic materials.

Kandinsky found such properties in the very nature of colors:

"Some colors appear soft (madder-lake) others hard (cobalt green, blue-green oxide)." 36

It is a well-known fact that color is capable of affecting us powerfully and inducing definite "moods."

Whether such properties of color are the result of association or of direct psychical influence is not quite clear. But, there are precise reactions and "moods" to be related with certain colors or combinations of colors.

Warm colors are considered as aggressive, active, stimulating and promoting joy and cheerfulness.

Cool colors are aloof, retiring, serene, and they make us feel relaxed and calm.

Other colors are gay -- like yellow -- or sad and suppressing -- like purple, violet or black.

Furthermore, color having a strong emotional appeal lends itself to symbolism. Being associated with religious and other beliefs, color has acquired certain symbolic meanings which have been established.

36 W. Kandinsky, op. cit., p. 45.
in man's mind through the ages and they influence his attitude towards the various colors.

Large areas of deep purple may be pleasant in a church or other ritual building but they are objectionable in a living room or in another space with simple character.

The properties of colors just examined are fundamental for the explanation of the role of color in architecture. In the next chapter, it will be examined how these properties of color contribute to the establishment of scale.
The properties of color, dealt with in the preceding chapter, principally show that every color relationship and every different way in which a color appears is interpreted meaningfully by man.

The implied meaning does not refer to an abstract knowledge about color itself, but it concerns an immediate knowledge about the visual form in which the color belongs. This means that the colors of an architectural work do not simply "paint" its form but they constitute it, since any visual form is the meaningful interpretation of all the visual elements which are given for its apprehension. As we have already said, an architectural form acquires its basic meaning through its relation to man. Therefore, what serves for the establishment of this relationship is the colors of the form, since colors are the basis of all visual elements. Color -- in the various ways it appears -- creates the architectural form and at the same time it creates also the conditions which demonstrate the "fitness" of this form to its human purpose.
Every property of the architectural form regarding scale has its origin in colors.

Now, it seems obvious what the relationship is that exists between color and scale.

In the following pages this relationship will be analytically examined by explaining this relationship and the effect of color on each one of the three component parts which seem to constitute scale.

Color and "definition and freedom of visual movement"

One of the properties of colors which have been described is that they "catch the eye" — the property of insistence.

Every color has this property independently of its mode of appearance. By "catching the eye" every color serves as a visual barrier.

In the case of non-object colors this barrier does not have a definite location in space. Object-colors do not only attract the eye; they also offer a resistance, they do not let the eye penetrate through their surface and thus they show the location of their field in space.

As we have already seen, man's primary demand for a definite space is mainly a demand for visual definition or definition of its visual movement. We can see now that the satisfaction of this demand depends exclusively on colors and their property of insistence.
It is the color which offers a reference for the eye—a visual boundary that serves as a definition of space. But every color has a different degree of insistence. Moreover, some colors let the eye penetrate, other colors do not. (Non-object colors—object colors.) This means that our visual environment is a composition of colors in which every color attracts or resists the eye differently.

It is these properties of colors which primarily make an architectural form have a meaning. This meaning expresses the fact that the architectural form is a plastic entity, that is, a sum of relationships of actual space and actual mass which is an integral part of our environment.

These same properties of colors, (attracting or resisting the eye differently), is what makes visual movement possible. In fact, this is the very meaning of visual movement—changes of visual definition.

And since "freedom" of visual movement means visual movement in an organized sense, it is obvious that this freedom depends on the characteristics of colors regarding their properties of different spatial definition; it depends upon the organization of colors according to those characteristics.
Visual movement following the colors of a form, it follows a certain contour in space because colors set the boundaries of this movement in various locations depending on their properties of attracting or resisting the eye.

The different conditions of visual definition which make the plastic existence of an architectural form possible are mainly expressed by the differences of colors in value.

A high value expresses a convexity, a low value expresses a concavity, when those values are compared.

This is shown in Plate 5, I, where white, black, and the different values of gray express the different positions of the architectural elements in space.

Generally, the intense and especially the warm colors "pull" the elements of the architectural form closer to the viewer.

They unite furniture groups and they make high ceilings appear lower.

Colors of low intensity and particularly the cool ones extend seemingly the limits of space by pushing the architectural elements away from the viewer. Colors show in this manner how the volume of space fits into the contour of the masses; they show also how space itself is articulated, or in other words,
they define the flow of visual movement into the volume of space.

In this way: A definite space can be suggested by colors. The blue columns against the orange "separate" the space; the area in shadow is intensified because its darkness heightens the same effect. (Plate 5, II).

A larger space can be subdivided into smaller spaces by different colors. (Plate 5, III).

Colors on the exterior of a building are capable of suggesting how the interior space is organized. (Plate 5, IV).

But spatial definition of visual movement is not only concerned with differences in depth. Each surface, existing in a different depth, is a field on which visual movement seeks definition.

Sufficient differences of colors in hue, value or chroma, differentiate the elements existing on the same surface and define the course of the visual movement on it. (Plate 5, V).

Even on the same surface, colors are capable of suggesting apparent differences of depth depending on their contrast as it is shown in Plate 5, VI, where the areas between the mullions have an "infilling" or "screen" quality.

The "freedom" of the visual movement depends on the arrangement of the various spaces — defined by colors — and on the ways in which the transition from one of those spaces to another, or from one condition of definition to another, is suggested.

There are certain arrangements of colors which favor the visual transition and thus they give a sequence to the flow of visual
movement in space. The principal ones are:
Repetition of the same color.
Gradation of same colors in value or chroma.
Direction indicated by strong and vivid colors which attract the sight and they direct it.

Color and "measure"

Because of their properties to differ in terms of visual definition, colors have recognizable boundaries between their fields. Those boundaries form lines, shapes and volumes. Since these elements, shape in particular, introduce determinate units which may be compared with each other, the procedure of "measure" and, therefore, the establishment of dimensional relationship between man and the architectural form is possible.

This way, colors express another part of the meaning of the architectural form which scale implies. It is the meaning concerning the quantitative correlation (bigness, smallness) of the form with man, and therefore with the whole environment, since man is the measure of everything.

The procedure of "measure" is based on the properties of color concerning visual movement, because the transition from one part of an architectural form to another and from the various parts to the whole is nothing but the transition from one color or composition
of colors to another.

The effect of color on "measure"

The same properties of color which affect the definition and freedom of visual movement affect also the procedure of "measure" on an architectural form and its space.

Extending or contracting the limits of a space by means of colors, a space appears larger or smaller, deeper or shallower, higher or lower, than what it actually is. (Plate 6, I).

Bright colored elements look larger compared to dull-colored elements of the same size. This is the case with the columns in Plate 6, II. The orange columns appear taller than the gray ones, although all of them are of the same height.

A strong impression of visual movement established by a repetition of contrasting colors may show a space deeper or shorter than what it is. (Plate 6, III).

The dimensions of a space can be better apprehended when visual movement is articulated in that space with colors dividing it, in smaller spaces and creating a succession of different conditions of visual definition.

But the procedure of "measure" is mainly affected by the ability of colors to unite and separate the various elements of an architectural form, and in this way establishing a series of relationships which relate each element to the other and finally to the whole form.
Plate 7.
Plate 8.
Plate 9.
When a color is prevailing on several elements of the same form, those elements are united visually into one group. The same thing happens in the case when those elements have relative colors. This is because colors of "one family" (mainly colors of the same or similar hue) are resolved into the impression of one prevailing color according to the law of the threshold of optimum discrimination. This way, minor parts of the form are united and they make few major parts while the whole form is separated into few major parts whose sizes can be easily compared.

In the case of the building shown in Plate 7, we may say that the whole upper part is resolved into one area of blue and the louvered part into one area of white; also, the brick walls are resolved into areas of red and the lower windows into areas of black. (Plate 8).

The same procedure is followed on each individual group of the same prevailing color, where further similarities or relations of colors form smaller unities, dividing each major part into smaller parts whose sizes are again compared.

In this case the elements of the upper part are united into groups depending on the similarities of their blue colors in chroma; thus the large area of the prevailing blue is subdivided in smaller horizontal parts. In the like manner, the white, red and black areas are also subdivided into smaller unities. (Plate 9).

Finally, this procedure leads to the smaller elements which cannot be further analyzed, for they are

*See p. 74.*
Plate IO.
irreducible unities by themselves.

In the same example, this is the case with the various white lines (such as the lines of the framework, of the louvers, of the mortar joints and of the mullions of the windows) and the colored areas between those lines. (Plate 10).

Repetition of the same color suggests a visual movement whose rhythmic changes of definition serve in the same way as the subdivisions of a yardstick. The smaller irreducible elements that have the same or similar colors establish a series of points of reference which measures the part in which they belong. Similarly, the repetition of smaller parts with the same prevailing color measures the major parts. The comparison between the sizes of those major parts relates all measured parts together and establishes a continuity of dimensional relationships from the smallest element to the whole.

Color and "equilibrium"

The difference in visual definition and resistance of every color element of the form implies an energy which actually is a human energy but it is rendered to the colors. Colors represent visual forces and we have already seen that we react to those forces in trying to establish an equilibrium.
A characteristic reaction leading to the establishment of this equilibrium is man's response to every color with its contrast.

The balance of all the energies implied by the colors of the architectural form gives satisfaction to man's primary demand for visual equilibrium. And this demand is so strong that, generally, only when it is satisfied do we consider the relationships of colors aesthetically correct; then, we call them harmonic.

We may say that, in this way, color expresses the "qualitative" meaning of the architectural form. Because in a general aspect, visual equilibrium is a "qualitative" relationship between man and architectural form, since the equilibrium of the sensuous energies implied by this form leads to the aesthetic appreciation. When our visual impressions and generally our sensations do not balance, the form is not considered aesthetically pleasant.

Furthermore, the colors of an architectural form represent visually those material properties such as actual forces, weight, hardness or softness because of their associative qualities. For this reason the physical balance and stability of an architectural work is apprehended visually as an equilibrium of the visual forces implied by the colors of its form.
The effect of color on "equilibrium"

As we have already seen, equilibrium in architecture means the establishment of a restfulness in which the human activities can be developed. The forces involved in this equilibrium are visual forces coming from the visual manifestation of the physical properties of the building as well as from the requirements of human activities within the architectural space.

The visual forces implied by the colors of the architectural form must be organized as if they are actual physical forces in order to give the feeling of the phenomenal equilibrium of the form. In this manner, in order to balance around a vertical axis (tangible or intangible) an architectural form must have its colors distributed not only according to their apparent weight but also according to their properties to act as visual forces upon man's impressions.

A small area of a dark color balances a large area of a pale color because of their difference in apparent weight, but a small area of a color of great attention-value, such as a saturated color, is capable of balancing a large area of a dark but not strongly sensed color.

Vertical balance requires from the color composition of a form that it exhibits a correct distribution of apparent weights. This means that generally dark
or strongly contrasted colors must be placed at the lower part of the composition, while pale or weakly contrasted colors must be placed on the upper parts.

In the case of forms in which solids are dominant, correct distribution of the apparent weights, expressed by colors, manifests stability, since the bulk of the material is already an indication of ample resistance to forces.

But the phenomenal stability of an architectural work does not always depend on the distribution of the apparent weights. When in an architectural form (Plate 11) voids are dominant, the conditions of equilibrium are different. Heavy loads are concentrated on few and comparatively small elements which have their potential in force resistance increased in order to compensate for lack of material. Therefore, the phenomenal equilibrium of such a form is not correctly expressed if colors are arranged according to their properties of apparent weight. Its colors must act as forces offering resistance to the loads and not as passive indications of weight. (Plate 12).

Strength is expressed by intense colors which intensify visually the elements that bear the loads.

A color which appears heavy usually does not suggest strength. This is the case with black which does not suggest strength, though it is the "heaviest" color. White -- the "lightest" color -- can intensify visually the strength of an architectural element.
Black is like sand — heavy and weak.

White is like the egg-shell — light and strong.

Generally, on an architectural element which indicates clearly how forces are acting in it — such as a column, a beam, a shell — intense colors, contrasting and stressing the importance of this element in its environment, suggest a high potential of force resistance.

This is why metallic and lustrous colors intensify visually the strength of thin, linear elements. This is also the case with the light (white) mullions against the dark (black) window panes of Georgian Architecture.

However, manifestation of the physical balance and stability of the architectural form is only one of the factors which establish the equilibrium of the human space of architecture. It has been said before that this equilibrium depends on the neutralization of all visual forces; man, reacting through his intellect, is supplying the neutralizing forces. Architecture simply creates certain conditions of visual forces that must be complemented by human reactions in order to have this equilibrium established.

The "qualitative" meaning of the architectural form depends on the degree and character of this complement. The visual forces of the colors can serve as compositional elements for the purposive organization of the human reactions in the space of architecture.
An architectural element with a strong color might not be in accordance with the physical balance and stability of the form expressed by the whole color composition. But this might not disturb the whole equilibrium if the strong color suggests the importance of this element in the whole form, e.g. the strong red flagpoles in the Piazza San Marco, Venice. In this case, one reacts to the strong impression of the particular element giving importance to it and thus equilibrium is established. Suggesting strong visual forces by giving contrasting colors to non-important elements of the form or neutralizing the visual forces of the colors of important elements is equally wrong.

In a church, symbolic and ritual colors can supply the visual forces which make man react with his spiritual forces.

In a hospital, calm and neutral colors can neutralize all human reactions and thus create the atmosphere of calmness and relief which is required.

In general, those reactions to color have a psychological basis which cannot be adequately analyzed in this work. But their existence intensifies the fact that color is closely related to the human purpose of architecture.

Correspondence between the scale and the color composition of an architectural form.

The examination of the effects of color on each one of the three component parts of scale has shown that every property of colors which has an influence on one of those component parts influences simultaneously
all of them, in a similar way. This reinforces what has been already said about their common dependency.
It shows that they are inseparable parts of scale; each one is but "scale" seen from another aspect.

It has been also said that an architectural form is in "scale" when its visual conditions of "measure," "movement" (definition and freedom) and "equilibrium" are properly related between themselves. In the previous pages of this chapter we have seen that in all occasions every one of these visual conditions is the outcome of a specific arrangement of colors.

But in a particular architectural form all three conditions must be simultaneously expressed by the same arrangement of colors because for every architectural form there is only one color composition. It is through this composition that these three conditions must be expressed in their correct relationship which assures the correct expression of the "unique" scale of the form. This means that for every situation of scale there is one corresponding color composition. There is only one color composition which is able to express the scale of a particular architectural form.

There cannot be any rules defining this "correspondence" between the color composition and the scale of an architectural form.

What has been said in this work can serve only as an indication of the factors which must be taken into consideration when approaching this problem.
In all problems concerning the creative aspect of architecture where there may be "ultimate" solutions which are the best, the human variances prevent us from attaining those solutions. The same reasoning applies to this particular problem of color and scale. The "ultimate" color composition is the goal which cannot be reached. The degree of "correspondence" between color composition and scale of an architectural form depends on how closely the designer approximated this "ultimate" reality.

An examination of actual architectonic situations will serve to show how the colors of an architectural form establish its one and unique "scale" by expressing correctly all three aspects together. And, it should indicate the character of the correspondence between the color composition and the scale of each architectural work.
Examples selected to illustrate the relationship of color and scale in different architectural situations.

1. **Plane organization**
   - "Wall decoration," House of the Gei, Pompeii.
   - "Mile High Center," Denver, Colorado.
   - "Cafe de Unie," Rotterdam.

2. **Organization of space**
   - "Palazzo Ducale," Venice.
   - "Grand Room of Shoin," Nishi Hongan-ji Monastery, Japan.
   - "Gothic stained-glass window," Koenigsfelden, Switzerland.
Wall decoration
House of the Gell, Pompeii.

What is the "unique" scale of this composition? What is its meaning and how is it expressed by its colors?

a) This is a wall, an actual element of the human space, neither a painting nor a representation of another actual architectural element.

The gray framework of the visual "structure" of the composition does not have any relation to any actual structure. It does not suggest any actual forces and, for this reason, it does not have an intense color. Its role is only to separate and help articulate the panels with the vivid colors. Its neutral color expresses its passive character, not interfering with the "action" of the strong colors which are the main visually-acting elements of the composition.

The first horizontal line of this framework divides the wall, from floor to ceiling, in two equal parts. Vertically, the wall is divided in three equal parts.

Red is the dominant color. The two large, red rectangles dominate the lower half area suggesting the first principal dimension of height. They define the
area which serves as a background for the human body and its activities; they relate the whole composition to the actual human space. These red panels measure the whole wall horizontally, because, by being separated by an equal blue panel, they establish a rhythm and suggest a visual movement.

The lower part of the upper half of the composition forms a narrow strip. New colors now — strong, contrasting black and yellow-ochre — differentiate this strip from the lower half of the composition and they suggest a stronger horizontal movement because each color has a shape with a horizontal direction. This strip is the "horizon" itself, it indicates the eye level.

This is the reason why the few and small naturalistic details and decorative elements of the composition have been placed in this area.

The "horizon" now gives the exact relation between the human figure and the whole composition. It also serves as a transition from the lower to the upper part of the composition.

But, there is an important difference between those two parts. This brings up the second major point of this composition.

b) As we have already seen, the lower part — including the "horizon" — belongs to, and is part of the "actual" human space, while the upper part is a
representation of an actual space; it is expressing a similar space which is proportionally smaller than the "actual" human space. It is as though the lower part were a wall that was painted, but, the upper part may be likened to a "picture" of another space, "hung" on the wall. Each part, separately yet correctly, expresses a different relationship to man. In the upper part:

Different conditions of measure expressed by:
smaller areas of color;
more repetitions of the same color.

Different conditions of visual movement (definition and freedom) expressed by:
more "structural" lines;
more panels of the same color.

Different conditions of visual equilibrium:
the upper part is composed of two smaller unities of elements balancing each other on both sides of a large white area, while the lower part is one unity of balancing elements.

But, we can see how perfectly these two spaces are interrelated, each one expressing its own relationship to man but making an integral unity.

The two parts are closely related because:

1) Their dimensions are proportional to each other and to the whole composition.

What measures the lower part is the two red panels. What serves as a measuring unit of the upper part is the two smaller red panels. They show the exact proportional relationship of that "smaller space" to man; because each small red panel is 1/6 of each large red panel which, in turn, is 1/6 of the whole area of the wall.

2) Visual movement is directed from the lower to the upper part and this unifies the two parts, not only
because it indicates the transition from one part to
the other, but also because it establishes two principal directions on the whole composition.

The red colors show a direction from the lower corners to the center of the wall because the same red, existing at the lower corners, is repeated close to the center of the wall in smaller areas of similar shape. The yellow-ochre color shows a direction from the center of the wall to the upper corners, because the same yellow-ochre of the center is repeated in areas which become smaller as they get closer to the upper corners.

3) The visual equilibrium of the whole is a result of balancing relationships existing between the two parts.

The few, powerful, simple, large areas of color of the lower part are balanced by the numerous smaller areas of similar color of the upper part which are mingled with the areas of white.

c) Another major point is that this architectural element, this wall, defines space by being a plane surface. This is its plastic meaning (as being plane in space).

Visual movement can be correctly organized in this element; — Then, it can be free, but only as long as it is restricted to the two-dimensional area.

All colors of the composition are of the same value. Even grays and blacks are local, or "unshaded" colors; they do not suggest any depth.

There is a slight indication of depth, or perspective, in the small box shapes in the upper corners.
of the composition, but the impression of depth is strongly annihilated by the existence, on the underside of the "box top," of the same color (maroon) as in elements which do not have a meaning of depth, (i.e. the strip over the last line of the framework, on top of the whole composition; also the strips down the right side and in the center of the wall).

The same thing occurs with all the colors of the upper part. They could be taken as indications of depth, because they are parts of a composition having its own pictorial space; but this does not happen because the same colors are repeated on the lower part with exactly the same hues, values and chromas. And the colors of the lower part are strictly local, or "unshaded," as the geometrical arrangement of their areas suggests.

The three major points of this composition which have been analyzed show how colors "act" in the articulation of this wall. Colors are capable of expressing the true architectonic meaning of the composition. This, we have seen, is different from the meaning of a color-composition of a simple painting which has a different relationship to man.
Note: Color reproduction poor; actually, structural framework is gray, venetian blinds are yellow.

Plate 14.
What is shown here is only a part of the exterior wall of the building. It shows the relationship between the basic elements which, by their repetition, form the elevations of the building.

This wall is presented in two different ways:

a) with the Venetian blinds up
b) with the Venetian blinds down,
in order to show the effect of different colors on the same form.

A gray-colored framework is the basis for the actual structure as well as for the visual one. Its color is not intense but the width of its strips and the wide spacing of its vertical members make it the dominant element.

In the case where no Venetian blinds are shown, the black voids of the openings intensify both the color and the importance of the gray framework as the main structural element. The contrast between black and gray makes gray appear lighter in value.

It is known that when two colors are contrasted the light one appears lighter and the dark one appears darker.

The black of the void intensifies the importance of the gray framework as a structural element because it shows where forces are concentrated.
The visual equilibrium of the composition depends upon the balance of the different forces that the relationship between voids and solids implies. The black of the voids is a strong visual impression. The colors of the solids, intensified by the black, balance its strong impression. The mullions of the windows are rendered intensely by the black void. These, in turn, balance the larger areas of the gray framework and the yellow-ochre spandrels.

In the second case, the yellow appearance of the openings weakens the importance of the gray framework. Because 1) the contrast between yellow and gray makes the latter appear darker, 2) the yellow annihilates the impression of void and makes the openings appear to be filled with solid.

The conditions of visual equilibrium are less "extreme" than in the first case. The gray framework and the yellow-ochre spandrels balance out evenly without the interference of any other element; the yellow of the blinds acts as a neutral.

Going back to the first case, we can see clearly what the conditions of visual definition are. The gray framework gives the first important definition of visual movement by dividing the wall in smaller areas and clarifying the relations between voids and solids. The yellow-ochre framework, (spandrels), though it has a stronger color than the first, does not appear as
important, because its continuity is interrupted by
the gray and its vertical members have a narrower width
and spacing. By superimposing the two frameworks of
different colors a sense of void behind them is sug-
gested. In this way, the curtain-wall character of
this wall is strongly suggested, in regard to spatial
definition.

The gray framework measures the whole and defines
the voids. The yellow-ochre framework measures the
voids by defining their width and by separating them
in smaller areas. Its strong color serves as a visual
transition from one void to the other. Finally, the
thin lines of the aluminum windows clearly define each
smaller unit of void and give also a strong indication
of the actual human dimensions.
Palazzo Ducale.
Venice, 14th-16th Century.

The characteristic of this architectural form is its graceful equilibrium. All forces -- visual and physical -- are in a perfect state of balance, and the whole form seems like springing from the ground instead of pressing it heavily.

Being a form where voids are dominant, its equilibrium is based on the expression of strength by its elements, rather than the expression of weight. The intense white of its supporting elements contrasted with the dark appearance of the voids gives that impression of strength. The two lower parts of the building are nothing but rows of intense vertical white lines supporting the upper part which, with its pinkish color, is not heavy, but bulky.

The same strong contrast of white and darkness -- of white and black -- is what strongly defines the visual movement. White is solid and black is void. Horizontally, the visual movement is free to flow, following the rhythm of the interchanging black and white. It penetrates through the darkness, it comes out of it to meet the next white, the solid, and thus weaving between the columns it shows how the outside space is related to the inside, how the volume of void of the human movement is articulated.
The same visual movement measures the form and the space. The superimposed rhythms of the vertical white lines form a perfect yardstick which measures the width and the length of the building. The unit of this measurement is unmistakable: it is the human dimensions, introduced in this yardstick mainly by the balustrade of the second floor.

Vertically, visual movement is suggested by the decrease of the solidity of the parts and an increase of the number of parts.

The lower part has less white lines than its upper part; this suggests perforation, diminished solidity.

In the second part, white lines are doubled in quantity; this part is more "solid" than the lower one.

The upper part is perfectly solid but made up of many small elements. Its light color is a strong foil for definition of visual movement. Its perforations are comparatively so few that they intensify the solidity rather than weaken it.

Finally, the lace-like parapet is an intermediate element, neither solid nor void; it is airy. It suggests a transition from the mass of the building to the luminous void of the sky.

This visual movement measures the form vertically.
But what relates all parts to a perfectly measured unity is the dynamic equilibrium existing on this form, expressed mainly by the relationship of the three main parts.

The lower part manifests strength by the intense rhythm of the white lines which represent concentrated forces. But, proportionally, this part is smaller than the upper one. This is bigger but apparently weaker because its bulkiness — suggested by the continuous light color — does not manifest any organized forces. Dynamically, the two parts are equal while the properties of both of them are intensified by the middle part.

Its solidity intensifies the voids of the lower part and thus it increases the strength of the solids of this part.

Its voids intensify the solidity of the upper part, making it appear lighter and with no definite forces.

We may say that the proportions of the parts depend on the proportional relationship of the amount of forces that each part exhibits visually.
Grand Room (Chiroma) of Shoin.  
Nishi Hongan-ji Monastery, Japan (1624-43)

What forms this space is mainly the wooden structural framework which defines and subdivides it. Its modular organization perfectly measures the volume of the space. The conditions of physical balance and stability, that this framework manifests visually, are the basis for the visual equilibrium of this space.

In the formation of this space, the voids — the openings between the framework — are of the same importance as the solid members. Like invisible planes, those voids separate the whole space in smaller parts and they define its volume.

Colors, serving as a means to separate voids from solids, direct and articulate the visual movement in this space. The brown color expressing the material of the framework indicates the solidity of the members and — in a negative way — the void of the openings. In the case in which the openings are filled with solid panels, colors suggest an impression of void by differentiating the solid of the panel from the solid of the framework.

The decorative painting of the wall has a dominant gold color. This shiny color represents the sunlight which comes from the outside and illuminates the space. This feeling is intensified by the existence of many other golden-colored elements which look as reflecting this imaginary sunlight.
This way, the openings of the framework give the impression of void even when they are filled by a solid panel.

The same impression is repeated on the ceiling and on the upper subdivision of the central part of the framework. The openings between the framework of the ceiling appear like skylights open to the sunlight. The whole ceiling is apparently supported by linear golden-colored elements and this way it looks like "floating" over the space without exercising any heaviness.

What further intensifies this feeling of void is the black margins which separate every panel from the framework. The strongly contrasted black lines make any material connection between the panels and the members of the framework disappear. In this manner, the panels appear as not having any definite location in space; they look like openings to the open air. This differentiation between voids and solids expresses also the correct distribution of the physical forces.

The repetition of solids and voids which are represented correspondingly by brown and gold colors is a factor for the "measurement" of the space. Similar colors repeat the same "measurement" on the floor. Brown is again on the linear elements and a pale yellow-gray is filling the areas between the brown lines.
As we have said, what measures the space is the framework which is proportionally analyzed from the large openings between two vertical members to the small openings of the ceiling. Colors express a similar analytical procedure by their relations in the whole composition. All the colors of the composition have, more or less, the same or similar hues, but they differ in value. The gradation of values follows the gradations of the comparative sizes of the various elements and this is how:

The large elements -- panels and areas between the lines of the floor -- have gold or yellow colors, that is, colors with the highest values in this composition.

The framework has a brown color and the lines of the floor, which are thinner, have a darker brown color.

Finally, the thin lines of the margins and small decorative elements of the ceiling are black.

This way, the analytical sense which characterizes the container of this space is also extended to the invisible atmosphere of the space.

The correct differentiation of voids and solids not only expresses the distribution of the physical forces, but it serves generally for the establishment of the visual equilibrium in this space. The voids and the panels with the bright gold color suggest an openness and a freedom for visual expansion. The solids, with their strong brown color, balance this
feeling by suggesting a definition and a spatial order.
Gothic stained-glass window.

Its effect on the interior space of the Gothic Cathedral.

The interior of the Gothic Cathedral contains a space whose characteristic conditions concerning scale are:

a) It is in a complete dimensional relationship to man while it gives a feeling that it is immeasurable; it is an image of the Heavenly Universe brought down by clearly defined degrees and elements to the measure of man.

b) Visual movement is perfectly defined and organized in it, but this movement is free to expand in a boundless and spiritual space.

c) All visual forces suggest a movement towards the sky. Man supplies the balancing force by giving symbolic and spiritual meaning to this movement; thus he establishes the equilibrium of this space.

This is, in general, how the Gothic space is related to man.

Every element in that space expresses this relationship. To mention only a few of them ....
...the infinite number of the elements of the structure — (stones) — expresses the immeasurability of the space. At the same time they show the relation of the space to man by their size which apparently is correctly related to the human dimensions. The same immeasurability is indicated by the detailed ornamentation and the analysis of every structural member in numerous subdivisions.

...the decomposition of the matter, the analysis of the walls in light multi-perforated panels, all suggest an openness; they indicate the boundless of the space.

...the visual movement suggested by the columns, the pillars and nearly every element of the interior leads upwards, towards the ceiling of the nave.

Then, what is the role of the stained glass window in the expression of this relationship?

A space does not exist without light; light creates the invisible atmosphere which is the space itself. In the case of the Gothic space this atmosphere has a real existence with a quality of movement vibration and dynamic tension. This is due to the color of the light.

"Light is form, since it is admitted to the nave only after it has been patterned by the colored network of the stained glass window."

Light transforms the volume of void, the atmosphere itself. Reflecting on the various surfaces it

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1H. Focillon, op. cit., p. 23.
gives to this atmosphere a gradation of values and hues from the darkness of the remote corners to the bright colored rays coming from the windows. It shines with many various intensities and hues creating in this way the impression of numerous small surfaces of various depths. The space looks boundless. Visual movement is free to move within the space and to expand beyond its limits.

At the same time this boundless space does not loose its property of being definite. The colored light differentiates the interior space from the exterior one, changing the monotonous quality of the light of the northern countries into a polychrome and "warm" atmosphere. Colored light defines this space as being different than the open, the unorganized infinite space.

What is projected and diffused into the atmosphere of the Gothic space is the color composition of the stained-glass window.

We can see the expression of the above conditions of definition and freedom of visual movement on this color composition itself. Its colors are more or less primary with only few differences in chroma or value. The prismatic character of those colors makes the whole composition appear as being behind its actual plane.

This can be noticed if we compare the apparent position of the glass parts with the apparent position of the solid black parts. The latter appear in front
of the colored glass parts, though black is a color which regularly appears as receding when compared with chromatic colors. The strong vertical and horizontal black lines as well as the thin black network which forms the outline of every small area of color give the impression of a void and intensify the fact that colors are extended behind their actual position.

The analysis of the atmosphere in a manifold of different hues, gradation of values and intensities is also the factor which suggests the immeasurability of the space. What is important for the suggestion of this feeling is not the individual colors of the window but the total effect of their brilliant polychromy.

We can see in this particular composition of our example that the colors form a luminous pattern of numerous small areas. The human figures are analyzed in small areas of colors and thus they lose the character of a representational figure. They become abstract patterns of color and this way they do not influence the "measure" of the space; they cannot serve as references of human dimensions.

The colored light which attracts the eye in a space where dim light is dominant, the polychrome rays streaming from above, the airiness of the colored atmosphere, all suggest a visual movement from the lower parts of the space to the ceiling and a spiritual move-
ment from the earth to the sky.

In the window itself, as we have said, the whole composition of the chromatic colors appears as being on a "remote" plane. The black network defines the actual plane of the window and "sends" the colors behind it. The network of the small white lines defines this "remote" plane, and "holds" the colors balancing on it, by separating the colors with the different properties of visual definition.

Red is a background color that is "solid." Blue is a background which represents void. The white bands separate them and allow them to assume their proper role in the background of the composition. In a situation where the red robe of a figure meets the blue background there is no white or neutral color to split the areas; then, there is a "vibration" which takes the figure back to the plane of the red background.

Black and white have the same relationship as the one existing between the lower dark part and the luminous upper part of the whole space of the church; black shows where the visual movement starts and white is the light, the destination of this movement.

Here, we can see how those spatial relationships of the colors of the window, which are purely a matter of visual properties, are corresponding to symbolic and spiritual properties of the space of the Gothic Cathedral.
The conclusions to this study may be summarized as following:

SCALE is the relationship between man and the architectural form which gives to that form its primary meaning as an order of existence whose purpose is the expression of the organized human activities in actual space.

"Actual space" is the visual space in which every human activity is primarily a visual one.

The fundamental element of the visual space is COLOR.

A relationship exists between color and scale in architecture because:

- color is related to man physiologically, psychologically and spiritually, and
- scale involves the consciousness of the basic psycho-physical characteristics which man's existence in this visual
space implies; that is, the sense of "measure," the sense of "definition and freedom of visual movement," and the sense of "equilibrium."

Color gives meaning to these "senses" because their satisfaction depends on visual experiences and color is the basis of all such experiences.

Color is qualified by these senses because, through them, the colors which form the visual manifestation of the objects of architecture are interpreted into spatial relationships with a human meaning.

The basic apprehension of color as well as the sense of "measure," the sense of "definition and freedom of visual movement," and the sense of "equilibrium," are generally the same for all people.

But while man's apprehension of color tends to be an absolute, as a constant element belonging to the visual space, the relationship of scale is variable. This is because each architectural form has different arrangement of the "absolute" element and this involves different organization of the data, given by the above senses, within the human mind.

Each architectural form has its own "scale."

What differentiates the "scale" of one form from the "scale" of another is this different organization. What relates all forms, which are in "scale," is the
constant elements and "senses" that this organization implies.

The problem of architecture is primarily a visual one. What the designer has in hand as means to solve this problem is means of visual expression.

With these he shapes a container capable of containing man whose intangible "volume" is defined by his fundamental and constant senses of "measure," "definition and freedom of visual movement," and "equilibrium."

The technical means (structure, materials and construction techniques) serve to materialize this "container."

The number of the "containers," that is, the number of the architectural forms is unlimited because the variations of the human needs in space are unlimited. But each different architectural form must be made for the same intangible human "volume" which is the constant factor.

The primary and constant element that constitutes each architectural form is color. This is also the element which is capable of expressing the ability of each form to contain this "volume."

The designer is called upon to define the one composition of visual means (and, hence, colors) which a) gives the desired form for each situation of human
needs in space, and, which b) results in the one of the variable relationships to man which is appropriate to this form.

With this composition found, a unique relationship is established between man and this particular form; and this form is related to all other forms of human origin and purpose, existing in space.
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