# TRANSFORMATION FOR ARCHITECTS

by

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## 1: INTRODUCTION

> The economic man seeks the maximum of satisfaction with the least effort.... That is the very principle of economy.[1]
>
> Croce

Frank Lloyd Wright once responded to Mies van der Rohe's dictum that less is more by saying,"never use five lines where nine are required nor nine where five will do."[2] When seen in terms of economy, these two statements are not contradictories. In terms of economy in the deepest sense, less is more just in those cases in which it is not less, and transformation is a means to the more in less as well as to the more that is more.

Transformation is the variation of a generic form, element, condition or structure so that something changes while something else remains constant. Acts of transformation are manifestations of two fundamental human desires: the desire to unify diversities on the one hand and to diversify unities on the other. It is in pursuing these two fundamental goals that man often unconsciously becomes the transformer.

When Croce said that economic man seeks the maximum satisfaction with the least effort, he did not intend just the trivial truth that man is by nature lazy. What Croce meant to assert is that the basic principle of economy consists in the expenditure of only as much in

human resources as is necessary to fulfill a need or desire; no more and no less. But the fundamental human disposition to economy cannot be adequately expressed in the language of costs and benefits alone, and it is only the material bias of an historical period that tempts us to do so. When the mathematician tries to prove a theorem with as few postulates as possible, he too is expressing the basic human desire for economy. And when the linguist searches for the transformation rules of a natural language, his action is also motivated by a profound desire to reduce the multitude of apparently unrelated sentences to a few generating principles.

The arts too acknowledge the principle of economy. A drawing which is over-worked is also perceived as a drawing which is uneconomical because it contains more than is required to develop the idea or convey the image which the artist intended. The principle of economy runs deeper in the human psyche than a concern for benefits gained from effort expended. It runs to the very foundation of knowledge and thus to the law of parsimony.

According to an old Stoic doctrine, to know is to grasp; to hold the many by means of the one. The process of classifying by genus and species is also called classification by genus and <u>difference</u>. The genus is what a group has in common, while the several species constitute variations within the genus. To understand the relation between a genus and its several species is thus to grasp the many by means of the one. According to the Medievals, to know is to com-prehend; that is, to hold together, and what is held together in knowing was once also said to be the in-tention; that is, something held in tension. The old word

"intention" which is sometimes a synonym for "meaning" expresses just the sort of strain we feel in trying to hold the many aspects of a concept by the single word we use to refer to it. To know is thus to overcome the inertia of things--their tendency to remain pulled apart and separate.

Transformation is a technique we sometimes use to extend our grasp. In geometry transformation has been used for several hundred years to reduce the number of theorems requiring separate proof. Transformation has also been used as an organizing technique in the arts. Particularly in music, the process of thematic transformation has been a principle of organization which began to be used in late Medieval times and continues to the present day. A symphony is recognized as a whole rather than a potpouri of unrelated tunes because, at least in the best works, the themes of a symphony are all derived from a single melodic motive by the process of transformative variation. In music, the symphonic form and the variation form can be conceived of as structures which encourage the furthest possible extension of the grasp of a melodic concept or motive. Because fulfillment of the potential of symphonic form places the maximum simultaneous demand for both unity and diversity, it is a form that has been mastered by only a few supremely gifted individuals, among whom the most successful were Mozart and Beethoven. In the hands of these men, the symphony became a kind of alter ego or doppelgänger of the structure of knowledge itself. For, if knowledge is conceived of as the grasping of the many by means of the one, and the symphony is understood as a transformationally structured diversity, both will be seen to share the same fundamental organizing principle.

In architecture, unlike the other fields we have been discussing,

there is no history of the conscious use of transformation. There have been no problems transformation has been consciously used to solve, and there have been no phenomena it has been used to explain. None the less, we shall see that transformation occurs with some frequency in architecture, and this is a phenomenon that needs explanation. The explanation to be proposed here is that the architect is also motivated by the urge to economy, and that in response to that urge, he sometimes works transformationally--usually without being aware that he is doing so.

Economy has been an expressed concern of the architect at least since the time of Vitruvius, and it is a concern developed in architectural students even to day.[3] The student is taught to value the structured whole over the miscellany, and he is encouraged to find an organizing principle or concept which can structure his entire project. If, in these circumstances, he stumbles upon a transformational method of organization, it is because he exists in an atmosphere which encourages him to value this over any less integrative principle of organization.

Transformation, as a way of working, however has limitations as well as virtues when applied to architecture, and it is hoped that by presenting here an analysis of transformation in terms of what it is, what it does, and what it can be used to do, the architect will be in a better position to understand what it can and cannot do for him. It has been my personal experience that those who fail to understand the nature of transformation are as often the victims of it as they are the benefactors. Those who respond to the urge to unify a building by deriving all of its forms from a single geometric motive or figure,

need to recognize that in so-doing they are committing themselves to a formal principle that may needlessly limit the range of experience which the building can provide. At the same time, those who for want of the most basic understanding of transformation, have a tendency to throw forms together into a kind of architectural tossed salad, may come to see that a more highly structured organization is possible through a study of transformation.

In order to lay the groundwork for an understanding of transformation in architecture, we have to equip ourselves with an account which tells us what transformation is, and what it has been used to do in other fields. This is the task of the first chapter. In the second chapter, two alternative principles for guiding the investigation of transformation in architecture are discussed together with the conceptual problems any such extension of the concept involves. Finally, in the third chapter, we look at some cases of transformation in existing architecture and suggest some further applications of the technique.

Since transformation is the key concept in the investigation, and it has not been analyzed before, the major portion of this essay is devoted to that necessary task and to developing the conceptual framework necessary to guide the application of the concept to the architectural milieu.

## 2: THE CONCEPT OF TRANSFORMATION

### Introduction

At the outset it is necessary to recognize that transformation is what Wittgenstein called a family-resemblance concept.[1] If we look at several fields in which transformations are discussed; say, mathematics, linguistics and music, we will find not only similarities but also differences both in the types of operations which are called transformations and in the kinds of structures to which they are applied. For example, if we compare the concept of transformation in mathematics with the concept of transformation in linguistics, we will see that in linguistics, unlike mathematics, the term 'transformation' is also used to refer to operations of connection and combination. In musical analysis on the other hand, we find both kinds of operations refered to as transformations. Thus we must be prepared to recognize, as Strawson once put it, that ordinary language has no exact logic, and that consequently the extension or denotation of our key term "transformation" cannot always be pinned down to refer to only one kind of operation or structure type upon which operations are performed.[2] This can only be accomplished by an act of stipulative definition. It should not however be supposed that we are therefore entitled to use the word 'transformation'any way we like.

Rather it means that when we look for transformations in architecture, we shall have to keep in mind both the similarities and the differences between what are called transformations in the various fields studied.

In the early stages of this study of the nature of transformation, it will be advantageous to limit the discussion to examples from the field of geometry. In this way it is possible to eliminate a number of complications which must be dealt with when studying transformation in other fields. Once the basic concept of transformation has been developed from a geometric paradigm, it will be possible to deal more easily with the concept outside of the field of geometry.

Transformation in Geometry

In geometry a transformation is a change in an object from an antecedent structure to a consequent structure in a way that leaves at least one significant aspect of the antecedent structure unchanged, while changing some or all of the other aspects of the structure. In geometry, the transformation called reflection (Figure 2.1) specifies the relation between an object and its miror image. Reflection is a case in which a minimum change in structure occurs, since all that changes is the orientation of the figure in space. Topological transformations on the other hand represent the maximum possible alteration of geometric structure, since only the relationship of neighborliness of points along a line is preserved through this transformation (Figure 2.1).

The several transformations of geometry can be ranked in a table according to the degree to which they alter the structure of the figure undergoing the transformation. In Figure 2.1 these transformations are listed vertically in order of the number of characteristics of the

structure which are changed.

Using geometric transformation as a paradigm, it is possible to list and give further discussion to a set of four basic characteristics which transformations exhibit. These characteristics are not sufficient for the identification of all the types of transformations we shall want to consider, but they will serve as a starting point. The four characteristics are as follows:

1) Transformations have a relational aspect and an operational aspect.

2) Transformations cannot be identified just on the basis of information presented by the transforms themselves, but rather must be identified on the basis of knowledge or reasonable belief that one transform has been derived from the other.

3) Transformations always leave at least one significant aspect of the structure of an object constant while at least one other aspect undergoes a change.

4) In transformations there is always an antecedent state and a consequent state.

In the following paragraphs, each of these characteristics is discussed in greater detail.

<u>Transformations have a relational aspect and an operational aspect</u>. If we consider the geometric transformation called reflection, we note that the term "reflection" specifies a relation between an object and a transform of the object. This relation which we may call reflectivity, is actually a complex relation because it can be broken down into several simpler constituent relations, all of which persist without change through the transformation process. Thus in reflection, the lengths of the sides

of the reflected triangle remain constant as do the sizes of its angles. The relational aspect of a transformation then consists in the relation which the name of the transformation refers to.

Considering only relations however does not yet give us what can properly be called a transformation. If for example we come across two triangles which differ only with regard to position in space, we can say that they exhibit the relation of reflectivity, but we will not be inclined to go on and say that they exhibit the transformation known as reflection because to speak of a transformation is to imply that something has undergone a change from an antecedent condition to a consequent condition, and the two triangles by themselves give no indication of being related in this way. In our example, the two triangles are, as far as we know, alike merely by chance rather than because something has been done to one of them or has happened to it in order to produce the other. Thus we see that the concept of transformation implies not only a relation between two things, but also a change or alteration in one thing by means of which the other comes into being. In cases of transformations done by people, we may refer to this as the operational aspect of a transformation.

Transformations cannot be identified just on the basis of information contained in the transforms themselves, but rather must be identified on the basis of knowledge or reasonable belief that one transform has been derived from the other. One the basis of what has been said above, we must take note of the fact that the product of a transformation is never a sufficient basis for the claim that a transformation has occured. If I show you a triangle which was in fact derived from another by reflection, there is no way that you can determine this just by looking at

one or both of the triangles. The same is true of a tadpole and a frog, or two themes from a Beethoven symphony. To determine that two objects are related by transformation, it is necessary that you supply an interpretation of their relation based on a theory or hypothesis which supports the claim that one is derived from the other.

Transformations always leave at least one significant aspect of the structure of an object constant while at least one other significant aspect undergoes a change. If all of the properties of an object were changed, no relation between the structure of the object before the change and the structure of the object after the change could be established, and the bare fact that one object had changed into another could at best be established only by seeing the change take place. Even in chemical reactions where the physical properties of two substances are radically altered, some aspects of the structures of the reacting substances remain unchanged at the atomic and subatomic levels.

In transformations there is always an antecedent state and a consequent state. Many kinds of transformations involve a change in an object over real time. This process can be described by saying that at time $T_1$ an object exists in a certain state, at time $T_2$ it undergoes a transformation and at time $T_3$ it begins to exhibit its transformed condition. This basic model of transformational change over time is satisfactory for the physical sciences, but as we shall se, it is not adequate for the arts.

Before leaving our paradigm of mathematical transformation, it is necessary to consider two important questions about the nature of transformation in this field. The first question concerns how the mathematician justifies the claim that a given example is in fact a case of

transformation. In asking this question, we are not concerned with the features of the objects which he refers to in order to identify the relation named by the transformation. Rather we want to know by which criteria he determines whether an operation has occured which entitles him to make the claim not only that a relation exists, but also that one figure or transform has been derived from the other. We need to know the answer to this question because we shall see that it is not the same in all fields in which transformations are studied, and when it comes time to look for transformations in architecture, we must guard against any temptation to borrow the justificatory criteria from one field for the purpose of claiming that transformations occur in another field. Such a move can only be made with the aid of a supporting argument that shows why this transposition of criteria is justified or desireable in a given situation.

In order to understand how the mathematician is for example justified in claiming not only that two identical triangles in different positions exhibit the relation of reflectivity, but also that the one has been derived from the other by the transformation known as reflection (or in some other way), we must understand the context of his enterprise. First, let it be understood that the mathematician does not set up a mirror to get his "reflection". He talks about "reflection" only because it is a helpful way of conceptualizing the relation he wants to refer to. This principle applies to most of the terms the mathematician uses in order to refer to transformations; they are aids to the conceptualization and visualization of the relations under discussion, not prescriptions for generating them. Second, it is of great importance to realize that

the mathematician's entire enterprise is founded on a concern with relations. Consequently, there is a perfectly good sense in which it can be said that he works in a context in which the derivation of one transform from another is an assumed condition. If this is so, then there is no need for him to make special reference to the operational dimension of transformation. Put simply, the mathematician never has need or occasion to distinguish relations which occur by chance from relations which occur by design or intention when talking about transformations. In other fields, this is not the case.

The second question we want to ask before leaving the mathematical paradigm concerns why the mathematician finds it useful to talk about transformation. What does this way of talking and thinking enable him to do? The answer to this question must be in part historical, because it was in the seventeenth century that transformations began to be used in geometry.

In 1639, the self-taught architect and engineer Girard Desargues published a book on conic sections which showed how a number of cases could be handled as a single theorem. According to William Ivins:

> The contrast between the Greek conics and those of Desargues is brought into view most immediately by the fact that whereas in Greek practice and theory the facts about each particular case had to be worked out separately and by themselves, in those of Desargues, each descriptive relation that was true of a pattern of streight lines and regular curves in one plane was also true of the projection of that pattern upon another plane, no matter what the angle of incidence of the two planes might be.3

Desargues had stumbled upon this principle of projection while working on the practical problems of devising a method of perspective construction, and his original objective had been to reduce the number of theorems

and constructions which artists, stone cutters and engineers had to learn in order to practice their crafts at that time.[4]

Thus we see that it was the Renaissance and Baroque preocupation with perspective which served as a partial stimulus for the discovery of geometric transformation. But at the same time, it was the rather more Baroque preocupation with the idea of continuous change of mathematical entities that lead to the widespread application of transformation in mathematics and geometry in the years that followed Desargues' discovery. The development of calculus by Newton and Leibniz is another manifestation of the move toward conceiving problems on the model of continuous variation. If we look at the development of transformation in music during this same period, similar concerns are in evidence.

In more recent times, transformation has provided similar assistance in set theory and topology. Thus, for the mathematician, transformation contributes a measure of conceptual economy to the study of a number of types of structures and to the relations between them.

Transformation in Linguistics

The role played by transformation in linguistics is rather different from what we have found in the case of mathematics. Speakers of natural languages are not generally conscious of the transformations attributed to them by linguists, and linguists do not claim that speakers think about transformations in the process of constructing sentences. Why then do they want to talk about transformations at all? The linguist argues that the deep-structure transformation rules of his transformational grammar are necessary postulates if we are to account for some of the remarkable things people do with language.

There are at least four sorts of language behavior which are said to require the postulation of an innate grammatical competence:

1) The ease of the child's original language learning.

2) The ability to learn to speak without practice and the reinforcement of talking with others.

3) The ability to develop language-speaking competence regardless of I.Q.

4) The ability to constantly understand and produce novel utterances; that is, sentences never encountered before.[5]

In order to understand the nature of the deep-structures and transformation rules which the linguist postulates to explain the aforementioned abilities, it is necessary to look briefly at his structural and transformational model of the grammar of a natural language. For the transformational linguist, a deep-structure is a word, phrase or sentence upon which no transformation operations have been performed. Deep-structures are distinguished from surface-structures on the basis of transformations. For example, consider the following two sentences:

1) Richard sent a message to Henry.

2) Richard sent Henry a message.

If we apply the syntactic transformation called indirect-object movement to (1), we produce (2) above. Relative to (2), the linguist says that (1) has a deeper structure because it has been subjected to fewer transformations.[6] Now actually (1) is not a real deep-structure sentence because it already contains a transformation called affix movement. But, as we are not here concerned to produce an actual analysis, we can disregard this additional transformation and concentrate on the model of the relation between deep and surface structures which the example provides.

Transformational linguists distinguish two sorts of structuring rules; one set are called phrase-structure rules and the other set are called transformation rules. Phrase-structure rules control only the organization of deep-structure sentences. Transformation rules on the other hand are used to generate surface-structure sentences <u>from</u> deep-structure sentences. The aim of the linguist in working back (or down) from surface-structure sentences to deep-structure sentences via the transformation rules he formulates, is to find those organizing principles which are common to all natural languages. These deep-structure organizing rules are seen as constituting at least a part of the innate grammatical knowledge or competence which it is supposedly necessary to postulate in order to explain the kinds of language behavior we have already spoken of.

It should be fairly clear from what has been said that the linguist, at least at the present time, has no direct evidence that the phrase-structure rules represent an innate competence shared by all speakers of natural languages. But, unlike the mathematician, the linguist is not in a position to simply ignore the operational aspect of the transformations he attributes to speakers. In order to escape the claim that his transformation rules refer to operations actually performed by language users, he resorts to the competence/performance distinction, claiming that his rules only describe what a person would have to be able to do in order to speak the language as he does; not how the person in fact does it. So the transformations of linguistics are understood to have an operational dimension, but the linguist does not claim to describe the operational aspect of his transformations in a way

which represents what people actually do in writing or speaking. Thus the transformational linguist makes a distinction between language and speech, and claims that he is describing the structure of the language which is implied by the speech-acts of language users. The operations he talks about are thus characteristics of language rather than of speech.

Transformation in Poetics

Transformation also plays a role in literary analysis. One such role has to do with what have traditionally been called figures of speech. A figure of speech might be defined as a deviation from more typical ways of speaking for poetic or rhetorical impact. Consider for example the following statement: "I cannot see what flowers are at my feet nor what soft incense hangs upon the boughs." This is an example of the figure of speech known as the zeugma. A zeugma is a transformation produced by joining two words in relation to a third in a context where the relation is literally appropriate to only one of the two words. In the case of the example just given, only flowers can be seen; incense cannot. Thus, there are two terms: 'flowers' and 'incense' which are linked to a third term: 'see' where the relation is only appropriate to the term 'flowers' because only flowers can be seen in the visual sense of seeing.

Figures of speech such as the zeugma are semantic rather than syntactic transformations in the sense that they are produced by what might be called collisions or intersections of word meanings. Also, a person developing a figure of speech is concerned with the unexpected interactions of word-meanings which occur when the words are brought together in certain contexts. In the particular case of the zeugma under discussion here, several interesting interactions occur. For example,

the sentence appears to begin with a streight-forward use of the word 'see', but when we reach "soft incense hangs", we are forced to call our original reading of 'see' into question. The ambiguity of the meaning of 'see' is intensified in this context by the meaning of 'soft'. Softness is a tactile property rather than a visual one in the customary way of thinking, so the reference to softness weakens any tendency to read 'see' in the visual sense of the word. At the same time however, the occurence of 'hangs' acts to reinforce the visual reading of 'see' because hanging normally is perceived through the visual mode. Furthermore, both 'soft' and 'hang' tend to ambiguate the reading of 'incense' as meaning a fragrance. Incense as a smoke, might cling to the branches of trees or appear to do so under certain conditions.

The student of literature is interested in the structure of zeugmas and other figures of speech because they occur frequently in writings of many kinds, often with a very powerful effect, as the forgoing analysis indicates. Whether or not a particular writer was conscious of the zeugma structure in producing one is not a particular concern of the literary analyst. What matters is that the concept of the zeugma as a joining of two words in relation to a third, where the relation is literally appropriate to only one of the two allows him to begin to account for differences between poetic and non-literary language. This concern with the unique properties of poetic and literary language received new impetus in the early part of the present century through the work of the Russian formalists who were concerned to show that the essential function of poetry is to counteract the process of habituation encouraged by everyday modes of perception and speech.[7] If the poet's undertaking is con-

ceived in this way, then the so-called figures of speech loose their status as mere embellishments of ordinary language and take on a more significant role; that of shocking us into perception by deviation from accustomed ways of thinking and talking.

How can we show that the figures of speech constitute transformations of ordinary prose structures? In any dictionary of literary criticism, one will find terms like:

> Rhopalism: the successive increase in length of words, lines or stanzas.
>
> Zeugma: a joining of two words in relation to a third when the relation is literally appropriate to only one of the two terms.
>
> Antithesis: an opposition of ideas brought about by a parallelism of expression.
>
> Asyndeton: the omission of conjunctions.
>
> Chiasmus: reversing the order of words half way through a line.

All of these definitions, which incidently are based on the accounts actually given in several literary dictionaries as well as in Webster's Unabridged, state or imply an operation such as: increase line length, join two words, use parallel construction, leave out conjunctions, reverse word -order, and so on.[8] These are things you can do if you are writing poetry or literary prose, but what do you do them on or apply them to? It almost seems that in order to make sense out of these figures of speech, it is necessary to understand them as being applied to an actual prose surface structure, or at least to an implicit one.

In the Norton Lectures Bernstein makes a proposal of this sort.[9] In the lectures, he examines the following Shakespearean line:"Tired with all these, for restful death I cry." This line has what he calls a

poetic super-surface structure containing a number of transformations, some of which are linguistic and some of which are literary. Bernstein does not distinguish among transformations by source (linguistic/literary, etc.) but does note that the most noticeable transformations in this example are inversions; that is, reversals of more or less standard prose word orders. If the inversions are removed, he notes, the following more prose-like expression is produced: "I, tired with all these, cry for restful death." Quite clearly, removing the inversions totally destroys the poetic impact of the line. If one takes a further step and removes all of the transformations, both linguistic and poetic, a set of simpler deep-structure sentences like the following is produced:

I am tired.
Many things tire me.
I am crying (out).
I long for death.
Death is restful.
If I was dead, I would not be tired.

I am claiming that sets of prose sentences like these seem to be implied in the standard descriptions of the poetic transformation operations, even though of course the figures of speech were defined long before there was any such thing as a transformational grammar or a theory of linguistic deep-structures. This gives an additional rationale for speaking of the poetic line as a super-surface structure as Bernstein does.

Transformation in Music

Throughout the history of Western music from the origins of polyphony in about 1000 AD to the present time, we find a desire to produce a work with both unity and diversity. A musical work without some change from beginning to end is scarcely conceivable, and a work without the

unity of related parts would be chaos. There is no question that one of the primary techniques used by composers throughout the period under discussion to produce a work of unified diversity is the technique of transformation. Over the course of this period, the sophistication and rigor with which transformation was applied did indeed vary, but its role as a primary organizing principle remained a constant. Perhaps the most strict and systematic application of transformation is to be found in certain works by Arnold Schönberg and his pupils Alban Berg and Anton Webern. Even these composers however have seen their own use of transformation operations as a continuation of an historically established musical practice rather than as a deviation from it.

It is not perhaps too widely known that transformation has for some time received extensive discussion in works on music theory. For example, the compositional operation of turning a melody or some other musical element upside down has traditionally been called inversion. By means of a diagramming technique, some musical transformations can be shown on an actual score of a work being studied.[10] In Figure 2.2a, two occurrences of a basic musical element are shown together with two inversions of the element. In Figure 2.2b, three basic musical transformations are shown. In a strict inversion of a series of notes, a step up in pitch is replaced by an equal step down. In retrograde, an entire musical unit is turned end for end. In retrograde inversion, a musical unit is subjected to both retrograde and inversion at the same time.

The foregoing however constitute only the most basic of musical transformations, and can be compared to the various kinds of reflective transformations in geometry. Music as we know it would be inconceivable

without the transformations of augmentation and diminution. Augmentation refers to an increase in the time duration of a note of given pitch, and diminution refers to a decrease in the time duration of a note. Augmentation and diminution correspond to the geometric transformations of enlargement and dilation which respectively indicate the increase and decrease in the size of a figure.

The most interesting transformations in music have to do with more sophisticated procedures for developing and altering musical structures. Among these, the technique of thematic transformation deserves special attention. Particularly during the Classical and Romantic periods which together run from about 1700 to 1900, it became more or less standard practice to develop all of the themes of a symphony, sonata, or concerto from a single melodic motive. This technique of thematic transformation was far more than an esoteric exercise, for it is impossible to listen to a work built on such a plan without experiencing the "wholeness" which the melodic affinities produce--even if one knows nothing about musical transformation. In analyzing Beethoven's Piano Sonata Opus 27, No.2, Rudolph Reti asks of two of its primary themes: "What exactly...constitutes the common denominator linking these two themes together?" The answer, he says and demonstrates is that:

> The melodic line of one (theme) is expressed in the line of the other, though not in the latter's concrete melodic course, but indirectly, through a connection of some of its corner notes(or melodic turning points). In other words, the Adagio theme sounds from the contour of the Finale theme.[11]

Thus the motive of a work of this sort is a polyvalent melodic structure which is made to sound recognizably in and through all of the other themes of the work.

The technique of thematic transformation reached a high point in the works of Beethoven, for it is in his works more so than in the works of any before or after him that transformation maximizes both the unity and the diversity of the musical structure. What role, we might ask, do the simpler musical transformations which we discussed previously play in this sort of far-reaching and systematic transformation? In speaking of the compositional techniques of Beethoven's time, as compared with those of the Baroque period which preceded it, Reti says that:

> It has to be understood that all these (transformational) devices...were seldom used singly in the thematic style (of the Classical period), but more often in combinations of two, three, or more. A shape, for instance which was a theme in one movement would appear in the next in its inversion, simultaneously with shifted accents, in a new tempo, and so forth. In fact, this tendency to combine and intensify the devices (of transformation) became the main idea of shaping in the thematic era. It is the very phenomenon which we call transformation. Thus thematic transformation is in the last sense no longer carried out according to any specific device, old or new, that can be formulated, but is brought about freely, in what ever form the compositional inspiration envisions it. The possibilities are inumerable and every ingenious composer constantly invents new methods. In short, the thematic technique no longer inverts, augments, or simply varies the shapes, but transforms them in the full sense of the word.[12]

From what has been said, it will be apparent that one way in which the use of transformation in music differs from its use in mathematics and linguistics is in regard to the precision with which it is applied. In music, the main objective has usually been to produce the impression or experience of a unified whole in which each successive part seems to follow with an inexorable if unexpected logic. In music then, the ultimate test of the transformation is in the experience and not in the mathematical exactness with which it is done, even though composers have, in some cases, believed that a kind of mathematical perfection in music was

desirable. In poetics on the other hand, transformations are not specified in a way that makes it possible to test the rigor or precision with which they are applied.

The field of music, more than any other in which transformation has a history of recognized occurrence, indicates that there are some cases in which transformation exceeds the range of operations which can be reduced to a specifiable set of formulae or operation types. This is a condition which can be represented in a diagram which shows the relation between the specificity with which a transformation or even a set of transformations can be described or defined, and the controling power they have over the significant organization of a structure (Figure 2. ).

In the Baroque period, when transformations were circumscribed and easily definable in mathematical terms, their occurrence in music could be pinpointed and easily analyzed. But as the concept of music gradually shifted from the Baroque to the Classical and ultimately to the Romantic, the role of transformation as a structuring principle increased, but the degree to which transformation operations could be reduced to specific operations underwent a corresponding decrease.

The foregoing condition is implicit in one of the most important differences between Classical and Baroque music. Baroque compositions are often said to establish a state or mood at the beginning of a work and then to vary that state without really changing it, right through to the conclusion of the work. This is especially true of individual movements of works and of works in fugue form. The essence of Classical structure, on the other hand, particularly as manifested in sonata form which is the paradigm of the period, is one of changing states or moods. In this peri-

od, music begins to have what might be called an "atmospheric" quality, and this "atmosphere" is subject to sudden and often violent changes such as almost never occur in Baroque music. By the high-point of the Romantic period, the atmospheric possibilities of transformation have reached an almost literal level in which works sometimes become thinly disguised musical landscapes complete with suggestive titles such as Night-Ride and Sunrise (Sibelius) and Obermann's Valley (Liszt).

Since transformation has been a technique taught as a part of training in musical analysis and composition, it is reasonable to suppose that in the majority of cases, at least where first-class works by notable composers are concerned, the transformations were done consciously. However, transformation is a technique which becomes almost automatic with a gifted improvisator such as Bach or Mozart, and thus it slips into the "gray area" occupied by those skills which reach the level of a more or less automatic response. Even so, if transformations occur in a written score, they are generally regarded as intentional and treated as such in musical analysis. And, when they occur with the richness and frequency of a typical mature work by Beethoven, they cannot plausibly be credited to mere chance.

The arts today appear to be very much in a state of transition. Consequently it is worth giving at least brief consideration here to the question of whether transformative variation in music represents a passing phase in terms of possible musical organizations. This is a question which we shall also want to consider concerning the role of transformation in architecture.

The indications are that transformation is a necessary though not

a sufficient condition of unity in music of the periods under discussion. Transformations can be done effectively or inefectively, so this too is a factor which must be taken into consideration. Even so, this does not mean that transformation is the only way to achieve coherence in <u>any</u> music. The present proliferation of media and methods in contemporary avant-garde music makes it impossible to say whether new methods of coherence will eventually be developed, much less whether the results will ultimately be as satisfying as those developed by transformation in tonal music; we can only wait and see.

<u>Transformation in Painting</u>

While there is no precedent for the study of transformation in painting, we shall take a very brief look at this field in order to have some preparation for dealing with the simultaneous aspect of the architectural experience. The distinction between the simultaneous and the sequential arts is usually based on whether or not there is a significant time dimension in the experience of the object. On this model, music and the novel are paradigms of the sequential arts because they can only be experienced over time. Painting, on the other hand is considered a simultaneous art form because the many elements of a painting are all present together at a single instant. In dealing with architecture, we shall have to keep this distinction in mind because it is, in an important sense, both simultaneous and sequential. In passing through a building, we experience it sequentially, but in stopping to admire a space or look at a view, we experience at least some aspects of buildings with the same sort of simultaneity that we confront in a painting. Thus we have to be prepared to deal with transformation as it might appear in both ways of

experiencing a building.

Some of the works of Paul Klee provide a chance to study two kinds of transformation in painting. One of these involves a sequential aspect of the painting process, while the other involves a simultaneous aspect of the painting itself, as product. At one point in his career, Klee is known to have done a number of wash-gradation studies in order to increase his mastery of color. Each successive work in this series of watercolor studies can be regarded as a response to conditions discovered in previous studies. In this sense, the series exhibits a diachronic modification of pictorial conditions. At least some of the relations between the individual studies involve transformation operations. For example, Klee performs experiments on the relation between the saturation of a color patch and its size.

Along the synchronic axis, that is within the individual work, we also find Klee exploring transformation relations. Within a single painting, transformationally controled wash gradings are used to create local motions and an overall opposition of motion energies resulting in pictorial ballance. In some of his writings about these works, Klee makes rather pointed reference to transformation-like concerns. Of the series of stratified paintings which includes Monument on the Edge of Fertile Country (Figure 2. ) he says:"Assuming that the whole, taken by field, contained equal quantities of color, the color diminishes when the dimensions (of the color blocks) are increased and increases when they are diminished.[13] Here then we find an explicit reference to what the composer would call an inverse relation beteeen the transformations of augmentation and diminution. In mathematics, such transformations fall

into the category of the so-called similarity relation.

As with composers, Klee was more concerned with the experience which his paintings produced than with mathematical rigor for its own sake. Thus the test of the transformations in his works is not simply that they occur, but that they produce a worthwhile experience. Klee was fond of saying that the naked rule or organizing principle should never appear in the finished work, and the stratified paintings, as distinguished from some of the color studies are examples of his application of this principle.

To understand the full import of transformational simultaneity in painting we need to consider yet another type of painting which is to be found among Klee's works. His Strange Garden can be regarded as a tour de force of transformation generated ambiguities and multiple meanings (Figure 2. ). What matters in this case is that we see eyes as leaves, mouths and reproductive organs--as a whole stack of metaphors depending on a kind of duch-rabbit polyvalance of forms. Here in the painting of a man who was also a good musician, we see a phenomenon which is very similar to the results obtained by thematic transformation in music. In thematic transformation, we always hear the originating motive or melody sounding through the themes it generates. In Klee's painting, it is the eye which has become the theme or motive. It would indeed be very like Klee to do a painting which gave expression to a conception of what the eye is to a painter who believes that painting "does not reproduce the visible but rather makes visible."[14] Here the eye has been metaphorically identified with a number of bodily functions and things in the world, thus making visible what the eye is to Klee the artist.

Reexamination of the Characteristics of Transformation

Having examined the role of transformation in several fields, we are now in a position to check our initial account of the characteristics of transformation to see if it is still adequate. It will be remembered that the earlier account was based on just those characteristics which could be derived from the geometric paradigm.

On the basis of the discussion of painting, it is clear that a modification of characteristic (4) is required. The original version of (4) read as follows: In transformation there is always an antecedent state and a consequent state. But we now realize that we need to record the fact that in the simultaneous arts, transformations may appear together in a work, rather than one after the other as in the case of music. In order to deal with this condition, we will change characteristic (4) to read as follows: ($4_a$) In transformations there is always an antecedent state and a consequent state, or in the case of transformations which are not experienced as changes over time, a simultaneous duality of states which may be called polyvalence.

A second point which the geometric paradigm does not reveal is that even though the pure geometric figures have only one structure, this is not true of physical objects. Consider a cube which is made of wood for example. This is an example of an object which has at least two structures. Certain operations which can be performed on a wood cube may respect one structure, but violate the other. If for example, one sandblasts the cube, one is in a certain sense respecting the grain of the wood, but violating the geometry of the cube. On the other hand, if one cuts through the cube on the diagonal (from corner to corner), one is

respecting the geometry of the cube, but quite possibly violating the structure of the grain.

The foregoing example reveals two important points about transformations. The first is that what counts as a transformation of an object from one point of view may not appear as a transformation when considered from another point of view. What counts as a transformation thus seems to depend upon the structure being considered, at least in those cases where objects have more than one structure. The second point is that not every structure is capable of undergoing a given transformation. Consider for example the linguistic transformation called conjunction omission (leaving out the word "and" in certain contexts). This is obviously a transformation which cannot be performed on a deep-structure sentence which does not contain a conjunction. Likewise, the geometric transformation of reflection cannot be meaningfully applied to figures which are bilaterally symmetrical.

Thus we can begin to see that what counts as a transformation in a given case also depends upon that nature of the object to which it is applied. There is a certain trivial sense in which a person who chops a corner off a cube with an ax is performing a "deletion", but he is not doing a transformation unless his operation also respects a structure of the object to which it is applied. Consequently it is necessary to add a fifth criterion to our list of the characteristics of transformation. It can be stated as follows: (5) Transformation selects and then respects a structure of the object to which it is applied. With these additions, it will be helpful to set out the entire set of characteristics for transformation so that the reader may review them together.

1) Transformations have a relational aspect and an operational aspect.

2) Transformations cannot be identified just on the basis of information contained in the transforms themselves, but rather must be identified on the basis of knowledge or reasonable belief that one transform has been derived from the other.

3) Transformations always leave at least one significant aspect of the structure of an object constant while at least one other significant aspect undergoes a change.

4) In transformations, there is always an antecedent state and a consequent state of the object undergoing transformation, or in the case of transformations which do not involve a change over time, a simultaneous duality of states which may be called polyvalence.

5) Transformation selects and then respects a structure of the object to which it is applied.

Finally we must discuss what is perhaps the most important aspect of the concept of transformation--its relation to the law of parsimony and the principle of economy. There is an ordinary language use of the word "transformation" in which it means only something like "radical change." In those cases however where it is not a synonym for "radical change", it generally indicates operations or relations which result in an economy; either in means, as in geometry, in expression, as in music, or in explanation, as in linguistics. From this it follows that even when the five conditions listed above are met by a particular case, we may still feel disinclined to call it a transformation because we remain unconvinced that there was any intent, conscious or otherwise, to achieve economy.

## 3: DEVELOPING A STRATEGY FOR THE INVESTIGATION OF TRANSFORMATION IN ARCHITECTURE

### Introduction

In order to investigate transformation in architecture, it is necessary to develop a strategy to guide the inquiry. This strategy will be concerned with two main issues. First, it will be concerned with the relation between transformations as known through the fields already studied and the transformations which occur in architecture. Second, it will be concerned with the problems which result from attempting to look for transformations in a field in which there is no precedent for their discussion.

Suppose we were to begin our search for transformations in architecture by looking for just those transformations which occur in geometry. Is there any reason to limit ourselves to just these? We have already seen that the geometric transformations also occur in music, but music contains other transformations beside the geometric, and the most significant musical transformations have turned out to be those which cannot be reduced to simple operations but which rather are of the sort that result in complex "affinities" between a motive and the melodies related to it. Consequently, we must be prepared at the outset to realize that any account of transformation in architecture which limits itself to the simple geometric transformations is almost certain to leave many significantly transformational relations in architecture undiscussed.

The Analogy/Identity Distinction

Any attempt to study transformations in a field in which there is no precedent for such inquiry must consider whether the transformations found in known fields constitute a generalizable set of operations which one can expect to find in all fields, or whether each field has its own unique set of transformations. This means that one has to be prepared to distinguish between an analogy approach and an identity approach to the study of transformation. To say that something is identical with something else in the sense intended here, is to say that it has exactly the same properties or characteristics. By analogy on the other hand, we mean only that something is like something else in at least one respect, but not in every respect.

From the discussion in Chapter Two, it will be recalled that transformations have a relational aspect which consists of the relation (complex or simple) which they establish between transforms. It will also be recalled that transformations have a function which can be described in terms of the law of parsimony and the principle of economy. It follows that in discussing the identity/analogy distinction as it applies to transformation, it will be necessary to consider both the functional and the relational aspects of transformations. It is logically possible that all transformations are identical in function no matter how different the relations they establish in various fields may be. In this event, we would say that transformations are identical in function but only analogous with respect to the relations they establish. On the other hand, it is also possible that transformations in all fields are merely analogous both in function and in terms of the relations they establish. While the

foregoing are perhaps the two most plausible alternatives, a number of other logical possibilities exist.

As we are using the terms, things which are not identical may be either analogous or disanalogous. But, things which are not analogous can only be disanalogous. On the basis of these definitions, it is possible to generate a matrix which represents all of the logically possible relations which could exist between known transformations and those in architecture with regard to their function and the relations they establish between transforms. In order to make the alternatives represented by the matrix as readable as possible, we will set them out in the form of short sentences:

1) Transformations in other fields are identical in function and establish identical relations between transforms.

2) Transformations in other fields are analogous in function but establish identical relations between transforms.

3) Transformations in other fields are analogous in function and establish analogous relations between transforms.

4)Transformations in other fields are identical in function but establish analogous relations between transforms.

5) Transformations in other fields are identical in function but establish disanalogous relations between transforms.

6) Transformations in other fields are analogous in function but establish disanalogous relations between transforms.

7) Transformations in other fields are disanalogous in function but establish identical relations between transforms.

8) Transformations in other fields are disanalogous in function but establish analogous relations between transforms.

9) Transformations in other fields are disanalogous in function and establish disanalogous relations between transforms.

In the following pages, we will examine some of these possibilities in the light of the several fields discussed in Chapter Two.

We have already seen that in terms of the law of parsimony and the principle of economy, transformations have a number of analogous, but not identical functions. Transformations in methematics result in an economy of means, whereas transformations in linguistics provide a parsimonious explanation. In music, on the other hand, transformations make it possible to experience a unified diversity. Since, in terms of function, these transformations are only analogous, we may consider this point well enough established to drop it from further consideration. Conseqquently, in the discussion which follows, we will consider only the relational aspect of transformation in terms of the analogy/identity distinction.

The Identity Approach

The identity approach to the study of transformation either assumes or sets out to demonstrate that there is a specialized set of relations which have distinct characteristics. According to an identity theory, transformations constitute a unique set of relation producing operations which appear in many fields. Except in an extreme form, the identity theory does not exclude the possibility that there may also be more complex transformations which cannot be reduced to specifiable operations. These more complex forms would have to be regarded as transformations by analogy. Thus even the identity approach allows for the possibility of

analogy.

The rationale for thinking that at least some transformations are identical across fields lies in the fact that there are a number of cases where this in fact seems to happen. Inversion for example seems to be a clear case of a transformation which occurs both in music and geometry, and the same can be said for augmentation and diminution, or enlargement and dilation, as they are called in geometry. Inversion is also a transformation which occurs in linguistics and in poetics, and we have seen how Klee explored certain inverse relations between the size of a color-patch and its saturation, so here we seem to have at least one transformation relation which appears in all of the fields we have studied.

Why there should be at least some transformations which occur in several fields can perhaps be explained by the fact that, in terms of the law of parsimony and its corollary the principle of economy, the objectives in all of these fields are similar. Thus we might explain the use of similar operations in terms of similar goals. It may also be the case that at least some organizing principles apply to all cultural products, as Levi-Strauss attempts to show when he argues that the organization of a society's kinship structure is homologous with its language structure.[1] These at any rate are two possibilities by which it might be possible to account for the appearance of the same transformation relations in several fields.

On the identity model, an initial search for transformations in architecture would be made by abstracting the transformations found in other fields. To abstract a transformation in the sense spoken of here is to consider it apart from the medium in which it normally finds

expression (music for example), and also to disregard the function it has in a particular field. Thus for example, one might consider the linguistic transformation called "extraposition" in a purely relational way, disregarding its explanatory role as a part of the transformational grammar.

In making abstractions of this sort for a study of architecture, we would naturally want to pick first those transformations which suggest a relation which can be given expression in space. Some linguistic transformations do not lend themselves to this role very well. For example, the transformation that converts a deep-structure sentence into a noun-clause in a surface-structure sentence (nominalization) does not suggest a relation that can in any obvious way be given a spatial expression.

These basic relations which we abstract can be given a rudimentary expression by representing them with a series of nuts and bolts as shown in the photographs in the right-hand column of Figure 3.1. The other columns in this figure list the sources of the abstracted transformations by field and give the descriptions which they receive in those fields. This abstraction provides us with a set of relations to look for in architecture.

Probably the strongest objection to this procedure is that it would seem that it cannot <u>fail</u> to turn up transformations in architecture. But, such an objection, if it is to carry any weight, can only really be directed to a poor use of the abstracted set of transformations, for it is never sifficient to call something a transformation just on the basis of the fact that the relation is exhibited, or even on the basis of the fact that an operation has been done. It is also necessary to explain

the purpose behind the operation. We have already explained that operations which establish relations are called transformations when they result in the fulfillment of the law of parsimony or effect an economy. Without discussing operations in light of this aim to economy, there can be no justification for the claim that a given relation is in fact the result of a transformation. Consequently, any attempt to classify an operation as a transformation in architecture, must undertake anew the task of showing how this operation contributes to some form of economy. Thus it is necessary to understand the fact that our table gives us a set of relations which count as transformations in some fields, but in so far as architecture is concerned, they have yet to be shown to have that status. And this, it must be added, is a point which applies to transformations regardless of whether they are conceived on the analogy model or the identity model.

The Analogy Approach

Eventually, any study of transformation in architecture which takes as its starting point a set of transformations abstracted from other fields, must go a step further and, guided by the law of parsimony, ask whether there are any transformations in architecture which do not occur in these other fields. We know for example that the linguistic transformation called extraposition does not occur in geometry, and this should be enough to prepare us for the possibility that there are some transformations which are unique to the architectural milieu. Furthermore, if as we have suggested, it is not really the relation which an operation establishes or brings into effect which determines whether the relation is properly called a transformation, but rather what the

operation is used to do in terms of economy or the law of parsimony, then we have all the more reason to suspect that relations borrowed from other fields such as geometry, cannot possibly give us the complete range of transformations which occur in architecture.

The Procedure to be Followed

Once the virtues and the limitations of the identity and analogy approaches to the nature of transformation are recognized, it is possible to make some headway in the investigation of transformation in architecture. Our precedure will be to apply both approaches as it seems appropriate, forcing neither beyond what appears to be its reasonable limit. One the one hand, in spite of its limitations, the identity approach gives us a set of operations and relations to look for, and in the next chapter it will be shown that some of these transformations from other fields do in fact occur in architecture and have similar economizing functions as well. We will also look at a case of a simple transformation which does not occur in geometry or music, and thus reinforce the importance of the analogy approach.

Having looked at transformations in architecture at the rather limited level of individually specifiable operations, we will then expand the search field to look for cases which operate at the more pervasive scale of thematic transformation in music.

Types of Transformation to be Investigated

In a work of art such as a poem or a musical composition, transformations occur simultaneously at several different levels which should not be confused with each other. A poem or play for example will contain some of the transformations specified by the transformational

grammar of the linguist, but it may also contain figures of speech; that is, literary transformations. At yet another level, it may contain transformations of plot-structure and character development. If these various levels are not distinguished, the result may be that transformations from one level of analysis will be used to attempt to explain structures which in fact belong to other levels of structure.

In describing the transformations which occur at several levels in a poem, it is sometimes necessary or desirable to shift from a syntactic to a semantic point of view. The operations of the generative and transformational grammar are syntactic transformations because they are defined independently of the meanings of the sentences for which they provide the organizing rules. The figures of speech on the other hand are described largely in terms of the effects on meaning and are thus semantic rather than syntactic transformations, although in certain cases at least, they involve the employment or even the violation of the rules of the generative and transformational grammar.

The table of transformations which we have developed for the identity approach makes no reference to the semantic/syntactic distinction, and this is quite intentional. If one is concerned to study transformations as operation types, there is no need to make the semantic/syntactic distinction. There are no operations which are necessarily semantic or syntactic only. It is what an operation is applied to, and hence what it is used to do that determines whether it has a semantic or syntactic function in a particular case.

Several levels of transformation can be distinguished in the architecture/building milieu. They are to be found in operations on

structural systems such as the Western frame, in operations done on geometry in the process of architectural design and in operations done on organizations without reference to geometry, such as the generation of an open plan from a closed plan by deletion and embedding as in Wright's Moore House I (see page 98). In fact there is probably no class of operations in the architectural design process or in art making generally which cannot in principle be subjected to the control which transformational procedures can provide. Whether in any given case there is a need to apply transformational control is of course another matter.

In considering the occurrence of transformation in architecture, it will be necessary to keep in mind that art is not a language. Consequently, to search for the grammar of architecture or any other art form is a fundamentally misguided undertaking. With regard to the application of transformation operations, each work of art generates its own "grammar" or set of syntactic restrictions, and creating a work of art is in part a process of discovering those operations which the structure of the developing work will allow and those which it prohibits. Furthermore, the discovery of the allowed and prohibited operations is guided largly by semantic rather than syntactic considerations. This is true incidently even in those cases where a designer or poet consciously develops a rule structure before hand, to be followed in organizing the work. The manipulation of possible poetic structures or architectural geometries for their own sake remains an exercise until the result has been tested in terms of significance, and significance is a semantic concern rather than a syntactic concern.

One of the primary differences between a language structure and

the structure of a work of art is that a language is the common possession of a group of people, and as such, its phrase-structure and transformation rules are used over and over again with a prescribed hierarchical sequence that remains more or less constant. In this respect, a natural language is more like a craft than an art form, for in a craft, once the organizing rules have been developed for producing an object, they remain invariant through many replications of that object. In art on the other hand, there is no prescribed order or type for the operations to be used. Except for certain stylistic and formal conventions, it is up to the artist to determine the organizing rules and operational principles for each work he undertakes.

Both as a medium of experience and as an historical phenomenon, architecture may be studied both diachronically and synchronically. The distinction between the diachronic and the synchronic dimensions of a field has an historical precedent in linguistic analysis, and it has come to be seen as increasingly important in inquiries into other fields when a structural analysis is undertaken. In the experience of language as written or spoken, we are confronted with an "unfolding over time." Speech is in this sense diachronic. The diachronic dimension of an inquiry is concerned with change over time.

At the level of experience, architecture has both a synchronic and a diachronic aspect. In so far as a building or a space is experienced from a vantage point, it is confronted synchronically. In so far as the same building or space is experienced in time, as one passes through it for example, it is experienced diachronically. Architecture also has a diachronic dimension which extends over a greater span of time; buildings

change with age, and building styles change over historical time.

There are four sorts of things which transformation might do in architecture. These are listed below:

1) Though it clearly has not been, transformation might be used in architecture to explain how apparently diverse conditions may be derived from a small number of generative conditions, as is done by the transformational grammar in linguistics.

2) Transformation may occur in architecture as a part of a controled working method or design process.

3) Transformation may occur in the diachronic dimension of architecture in the form of changes in style or other conventions.

4) Transformation may occur in the synchronic dimension of architecture, manifesting itself as a part of the content of individual designs, and as such, as something to be enjoyed as a part of the experience which the building makes possible.

Dealing with the Operational Dimension of Transformation

If we do in fact discover that in architecture, the relational aspects of certain transformations are exemplified, how shall we deal with the further condition that true transformations also have an operational aspect? How do we know that a given case of what appears to be a transformation in architecture is not a relation which is the result of chance? A major conclusion to be drawn from the study of transformation in the fields such as music where it has for a long time been taught as a method of production as well as a method of analysis, is that in such cases, there is no problem about the identification of cases. In music, if something appears to be a transformation and has the unifying effect

one would expect from a transformation, it is called a transformation, and this is generally accepted as a reasonable analysis. In architecture, where transformation has never been taught as an organizing technique, the situation is very much different. In the case of architecture, it is very easy to show that any number of interesting organizations could have been developed by transformation, but it is very hard to determine whether they actually were developed in this way. Consequently, the description of architectural examples as instances of transformation requires for its justification either that the case be reasonably obvious, or that the architect have given some verbal indication that he was in fact working transformationally.

In cases where there is no direct evidence that the architect was working transformationally, we shall have to rely upon our understanding of the nature of the architect's enterprise and thus upon our understanding of the concerns he is likely to have as a result of being an architect. It is here that the fundamental principle of economy comes to be seen as a motivating concern of the architect just as it is for the composer.

## 4: TRANSFORMATION IN ARCHITECTURE

### Introduction

If what counts as a transformation in a given field is determined not only by the fact that it is an operation used to change something, but also by an aim to economy or parsimony, then ultimately we can only decide cases in architecture by determining what appears to be a reasonable account of what transformations are used to do and what effects they have on experience in architecture. We have already seen that geometric transformations have been devised in order to economize on the number of individual cases requiring separate proof. In music, we have seen that transformation is used to create the experience of a unified diversity--a thing enjoyable to experience for its own sake. In linguistics, we saw that the transformational grammar was developed in order to explain man's capacity to understand and produce an apparently infinite variety of different sentences. We therefore have some reason to suppose that when transformation occurs in architecture, it will do so as an expression of economy, ordering and parsimony--either as a part of a controled working method, or as a part of the content of a design, and as such, something intended to be enjoyed as a part of the experience which the building makes possible.

We will begin with an examination of some instances of transform-

mation in existing architecture. These examples are intended only as evidence that a number of architects have either employed transformations which are recorded in their finished products, or that they have at any rate produced products which can plausibly be explained transformationally even though the architects themselves were not conscious of doing transformations. These examples are neither intended to justify transformation as a working method nor to explain the architectural value of the buildings involved, though in some cases it will be easy enough to see that the transformations do contribute to an architecturally significant result. This is however due to the appropriateness with which the transformations are applied in given cases rather than to the mere fact that they have been done. Having examined some instances of transformation in architecture, the discussion turns to a consideration of some as yet unexplored possibilities for the use of transformation in future architectural undertakings. In each case, when a specific transformation is mentioned, we will indicate whether it is best conceived on the identity or the analogy model.

Simple Synchronic Transformations in Existing Architecture

The transformations in architecture which are easiest to detect and describe are those which involve simple operations on grids, elements and geometries. This does not mean that the architect, in producing his designed object, had the idea that what he was doing was in fact something which could be described as a transformation operation. It does mean that the sense of order and relatedness which the architect without a doubt employed in producing his product can in such cases be seen as yielding transformational results.

A grid is an organizing geometry which has the potential for transformational manipulation, but the use of a grid does not in and of itself produce transformations. A grid is rather to be understood as one potential means of developing the order and affinity which exists between true transforms. Mies Van Der Rohe's Chicago Convention Hall project shows a rudimentary application of transformation to a grid generated by a truss structure (Figure 4.1). In this design, the main concern was to develop an enclosure for a large space without resorting to interior supports. Consequently the exterior walls became huge trusses to support the roof-load. But Mies also used the truss geometry as a means of controlling interior light. Detailing for this project was never finalized, but proposals called for dark gray marble alternating with glass. Thus, by means of the simple transformation known as substitution, Mies used the truss geometry to control the natural light entering the hall from the outside. Substitution is a transformation which also occurs both in linguistics and in music.

In literary analysis, the transformation known as auxesis refers to a graduated increase in density. This increase in density may be either in the form of successively more frequent occurrences of a word, or more generally, of a successively intensified expression of an idea. It may even happen that the two phenomena occur simultaneously and work in opposition so that a decrease in the frequency of word occurence results in an intensification of an idea. A fine example of this double auxesis is to be found in lines 307 to 311 of T.S. Eliot's The Wasteland.[1] Since these must be seen together, they are reproduced on the following page.

To Carthage then I came

Burning burning burning burning
O Lord Thou pluckest me out
310 O Lord Thou pluckest

Burning

Here the force of the last occurrence of "burning" is overpowering if read in context. At the same time, a more typical if brief auxesis is found in lines 309-10, through which an increased concentration on the idea of plucking occurs. It is through these two complementary occurrences of auxesis that we are brought to total concentration on two related ideas at the end of the section: "plucked out burning."

Auxesis is a transformation which has at least an analog in existing architecture. However, in speaking of the architectural manifestation of the phenomenon it is necessary to develop a more general concept which might be called a "graduated <u>change</u> in density." Architecture tends to be a less sequential art than either music or poetry in that there are often for example vantage points from which a building can be seen as a whole or more nearly so than either a musical composition or a poem can. Consequently there is a greater need in the case of architecture to be able to discuss transformations without regard to the direction in time and space of the experience. This is why it is helpful to speak here of a "graduated change in density", though in fact there are also cases in both music and poetry in which this description is equally appropriate. There are also cases in architecture where a building can be read in more than one direction. To cite but one simple example, a corridor is usually a "two-way street", and the experience in each direction may be different. A musical composition or a poem on the other hand is almost

never intended to be read backwards.

In the Youth Center at Firminy-Vert and in several other buildings of the same period, Corbusier applied his modulor (a system of proportion) to the spacing of window mullions (Figure 4.2). This resulted in a continuous variation in the density of the window band. Corbusier's objectives in treating mullions in this way are indicated in Modulor Two, where he says that his aim was: "to develop patterns for window mullions which varied in a continuous manner after the fashion of the undulations of elastic media."[2] Here then is a case where the general principle of density variation occurs in architecture.

In music, the complementary transformations of augmentation and diminution refer respectively to the increase and decrease in time value or duration of notes and rests. In a more general way, these terms can be conceived of as referring to changes in size while other defining properties of an object remain constant (the enlargement and dilation of mathematics). An instance of this transformation occurs in the Cultural Center at Wolfsburg Germany by Alvar Aalto (Figure 4.3). In this project, it was necessary to develop auditoria of several sizes. In meeting this objective, Aalto retains the same basic form but changes the size as he rotates the form around two points of generation. There are also however differences in form between the auditoria, so it needs to be pointed out that this is ultimately a case of transformational "affinities" which are not reducible to a simple formula.

Embedding and extraposition are transformations in linguistics. In conceptual terms, embedding is nearly the opposite of extraposition. In embedding, parts which are normally separate are combined or integrated

with each other by means of some property or characteristic which they have in common. Embedding is however different from conjunction because in conjunction, connection between two elements is made by the introduction of some third element. The linguistic form of the embedding relation can be abstracted to a pure relation which occurs in architecture. An example of embedding is found in the Friedman House by Wright (Figure 4.4). In this case, the main living quarters are formed by embedding a smaller cylinder in a larger one. In terms of the pure relation involved, embedding appears to be identical with rather than merely analogous to embedding in linguistics.

Simple Transformations by Analogy

In the work of Louis Kahn, we find at least one transformation which does not have a direct counterpart in the other fields studied. This transformation might be called "inside-outside reversal" which is probably more correct than "inversion" to which the relation does show some similarity. In the Meeting House which Kahn proposed for the Salk Institute for Biological Research at La Jolla California, the inside-outside reversal is used to differentiate the reading rooms from the dining rooms (Figure 4.5, numbers 7 and 9). In the reading rooms, the plan shows a square inside a circle, whereas in the dining rooms, the plan organization is a circle inside a square. In both situations, the containing form is open several stories high, while the contained form consists of several separate floors which open into the space of the containing form.

What makes this transformation particularly interesting is that it differentiates the two functions of reading and dining with something

like the maximum succinctness or economy. Speaking loosely, we could say that two different "statements" are made by using the same "words" in different order. For Kahn, plans of this sort were often extremely diagrammatic, and it may very well be that, had this part of the Salk project reached the stage of final drawings, the differentiation would have been handled differently.[3] None the less,at the conceptual level, this is a clear expression of the combination of relatedness and difference which transformation so often produces.

Transformations of Grids

Historically speaking, there does not seem to be much precedent for the use of grid transformation as an organizing technique in architecture. Wright was a master of grid geometry at one level, but he did not transform grids in the sense spoken of here. He did however use the geometry of the plan grid to organize columns and other vertical elements, as for example in the Chapel at Florida Southern college (Figure 4.6). In cases like these, it is probably accurate to say that the basic unit of the grid, a hexagon in this instance, constitutes a kind of geometric "motive" which is subjected to various kinds of transformation, so that parts of the hexagon can serve as forms for diverse elements. In many instances, a literal transformation of the grid geometry will not solve the problem, so Wright carries over the feeling of the hexagon motive in a way analogous to those cases already discussed in music and painting, where it is the impression of relatedness that is the primary concern rather than mathematical exactness. This is also a case where the transformations cannot really be reduced to simple operations, yet we recognize the affinity between the constituent parts of the design.

In actual practice, performing operations on the grid itself has been carried forward at least to some degree by Walter Netsch at S.O.M. Their basic procedure has been to superimpose simple grids and to do some elementary mathematical transformations; mostly rotations, translations, deletions and dilations. In spite of claims about the need for organizations that allow for future changes, these grids are extremely rigid and can easily lead to the production of patterns that remind one of the growth of some ominous bacterium (Figure 4.7). Better results might be obtained by abandoning the idea of preparing the way for additions alltogether, or by giving careful consideration to what parts of a building are really likely to be altered. If for example it is only the configuration of the lab bays in a chemistry building that are likely to be changed, there is no need to subject the rest of the building to the same organizing geometry that the lab bays are given.[4] If it is uneconomical to vary the spacing of columns, then these might be placed on a regular grid, while other parts might be organized by another grid subjected to free transformation (Figure 4.8).

Bruce Goff seems to have preceded Netsch by a number of years in the use of double grids (Figure 4.9). This example is also noteworthy because the second grid, which is rotated at 45 degrees to the first, is made up of a series of squares which are embedded in each other. Here we have what is perhaps one of the first cases of a double grid in which one of the grids has been subjected to transformation. The operations here are for the most part identical with various mathematical transformations.

There is evidence that transformation of grids is an area of increasing interest in architecture and in other fields as well. By now,

D'Arcy-Thompson's work with grids in biology is fairly well known, and his basic procedure has been applied experimentally in the architecture of Bill Tilson.[5] Tilson has experimented with plotting existing buildings on grids which have been subjected to local enlargments and dilations (Figure 4.10). While Tilson has said that he did not see much genuine architectural potential in his method, it is in part through his idea that I have come to the more general concept of treating the grid itself as a subject of free transformational variation. Thus liberated of the need to manipulate some pre-existent entity, I believe that the full potential of grid transformation can be realized in architecture. By this process, almost any degree of relatedness among elements instantiated on the grid can be achieved.

There are at least three ways in which transformations may be done in relation to a grid. The first way is at the level of pure geometry, and involves doing operations on the gird itself (Figure 4.11a). The second way is to let the grid control the relation between elements superimposed upon it (Figure 4.11b). A third way is obviously to do both types of operation.

As soon as one applies transformations to a grid however, a conceptual ambiguity develops. This ambiguity concerns whether one is in fact still treating the grid as a grid in doing rotations, embeddings, deletions and extrapositions on it, since it appears that when this is done, the grid cells have become elements or are being treated as elements. That the transformations in Figure 4.11a are still being done on what is at least a grid-like entity can be seen if, as a next step, one goes on to see what can be transformationally organized by using this already-

transformed grid as an organizer. In Figure 4.11b, the transformed grid is being used to organize what appear to be some heavy lines. But, if it now is said that these lines are really intended to be the tops of planes or walls, and that what is being developed is a plan of some sort, then it can also be seen what is meant by saying that the grid is being used to organize an embedding of spaces (A) and (B) in the area (C). Further, this embedding is itself a transformation, but not a transformation done to the grid of the figure, so this is how the grid transformations are distinguished from transformations applied to other architectural elements.

Grid Transformation in Music and Architecture

There is an interesting parallel between the grid in architecture and meter in music, which it will be worth our while to explore. Meter in music is probably best understood as a means of measuring rythm. Thus the bar-line at the beginning of a measure is normally understood to occur before the note in the rythmic pattern which receives greatest stress or accent. In this way the bar-lines on a conventionally organized score become a kind of grid which aids in recognizing the rythmic pattern of the composition. But, without adjustment in the notation system, this type of grid works only for music with a regular pulse, and in fact, it also tends to encourage composition in regular rythmic patterns just as a grid of squares encourages certain kinds of regularity in archi-design.

It used to be conceived that meter in music was more or less constant, so that if a composer wanted to make a local change in rythm, he would do this by supplying accents to notes that the meter did not indicate accents for. In the music of today however, meter itself is

conceived as a variable subject to the constant manipulation of the composer. The variation of meter had its beginnings in the 19th century when composers would sometimes write alternate measures of, say, 5-4 and 6-4 meter. Moussorgsky for example did this in the Promenade section of Pictures at an Exhibition (Figure 4.12a). Later, in some of the works by Stravinsky such as the Soldier's March from The Soldier's Tale, the procedure has developed so far that the meter changes with every measure (Figure 4.12b). In this case, the result is an almost puppet-like angularity of motion. Note that the numbers included in these examples indicate the number of equal metric units which occur in each measure. Thus in Moussorgsky's Promenade, the numbers: 1-2-3-4-5 in the first measure additively count the quarter-notes (total of five) which occur in that measure. It is hoped that this will make it possible for those who do not read music to begin to "see" the metric variations in the score. The logical limit of this sort of development is obviously the case where the rythm and meter are so fluid that they can no longer be indicated with bar-lines at all. A number of composers have pushed to this state in the present century. Among them is Charles Ives, whose song The Cage (Figure 4.13) is without bar lines. In this case however, the lack of a meterable rythm serves to support the idea of the monotonous equality of the pacing of the leopard in his cage--a world practically without structural variation.

It needs to be mentioned that the change from regular to irregular meters in music represents something more than a mere change in notational conventions. It is almost as if a person had discovered that he could directly control the rate of his pulse--something that used to be

considered a constant or a variable which was only indirectly alterable by the level of physical activity,such as running rather than walking.

It may be significant that Moussorgsky uses this technique of meter variation in a promenade theme. He might very well have noted that a walk through an art gallery or exhibition is not the same as marching in a parade. In a walk throug a gallery, one's pace varies as different pictures strike the fancy. This "irregular motion" is apparent in the opening measures of the Promenade.

From what has been said it will be noted that "grid variation" is much more fully developed in music than it is in contemporary architecture.

Style Transformation--The Diachronic Dimension of Architecture

Up to this point in our study of architecture, transformations have only been discussed to about the same level and depth at which they are normally analyzed in music-theory courses. We have picked out some obvious and easily recognizable cases and illustrated them with examples. These have been cases in which the two or more transforms appear in the object as product. As such, they are synchronic transformations, both in the sense that they occur in a single work rather than through a history of works, and in the sense that, at least as read in plan, they appear simultaneously rather than sequentially in experience. If we shift our focus to a radically diachronic view of architecture, we may study the process of style transformation as it occurs over a period of years.

Certain cases of transformation can only be understood as such in relation to conventional ways of organizing a building. Wright's Jester House and Graves' Hanselmann House illustrate this point (Figures 4.14

and 4.15). It is hard to imagine two architects more divergent in concerns than Wright and Graves, yet here, in terms of the transformation of the traditional house parti, we find them doing similar things. In the case of the Jester House, Wright found that the climate and the needs of his client allowed him to separate the three traditional zones of the house (sleeping, living, eating). Thus in the Jester House, these three zones are completely surrounded by outside space. One might say that the conjunctions of functional areas in the traditional house parti have here been broken down. This involves a transformation similar to "extraposition" in linguistics. In the Hanselmann House, it is only the entry stair and some adjoining elements which have been extraposed from their traditional position.

In The Geometry of the Environment, Steadman and March make the interesting point that many of Wright's houses exhibit a common topology.[6] That is, however different in other respects, several of his houses show the same basic configuration of relations between functional areas (Figure 4.16, a and b). From this point of view, the Jester House is an example of how Wright was able to transform this basic map without completely changing its structure. In such cases, the architectural experience is significantly different, even though the structure remains, in certain respects, the same.

While space does not permit it here, it would be interesting to compare the topologies of Wright's houses with those of traditional building organizations past and present. In this way it would be possible to get a clearer picture of the extent to which he modified not only the experiential aspect of the house (open plan, etc.), but the

functional organization as well. The topology of the three houses presented here would suggest that his modifications of traditional functional organizations were not as drastic as the changes he effected in the area of the house as experience.

Another case in which an architect has transformed a conventionalized organization of ordinary building is to be found in the grass-stepped entry which Aalto designed for his Town Hall at Seinajoke (Figure 4.17). From a semantic point of view, this is really a case of a graduated experience where none is normally thought possible. The norm is to think of grass and steps as separate entities at the entrance to a public building, yet here Aalto combines them in a way that makes us see both grass and steps in a new way. The sod makes us see the step as something soft, offering tactile properties of interest to bare feet. At the same time, it is through the step that we also see grass and earth in a different light. At a more explicitly symbolic level, the steps begin to be an expression of a new way of understanding the relation between a town hall and the land upon which it is built.

Discussing this transformation from a syntactic point of view, one might say that the transformation involved is a kind of embedding in which two objects are joined in virtue of some characteristic they can have in common, but this is really a case where the transformation is no longer reducible to a simple operation or relation. What is most important is that the transformation was performed on the entry to a town hall. We have all seen outdoor amphitheaters constructed in this way, but these constructions do not usually have the same degree of architectural impact because in the context of the amphitheater, this

combination is a convention--it is the obvious way to build an amphitheater, but not town-hall steps.

Building Vrs. Architecture

When we examined the case of poetics in Chapter Two, we found that the figures of speech were traditionally defined in a way which implied either an actual or a covert prose surface-structure which undergoes transformation when poetic discourse is created. The model of a prose surface-structure from which a poetic super-surface-structure is derived by transformation has implications for the study of transformation in architecture because there appears to be an analog in architecture to this distinction. For a long time, there have been disputes about whether there is a real distinction between "mere building" and architecture. Those who have argued that there is a real distinction have normally suggested that the concept of architecture applies to buildings like Saint Sophia but not to the houses in Levitt-Town. Thus, according to one view, Levitt-Town does not qualify as architecture because the objectives of the producers and users lie outside the scope of the concept of architecture. Others however argue (Venturi for example) that this view is perverse and constitutes a covert attempt to impose a certain "elitist" ideology on the rest of society.[7]

Now a distinction between building and architecture can be based on what one takes to be the analog of the prose surface-structure/poetic super-surface-structure distinction in the building/architecture milieu. This approach treats "building" as the analog of prose surface-structure and takes "architecture" to result in those cases in which transformations and other operations are applied to this surface-structure of

building prose. On this model then, building is the analog of non-literary prose and architecture is the analog of literary prose and/or poetry. In each case, both levels involve transformation, but it is by means of the application of operations to mere building that what we perhaps overgrandly call "architectural poetry" is produced. Whether in fact this distinction is at the bottom of the elitist/anti-elitist controversy is hard to say, but in some respects the analogy is striking, and worthy of further consideration.

It should not be supposed that on the model being sketched here, the architectural design process is thought to involve a necessary step in which a "mere building" is produced, and that the architect at a later stage goes on to transform the building into architectural poetry if he has the time and ability to do so. Both architect and poet often work directly at the "poetic level" in their respective media, yet when first learning an art form, one often works from prose surface-structure to poetic super-surface-structure for example. This phenomenon is particularly noticeable in learning to write poetry. The first draft may be a very prosy set of lines in which there seem to be a great many useless or minimally effective words. At that point one may discover that the effect can be improved by a number of deletions and substitutions. In so doing, one is applying transformation operations to a real prose structure.

Is there a parallel phenomenon in architectural design? I think there is. It is probably true to say that no great work of architecture has ever been conceived, as it were, in a single premeditated flash of invention. Art making in general, and architectural design in particular

involves a process of working out an idea. Design is the process of discovery and refinement, not the recording of preconceptions. As such, design is a process of working from the ordinary, the predictable and the customary to the extraordinary, the unpredictable and the uncustomary. Great art is always reaching out from the norm of the present into the unknown of the future to bring back something we have not yet even conceived the possibility of. As such, the artist must always work beyond his own expectations; it is particularly in this respect that building--the customary, and architecture--the search for the "unexpectable" are different but interdependent.

This "working out" and "going beyond" in art generally takes as its implicit starting point all that has become known and hence conventional in its milieu. The life-cycles of styles are cases of this conventionalization process. To see this process at work in architecture, it is only necessary to think for example of the way Wright's once unique open plans became conventionalized. It is now possible to pick up a builder's plan book and learn for example that one has a choice between houses with open plans and houses with closed plans. Today, it is just this sort of conventionalized organizing principle which the architect confronts as a given starting point, just as Wright once confronted the closed plan as a starting point--a surface-structure to be transformed.

In architecture, remodeling is often a case of beginning with a surface-structure of building. To "remodel" is literally to change the model of something, and this has certain implications having to do also with the change of norms and stylistic conventions. An interesting example of the derivation of an architectural super-surface-structure

from an existing surface-structure of conventional building is to be found in Wright's Moore House I (Figure 4.18). This house was first moved from another lot to its present site on the Moore property. Originally, it way a typical Victorian frame house. Once it was on its new site however, Wright did everything possible to transform it into a "prairie-house" with an open plan. By considering some of the operations performed on the old house to produce this remodeling, we can begin to see how transformation can be applied to a surface-structure of ordinary building to produce architecture. The original house had a closed plan, and to open it up, it was necessary to perform several major deletion operations on walls. One of the most noticeable transformations on the exterior of the house is the extension of the soffits to provide the windows with that combination of light and weather protection which were trademarks of Wright's style. This transformation is like augmentation in music and enlargement in geometry. In this case, a transformation of a conventionalized overhang produces something which, in the context of the time was unconventional and unexpected. Originally, the front porch had been a mere "add-on", neither structurally nor formally integrated with the rest of the building. It was just the sort of conjunction which in fact results in an awkward compound sentence such as: "We built a house and we built a porch for the house." By the time Wright did the Moore House I, he was very much opposed to the additive concept of building organization, and he performed several operations to integrate the porch more closely with the structure of the house both visually and functionally. The general conceptual principle behind this integration involved the search for elements which could be common to

both house and porch. Most obvious among these are trim and rooflines, but there is also the idea of the "loggia"--as Wright conceived it, an outside space which is an extension of an interior space. In at least a general way we can say that the transformation implied by Wright's treatment of the porch here and in other buildings is that of embedding; that is, the linking of two or more elements by means of some feature they have in common.

In reacting to the residential style of his time, Wright seems to have quite frequently reversed or inverted the norm. In the Jester house, he disjoined and extraposed rooms that traditionally shared common walls. In the Moore House I on the other hand, he embeds what the norm merely conjoined.

These reactions to existing stylistic conventions should not be understood as motivated by a simplistic desire to be "different". Such an attitude usually results in nothing but superficial cleverness. Genuine style transformations result from the realization that there are possibilities that lie outside the style, and that these possibilities have a value in terms of experience that makes them worth pursuing. It is usually only in retrospect that the old style comes to be seen as "wrong" or as "outdated". The old style is not however always seen as defective in comparison with the new. In music for example, both Brahms and Schumann longed for the coherence of the Classical style even though at the same time they realized that they could no longer work that way. In genuine style transformation there usually is a desire to go beyond, but not to overthrow the past completely and start from scratch. In this way, style transformation also observes the principle of economy.

In the Norton Lectures, Bernstein identifies several levels of constituent elements in poetry, language and music.[8] These levels are based on the Chomskian concept of a generative and transformational grammar. In Figure 4.19, I have extended Bernstein's table to include architecture. In each field, what appears at level (A) in the chart constitutes the "art" level, while level (B) represents the "language"level of the field; that is, the level of conventionalized organizing rules. In the building milieu (as distinct from architecture), these rules have to do with such things as the organization of structural systems such as the Western frame, and conventionalized functional arrangements such as were discussed in terms of the topology of Wright's houses. If these distinctions are not pushed too far, they do, I believe, give some indication of what lies behind our intuitions about the difference between building and architecture.

Conclusion

While this survey has been relatively brief, as the reader was forewarned, it should be complete enough to give an idea of what transformation is, what it does and what it can be used to do in architecture. The discussion may appear to have emphasized the visual dimension of architectural experience at the expense of other perceptual dimensions such as touch, hearing and body movement, but this need not be the case. First let it be noted that as music amply demonstrantes, transformation can be applied to any medium over which the proper level of control can be established. Transformation cannot easily be applied to the olfactory dimension of experience because odors are hard to control in space and because, like tastes, they do not have structures which can be

manipulated by transformation. On the whole, one smell or taste cannot be derived from another in a way that is recognizable in experience.

Transformations, even of visible forms, are not however necessarily done just for their visual effect. Consider auxesis for example, which is an increase in density. Suppose the task is to increase the density of window mullions. This may be done just for some visual effect, but it may also be done for wind, light and temperature control on, for example, a curved wall with a continuously changing aspect. So it will easily be seen that the transformations are capable of affecting other dimensions of experience than the visual. To cite but one simple example, consider a boy running a stick along a picket fence. He experiences anaphora or repitition in three perceptual modes at the same time. In the visual mode, he sees the stick vibrate, in the tactile, he feels the stick shake in his hand and in the auditory mode, he hears the repeated impact of the stick on the pickets.

One issue in particular which this brief study does not give adequate attention to is the way the objectives behind the use of transformation have changed over time. Today for example, Wright's concept of organic architecture is no longer the call to arms it once was. Today we are more concerned with mystery, ambiguity and opposition than with the beautifully worked crystal structures of Wright's hexagonal grids. For our time, Wright's designs are a part of the history of art; things to be studied and learned from, but not to be repeated. Today we are at least as much concerned with opposition as we are with variation. In this respect, we are beginning to find ways to present <u>together</u> in archtecture things which before were conceived only as alternatives. In the

Palace of the Assembly at Chandigarh for example (Figure 4.20) Corbusier presents a truncated hyperboloid of revolution and an irregular pyramid; forms which before probably would only have been thought of as alternatives. Corbusier however was able to develop form-contexts which permitted such combinations.

It is also worth considering whether architecture has to some extent begun to manifest the contemporary relativity of space and time which we today experience through air travel. It would seem that the tendency to present together what in older styles could only be conceived as alternatives indicates a move in this direction. Venturi's talk about "both and rather than either or" also points in this direction. Today our modern methods of transportation contribute to this relativity of space and time. In terms of experience, jet travel makes it difficult or impossible to comprehend space in terms of travel time. London is eight hours from New York, but how much space is that? All we know is the space of the plane cabin while the world unroles below us like a movie scenario. Thus New York and London can now be "together" in experience in a way that was hardly conceivable in Baroque times. It would not be surprising if, through art, we begin to show ourselves these things--to make them visible--in ways that are lost in every-day experience.

The present study has also neglected the investigation of transformation in older architecture. It would be interesting for example to explore in depth the relation between the Baroque tendency to treat problems as continua and the architecture of the period. Even a cursory comparison of the Renaissance and Baroque styles suggests that something

like a similar shift in the treatment of forms did in fact occur. The Baroque is often curved, undulating and continuous where the Renaissance is angular, streight-lined and discontinuous. It was also during the early Baroque period that the twelve modes in music were reduced to two (major and minor) by means of the concept of the diatonic scale. This too is a case in which isolates began to be understood as parts of a larger system.

## NOTES

### 1: INTRODUCTION

1) Benedetto Croce, The Philosophy of the Practical (New York, 1969) p. 37.

2) Wright put this in various ways at different times. The only one I have been able to relocate for this essay is in Frank Lloyd Wright, The Natural House (New York, 1954) p. 42. There he says: " Five lines where three are enough is always stupidity. Nine pounds where three are sufficient is obesity. But to eliminate expressive words in speaking or writing--words that intensify or vivify meaning--is not simplicity. Nor is similar elimination in architecture simplicity. It may be, and usually is, stupidity."

3) Vitruvius, The Ten Books on Architecture, trans. Morris Hicky Morgan (New York, 1960) p. 13. It remains a mystery to me how Vitruvius' three terms ever got translated as "firmness, commodity and delight". Closer to the spirit of his idea are: ordering (taxis), transparancy (diathaesis) and economy (economia).

### 2: THE CONCEPT OF TRANSFORMATION

1) Ludwig Wittgenstein, Philosophical Investigations, trans. G.E.M. Anscombe (New York, 1953) p. 32.

2) This issue is given a rather full airing in a fabulously heated dispute between Bertrand Russell and P.F. Strawson over the analysis of definite descriptions, for which see P.F. Strawson, "On Referring," and Bertrand Russell, "Mr. Strawson on Referring," both in Contemporary Readings in Logical Theory, ed. Irving M. Copy and James A. Gould (New York, 1967) pp. 105-132. Both authors agree that ordinary language

has no exact logic but draw different conclusions from this point.

3) William Ivins, Art and Geometry (New York, 1964) p. 91.

4) Morris Kline, Mathematical Thought from Ancient to Modern Times (New York, 1972) p. 288.

5) Hilary Putnam, "The Innateness Hypothesis and Explanatory Models in Linguistics", Innate Ideas, ed. Stephen P. Stich (Los Angeles, 1975) pp. 136-137.

6) A good introduction to transformational linguistics is John P. Broderick, Modern English Linguistics: A Structural and Transformational Grammar (New York, 1975).

7) See for example Terence Hawkes, Structuralism and Semiotics (los Angeles, 1977) Chapter Three.

8) See for example Charles Duffy and Henry Pettit, Dictionary of Literary Terms (Denver, 1951).

9) Leonard Bernstein, The Unanswered Question: Six Talks At Harvard (Cambridge Mass., 1976) p. 83.

10) The diagram is from Paul Collaer, A History of Modern Music (New York, 1955) example 6b.

11) Rudolph Reti, The Thematic Process in Music (London, 1961) p. 93.

12) Reti, Thematic Process, p. 67.

13) An extensive discussion of the relation between color, line and form is to be found in Paul Klee, Das bildnerische Denken (Stuttgart, 1956)

14) See for example Carola Giedion Welcker, Paul Klee, trans. Alexander Gode (New York, 1952) p. 48 and also Will Grohmann, Paul Klee (New York, n.d.) p. 21.

3: DEVELOPING A STRATEGY FOR THE INVESTIGATION OF TRANSFORMATION IN ARCHITECTURE

1) Claude Levi-Strauss, Structural Anthropology (Baltimore Md., 1972) p. 62.

4: TRANSFORMATION IN ARCHITECTURE

1) An annotated version of "The Wasteland" is to be found in The Norton Anthology of Modern Poetry, ed. Richard Ellmann and Robert O'Clair (New York, 1973) pp. 459-470.

2) Le Corbusier, Modulor Two (Cambridge Mass., 1973) p. 324.

3) The point about the diagramatic quality of these plans and the model was made by Jaan Holt in a conversation in March 1978. Holt worked in Kahn's office at the time this part of the project was done.

4) For his own appraisal of field theory, see "Forms as Process" and "Field Theory to Date", Progressive Architecture, Vol. 50, No.3, March, 1969.pp. 94-103.

5) See D'Arcy Thompson, On Growth and Form, ed. J. T. Bonner (New York, 1969). Tilson's experiments are recorded in a 1975 Master's thesis called "Travels of a Semantic Geometer", a copy of which is in the VPI & SU architecture library.

6) Lionel March and Philip Steadman, The Geometry of the Environment (London, 1974) pp. 27-28.

7) See for example, Robert Venturi, Learning from Las Vegas (Cambridge, Mass, 1972).

8) Bernstein, Unanswered Question, pp. 80-86.

# APPENDIX OF FIGURES

• = INVARIANT PROPERTY

| NAME | MAPPING | POSITION | LENGTH | ANGLE & RATIO | PARALLISM | CROSS-RATIO | NEIGHBOR-LINESS |
|---|---|---|---|---|---|---|---|
| | IDENTITY  | • | • | • | • | • | • |
| ROTATION REFLECTION TRANSLATION | ISOMETRY  | | • | • | • | • | • |
| ENLARGEMENT DILATION | SIMILARITY  | | | • | • | • | • |
| SHEAR STRETCH | AFFINITY  | | | | • | • | • |
| PERSPECTIVE | PERSPECTIVITY  | | | | | • | • |
| | TOPOLOGY  | | | | | | • |

FIGURE 2.1 THE GEOMETRIC TRANSFORMATIONS

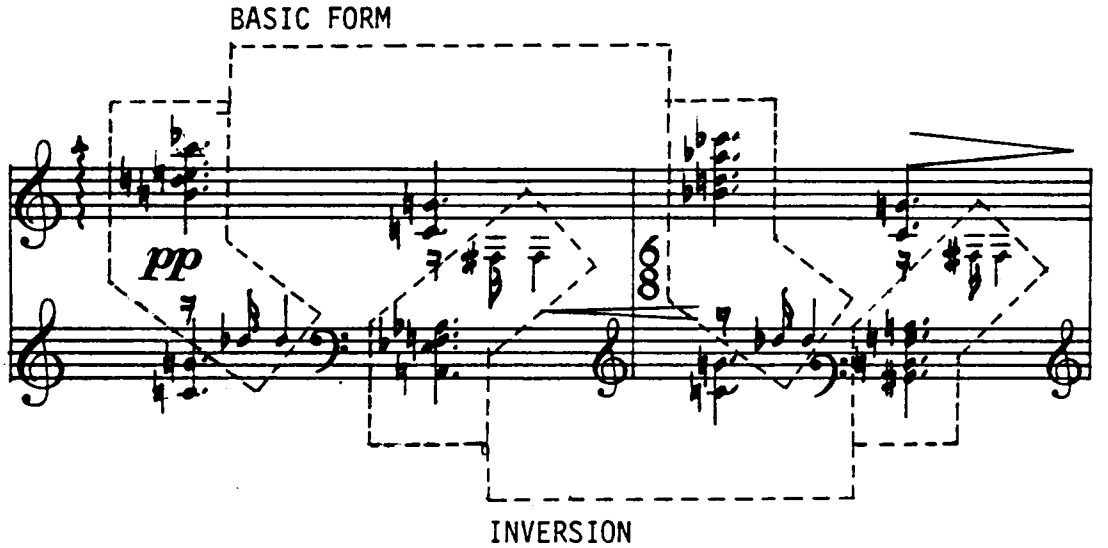



FIGURE 2.2a INVERSION IN MUSIC

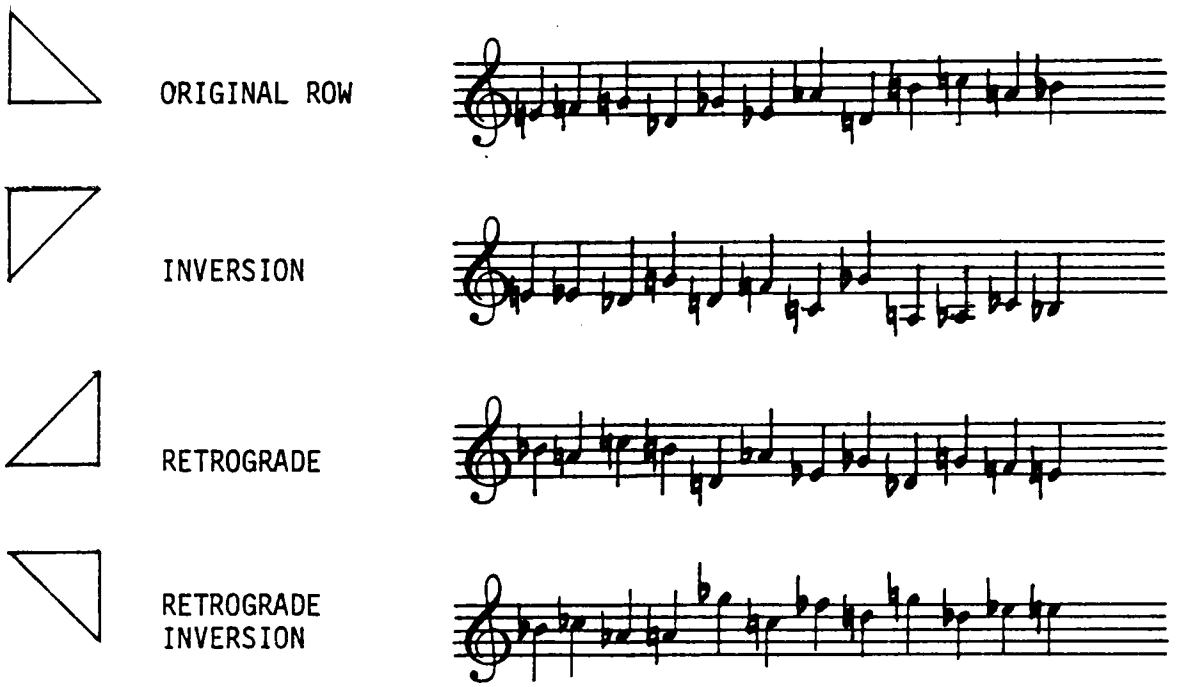



FIGURE 2.2b THE BASIC TRANSFORMATIONS IN MUSIC

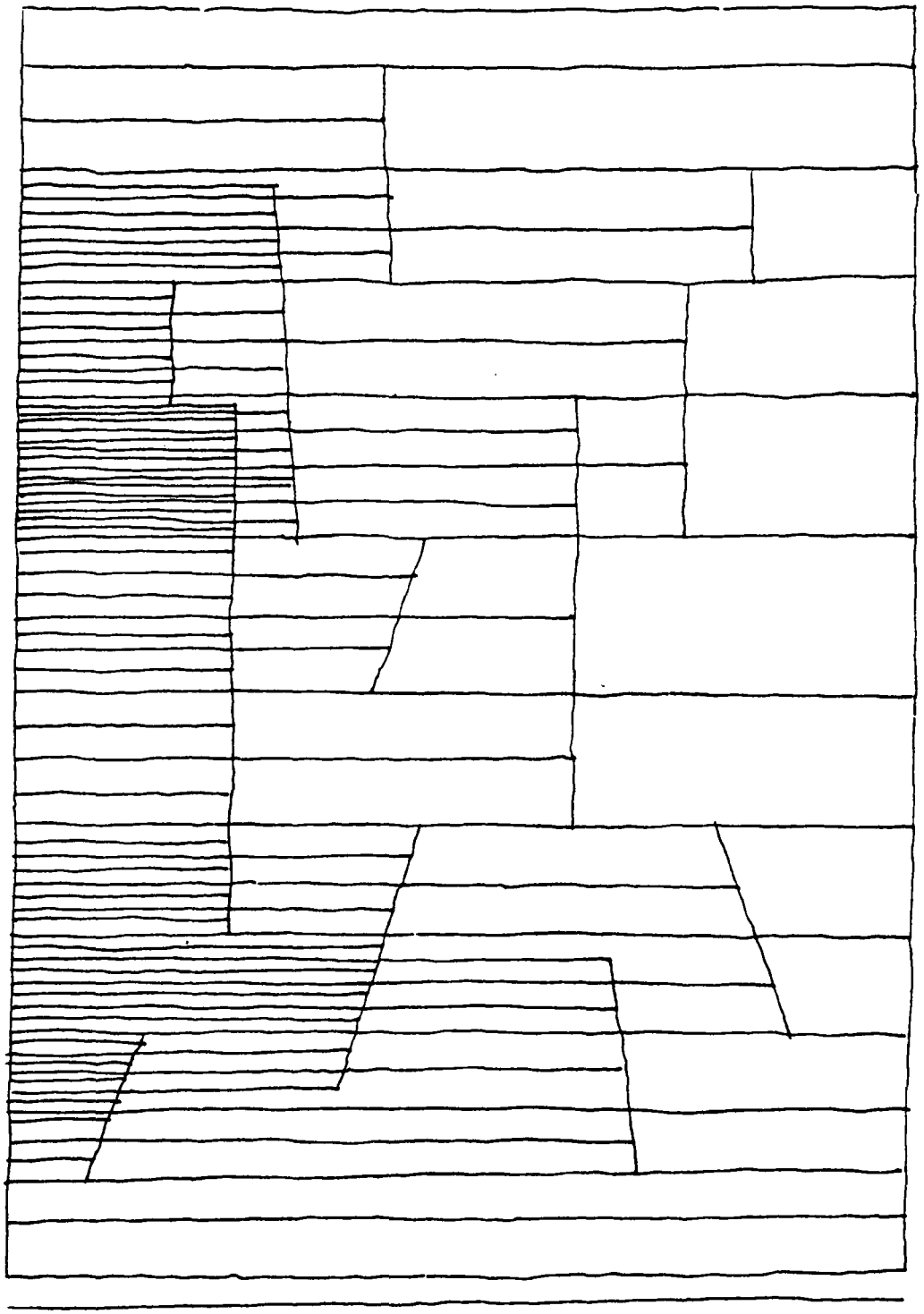


FIGURE 2.3 MONUMENT ON THE EDGE OF FERTILE COUNTRY PAUL KLEE
WASH TONES ARE NOT REPRODUCED

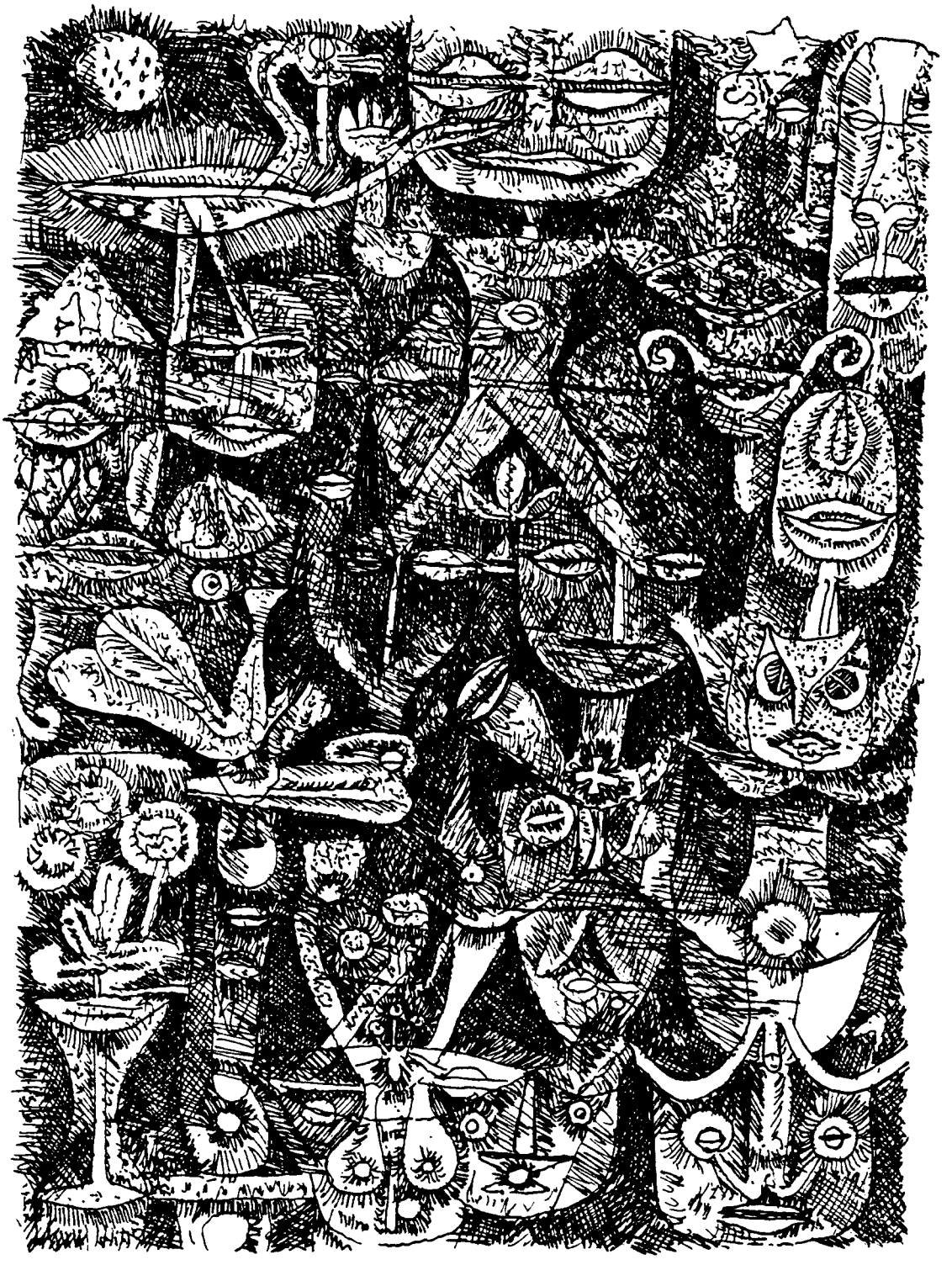


FIGURE 2.4 STRANGE GARDEN PAUL KLEE DRAWING FROM PHOTO OF THE ORIGINAL

FIGURE 3.1 COMPARISON OF TRANSFORMATIONS IN FOUR FIELDS

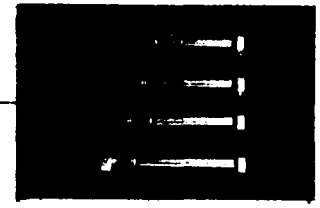
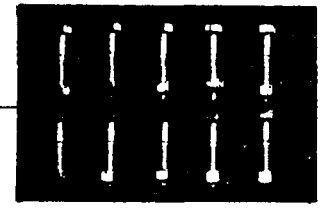
| LINGUISTICS | POETRY | MUSIC | GEOMETRY | DIAGRAM |
|---|---|---|---|---|
| | | AUGMENTATION | ENLARGEMENT |  |
| | ANAPHORA (repetition) | REPETITION | TRANSLATION |  |
| | ASYNDETON (conjunction elimination) | | |  |
| | AUXESIS | STRETTO Diminution can also have this result | |  |

FIGURE 3.1 (CONTINUED)

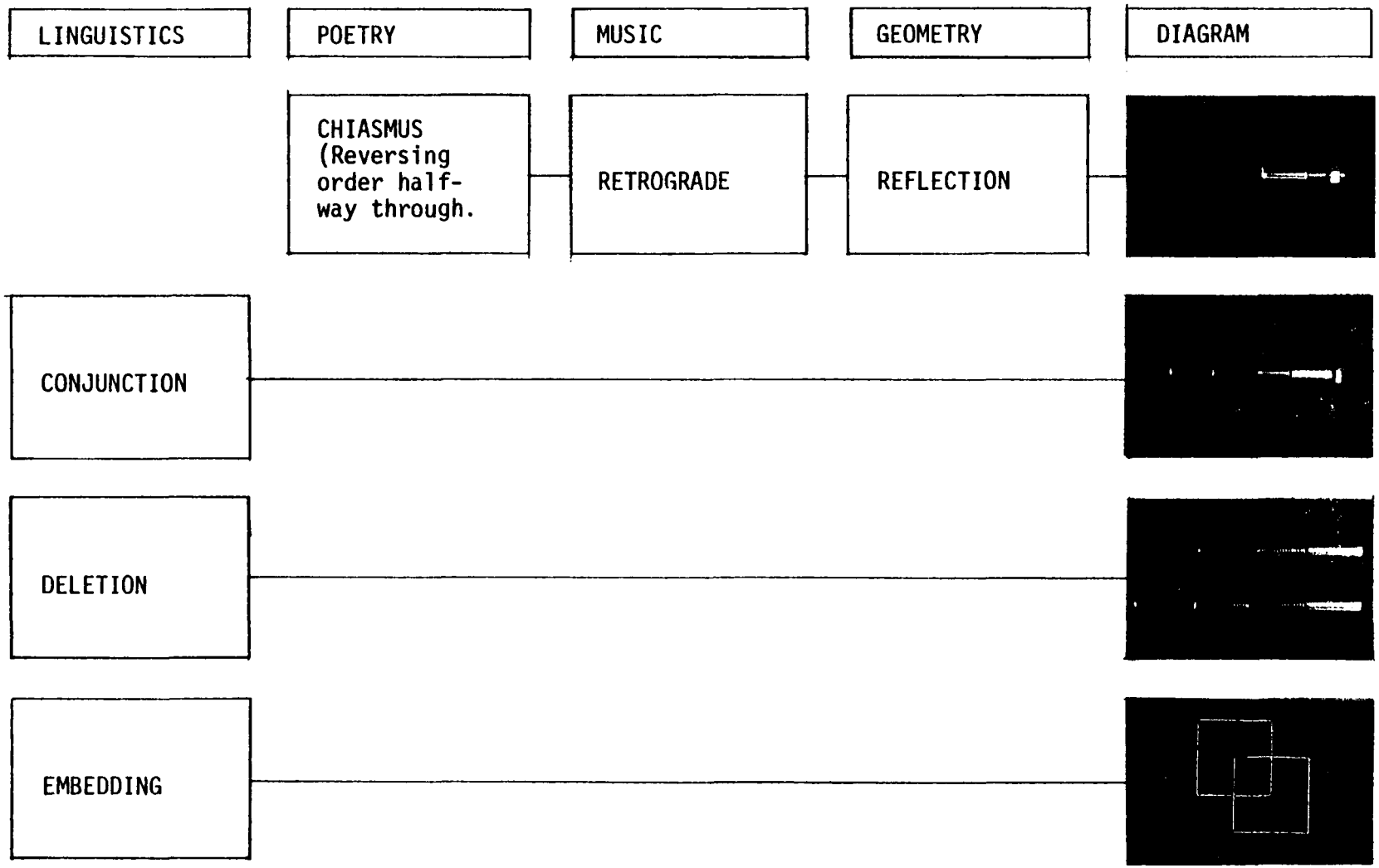


FIGURE 3.1 (CONTINUED)

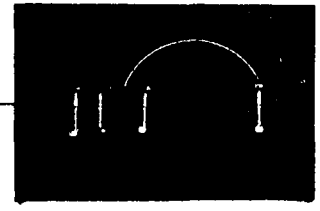
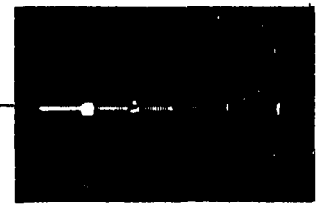
| LINGUISTICS | POETRY | MUSIC | GEOMETRY | DIAGRAM |
|---|---|---|---|---|
| EXTRAPOSITION | | | |  |
| INVERSION | INVERSION (Sometimes called ANASTROPHY) | INVERSION | REFLECTION |  |
| | POLYSYNDETON | | |  |
| | INVERSION | RETROGRADE | REFLECTION |  |

FIGURE 3.1 (CONTINUED)

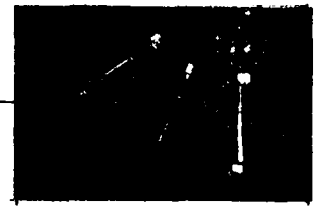
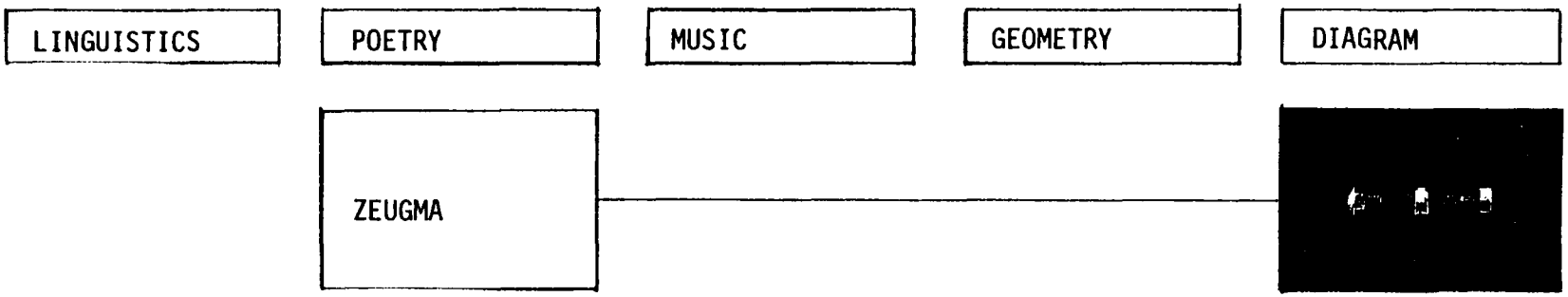
| LINGUISTICS | POETRY | MUSIC | GEOMETRY | DIAGRAM |
|---|---|---|---|---|
| | | RETROGRADE-INVERSION | SPECIAL CASE OF REFLECTION |  |
| | RHOPALISM | SPECIAL CASE OF AUGMENTATION | SPECIAL CASE OF ENLARGEMENT |  |
| | | | ROTATION |  |
| SUBSTITUTION | | SUBSTITUTION | |  |

FIGURE 3.1 (CONTINUED)



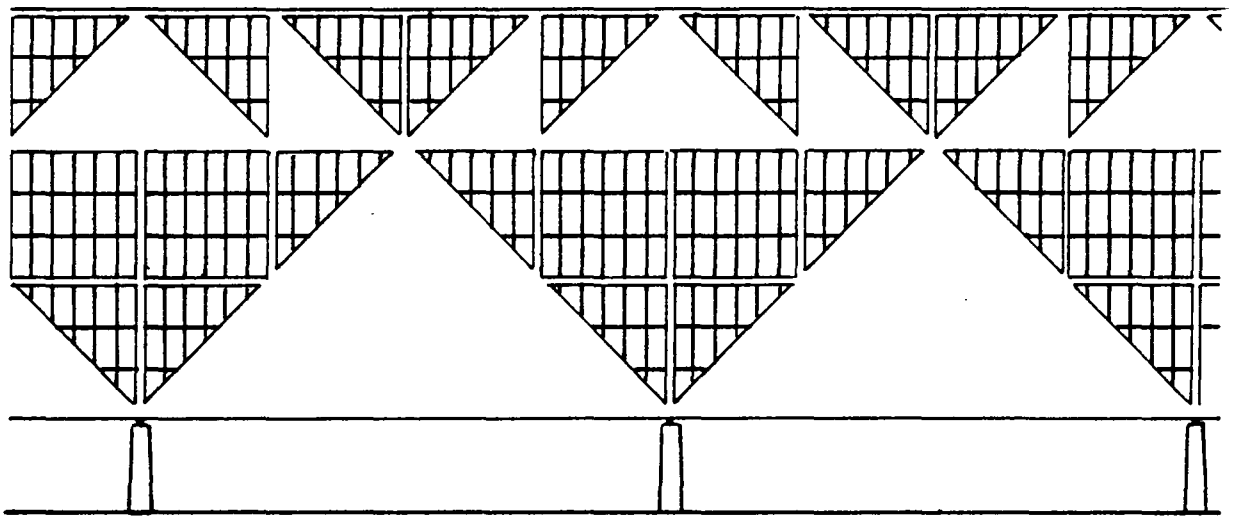
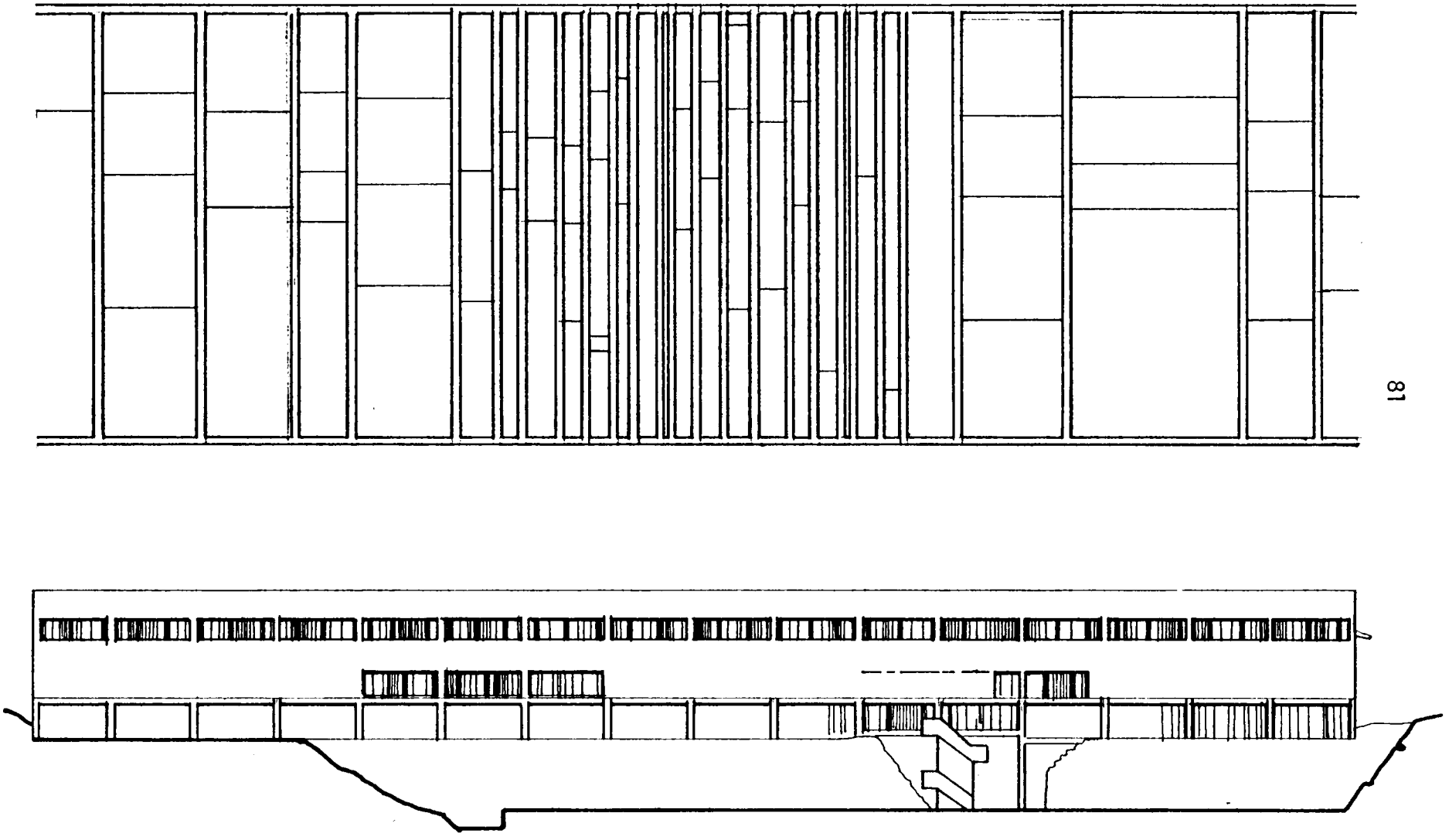


FIGURE 4.1 CHICAGO CONVENTION HALL MIES VAN DER ROHE

FIGURE 4.2 YOUTH CENTER AT FIRMINY-VERT CORBUSIER



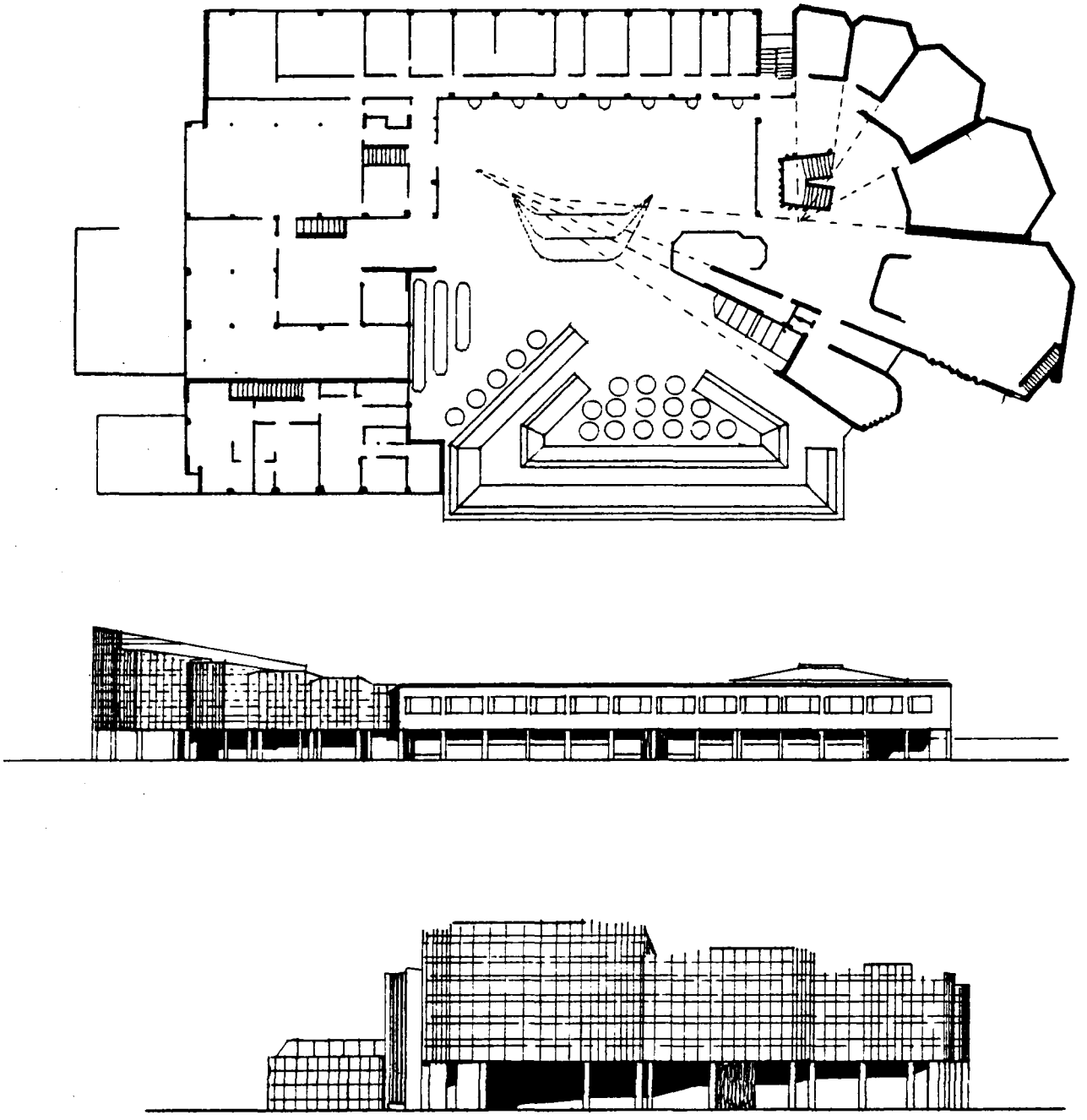


FIGURE 4.3 CULTURAL CENTER AT WOLFSBURG GERMANY ALVAR AALTO

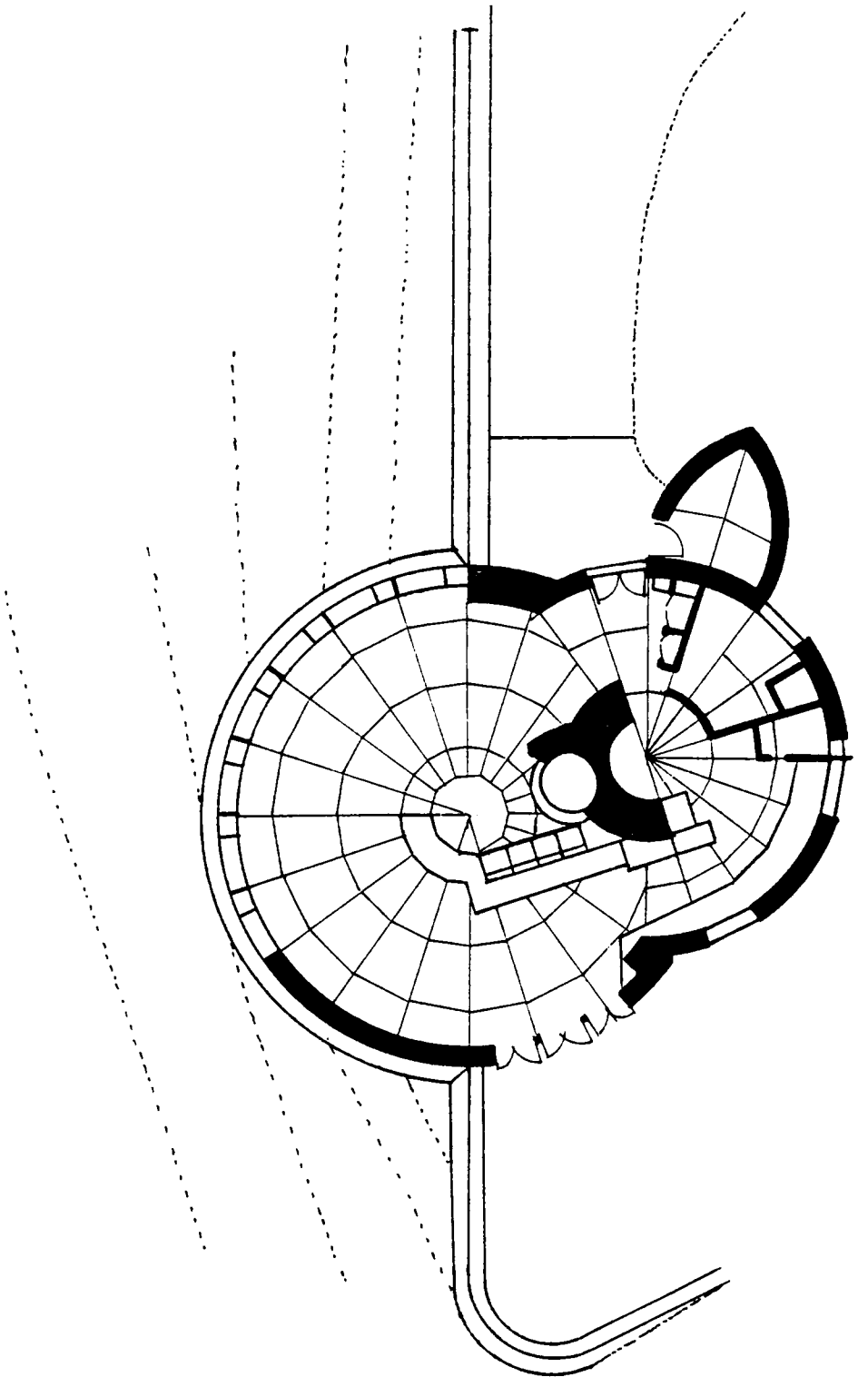


FIGURE 4.4 FRIEDMAN HOUSE FRANK LLOYD WRIGHT

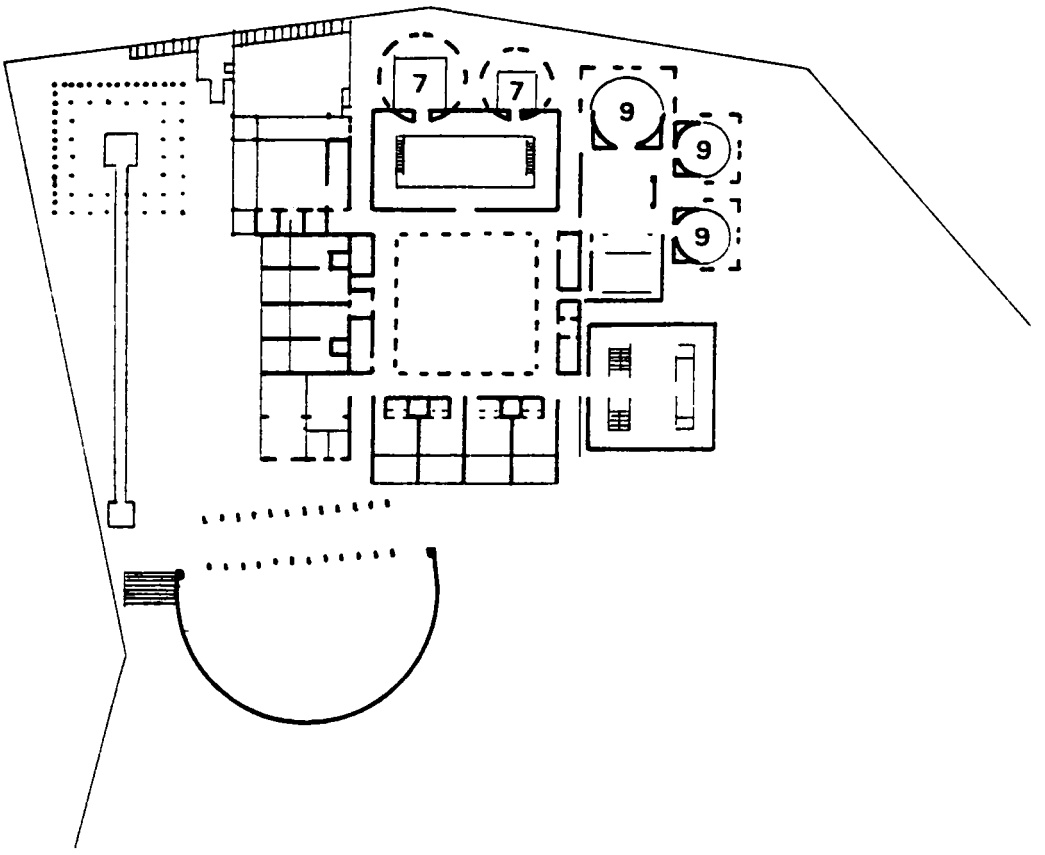



FIGURE 4.5 SAULK LABORATORY MEETING HOUSE LOUIS KAHN

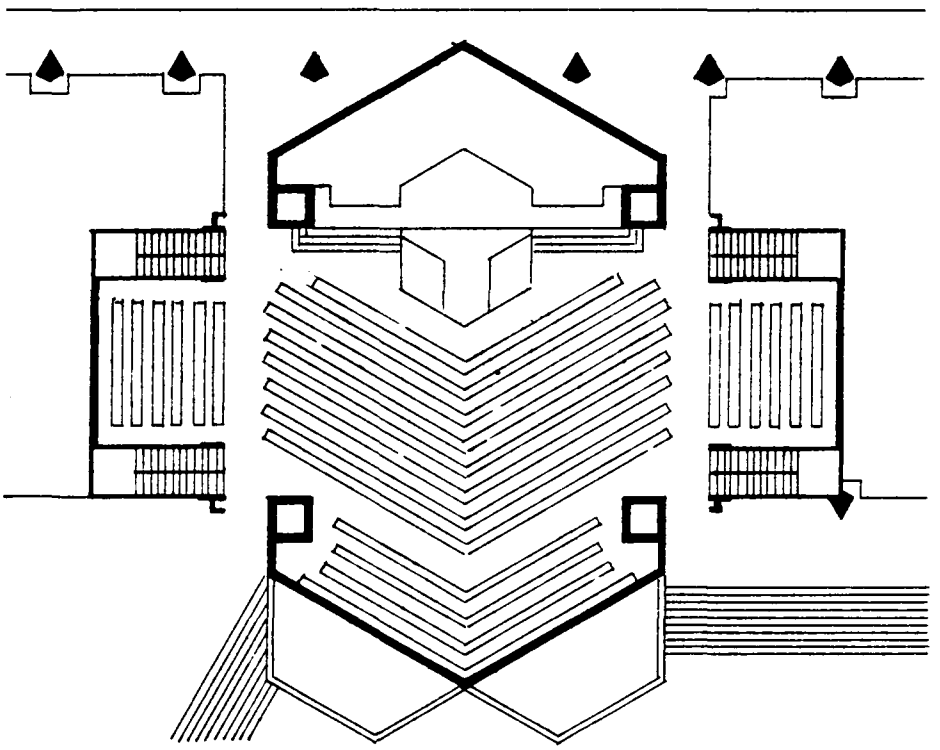


FIGURE 4.6 ANN PFEIFFER CHAPEL, FLORIDA SOUTHERN COL.
FRANK LLOYD WRIGHT

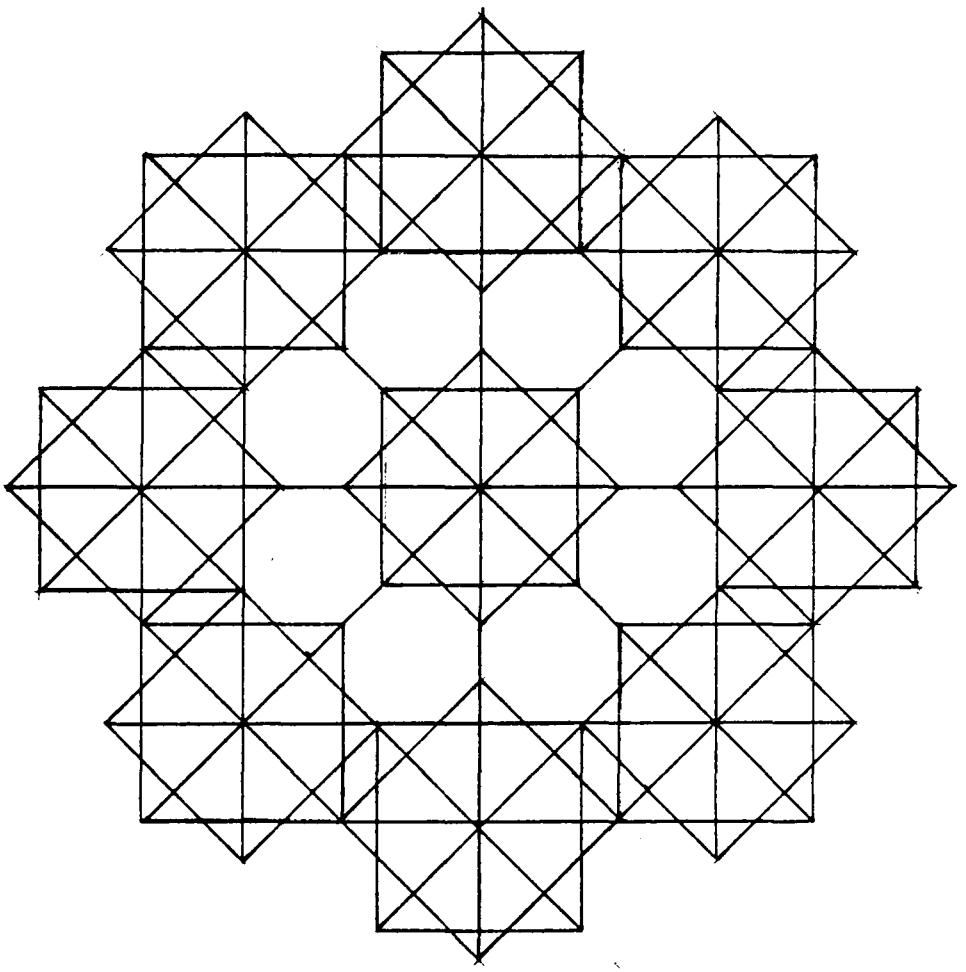


FIGURE 4.7 TYPICAL FIELD THEORY GRID BY WALTER NETSCH

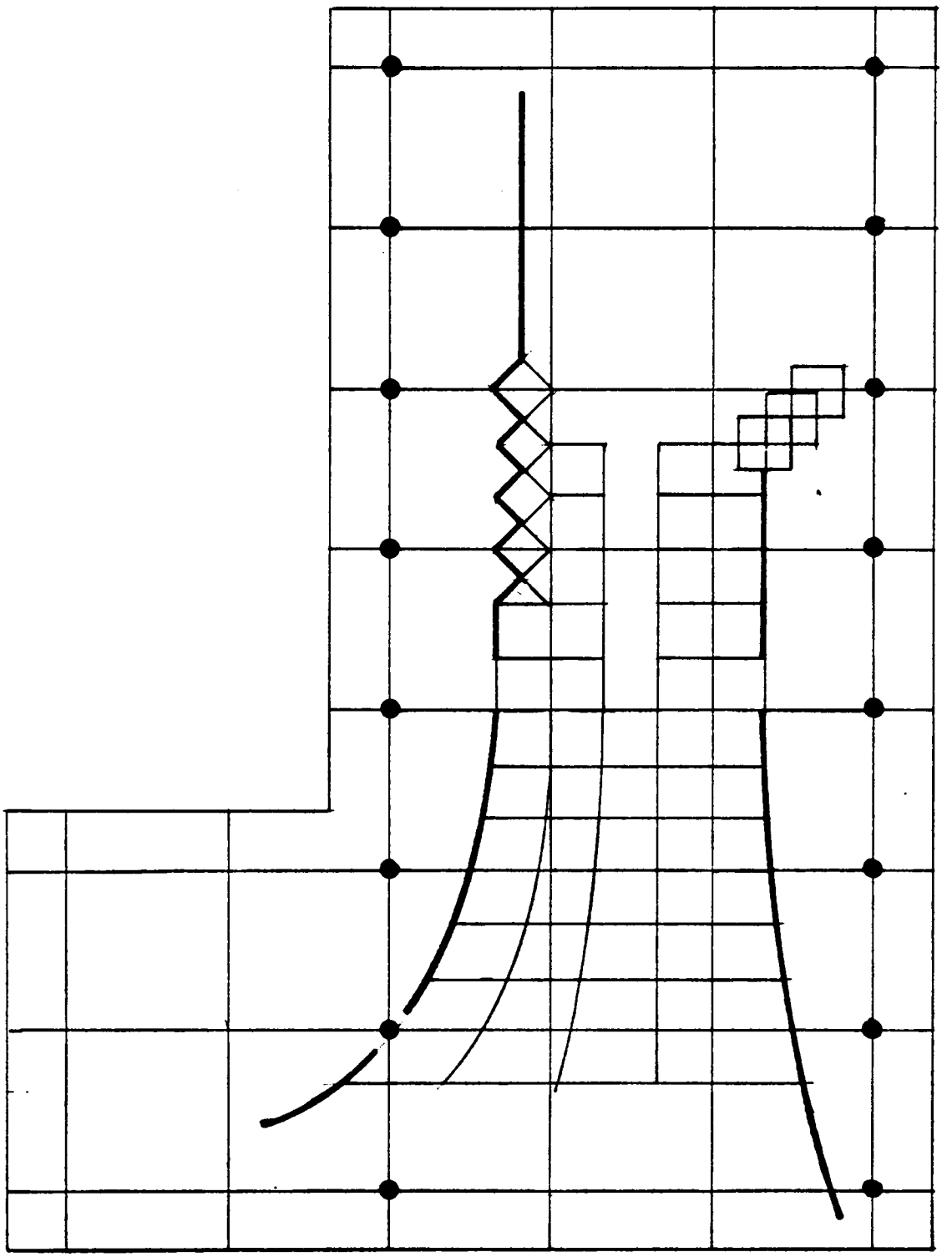
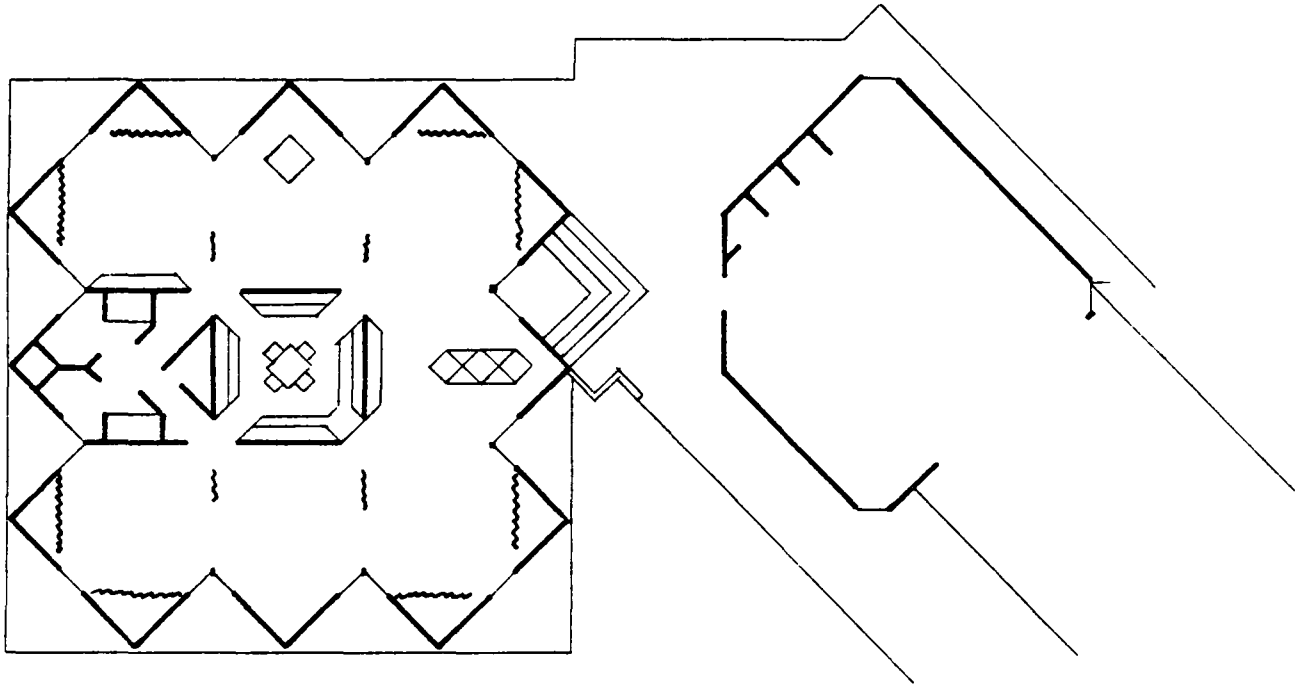


FIGURE 4.8 COMBINATION OF REGULAR AND TRANSFORMED GRIDS



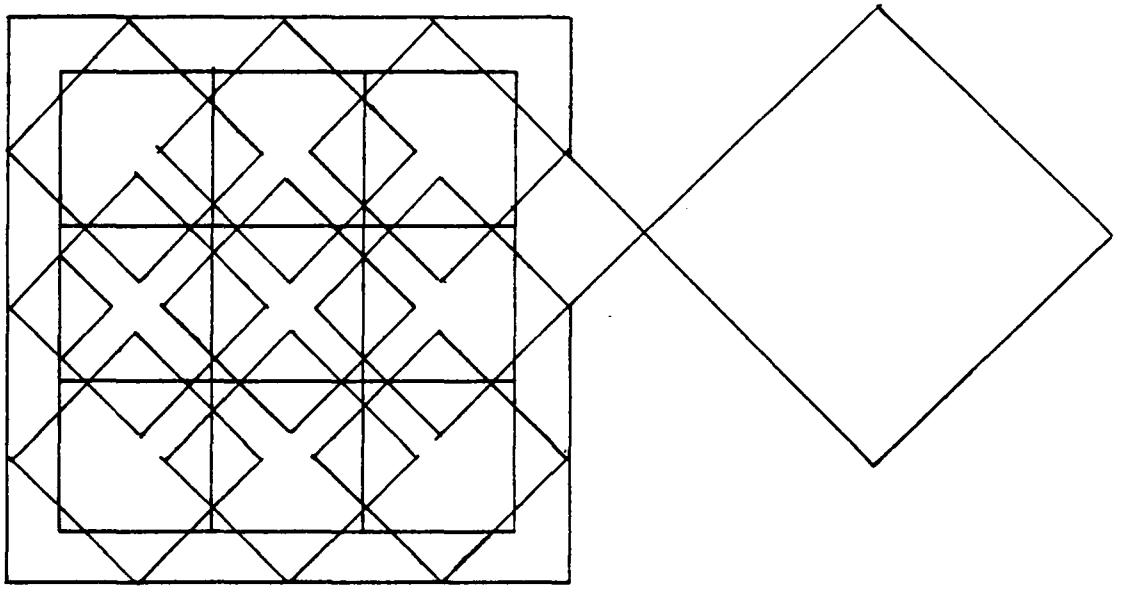


FIGURE 4.9 POLLOCK HOUSE BRUCE GOFF

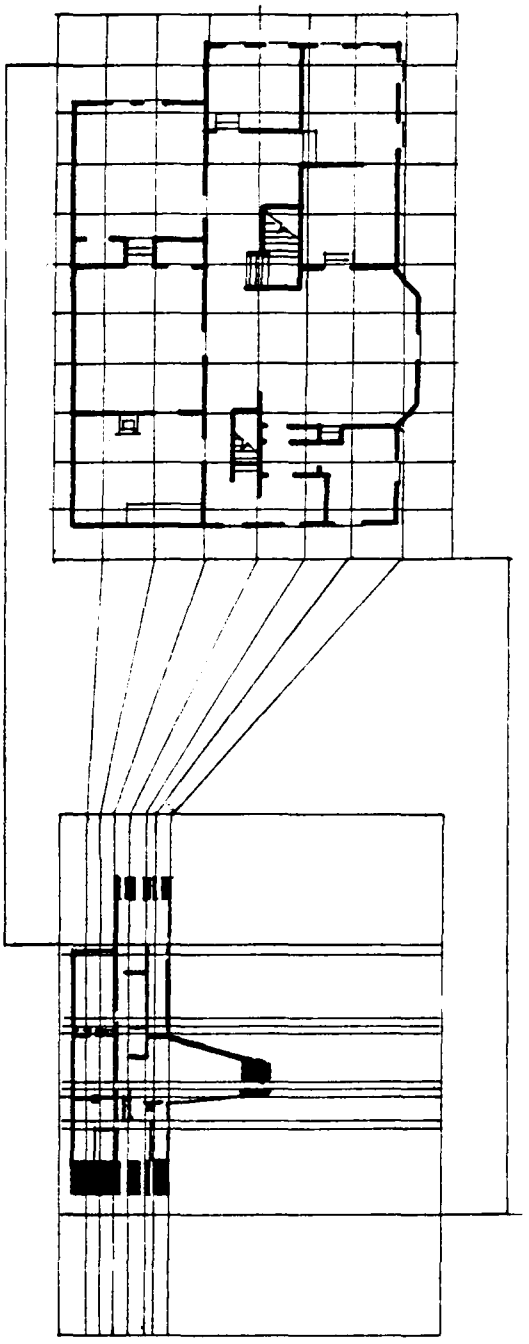


FIGURE 4.10 GRID TRANSFORMATION OF A PLAN AFTER TILSON

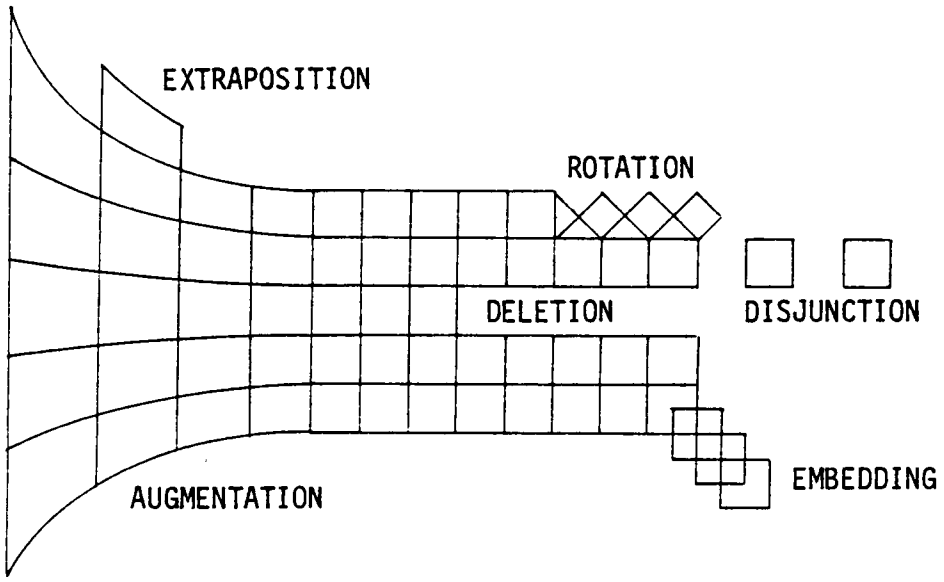



FIGURE 4.11a TRANSFORMATIONS OF A GRID

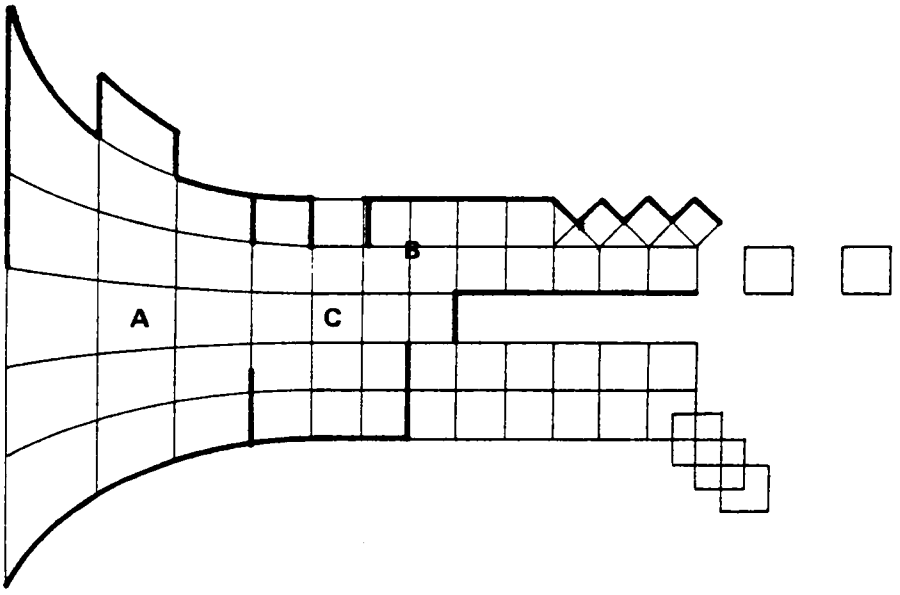



FIGURE 4.11b TRANSFORMED GRID USED AS AN ORGANIZER

Allegro giusto nel modo russico senza allegrezza ma poco sostenuto

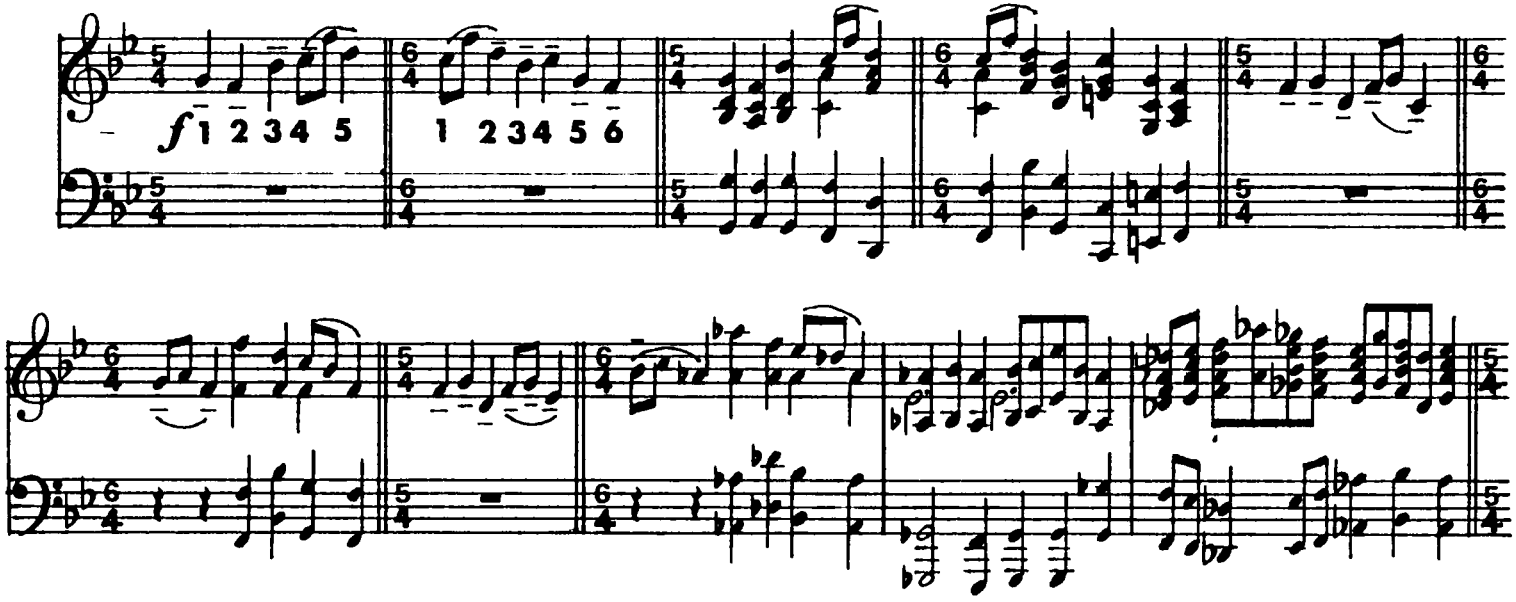



FIGURE 4.12a PROMENADE FROM MOUSSORGSKY'S PICTURES AT AN EXHIBITION

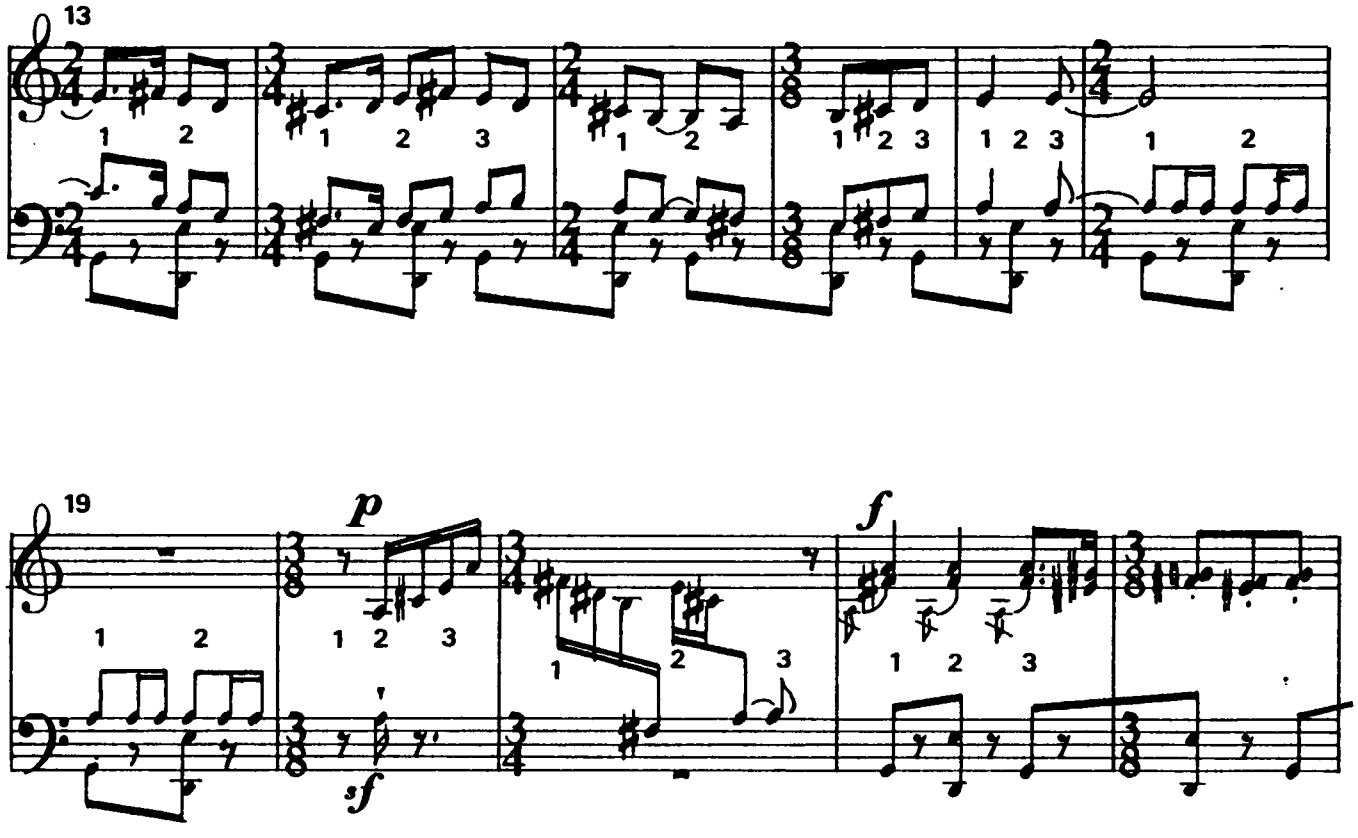
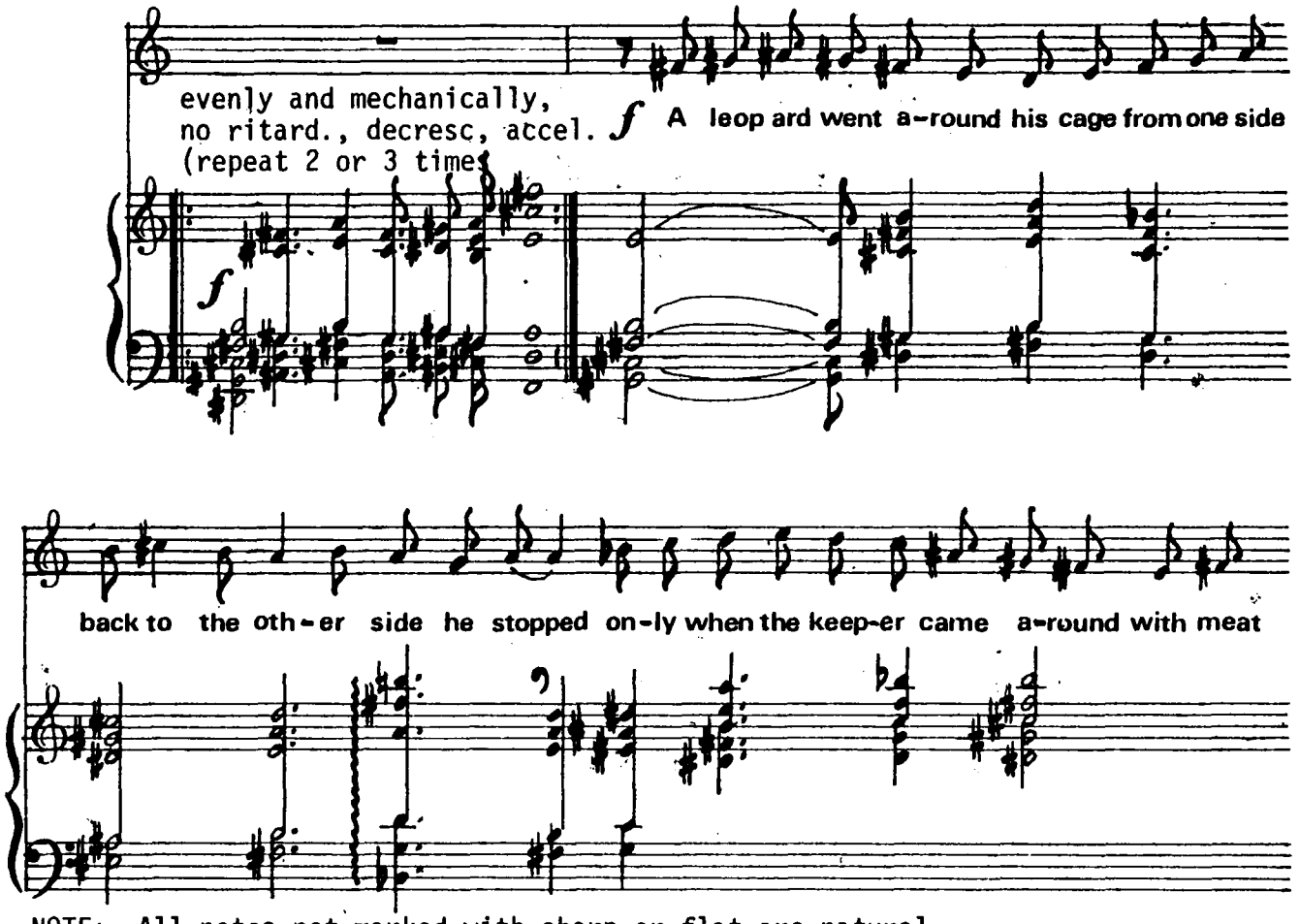



FIGURE 4.12b SOLDIER'S MARCH FROM THE SOLDIER'S TALE IGOR STRAVINSKY




NOTE: All notes not marked with sharp or flat are natural.

FIGURE 4.13 THE CAGE SONG BY CHARLES IVES

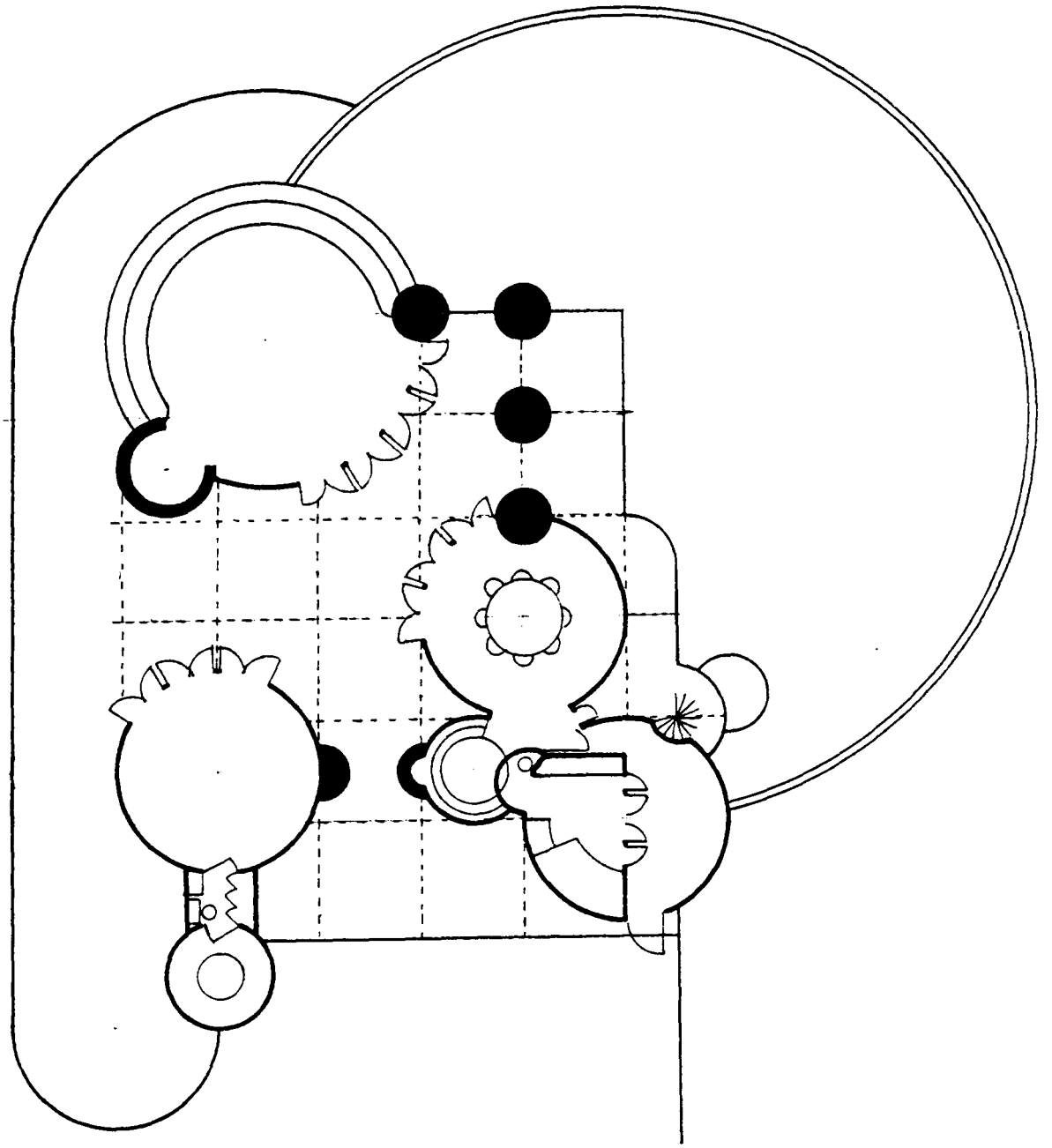


FIGURE 4.14 JESTER HOUSE FRANK LLOYD WRIGHT

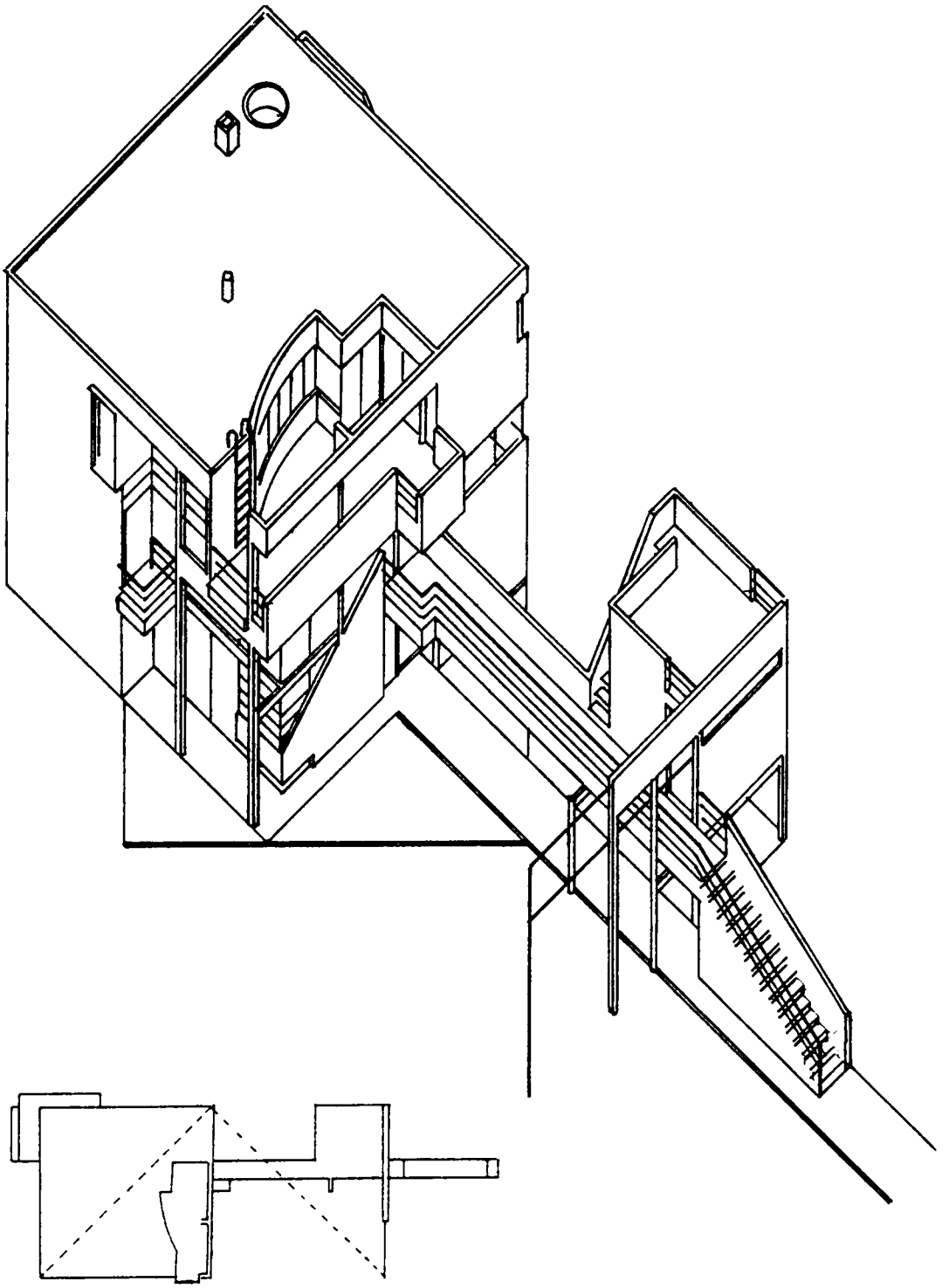
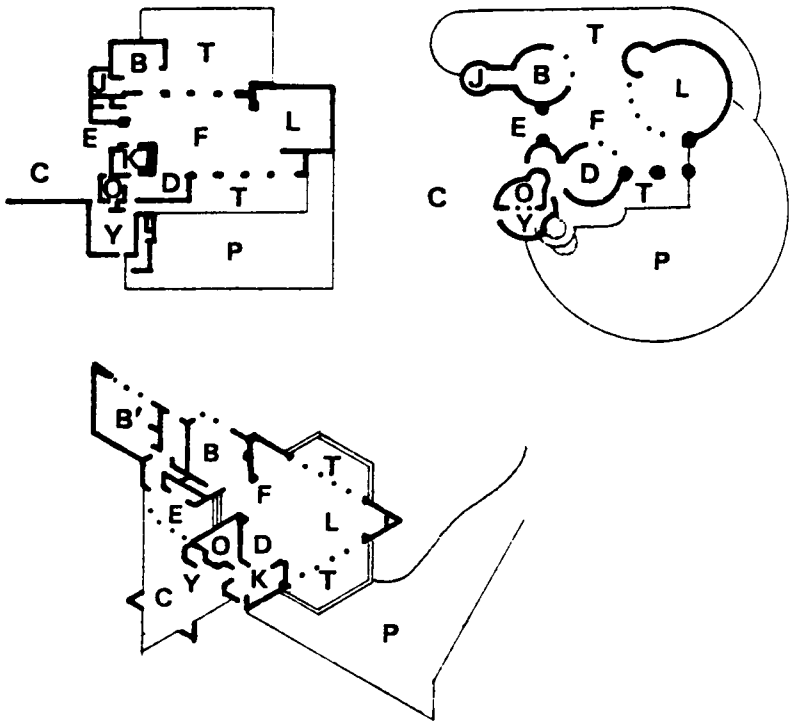


FIGURE 4.15 HANSELMANN HOUSE MICHAEL GRAVES




B-BEDROOM B'-SUNDT BEDROOM C-CAR PORT D-DINING RM
E-ENTRY F-FAMILY RM J-BATH K-KITCHEN L-LIVING O-OFFICE P-POOL
T-TERRACE Y-YARD

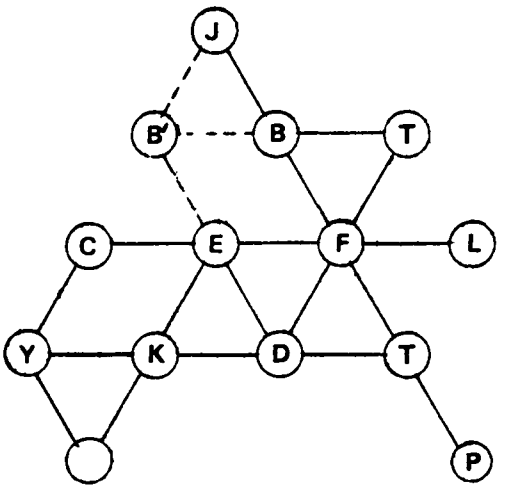



FIGURE 4.16 A COMMON TOPOLOGY IN THREE HOUSES BY WRIGHT

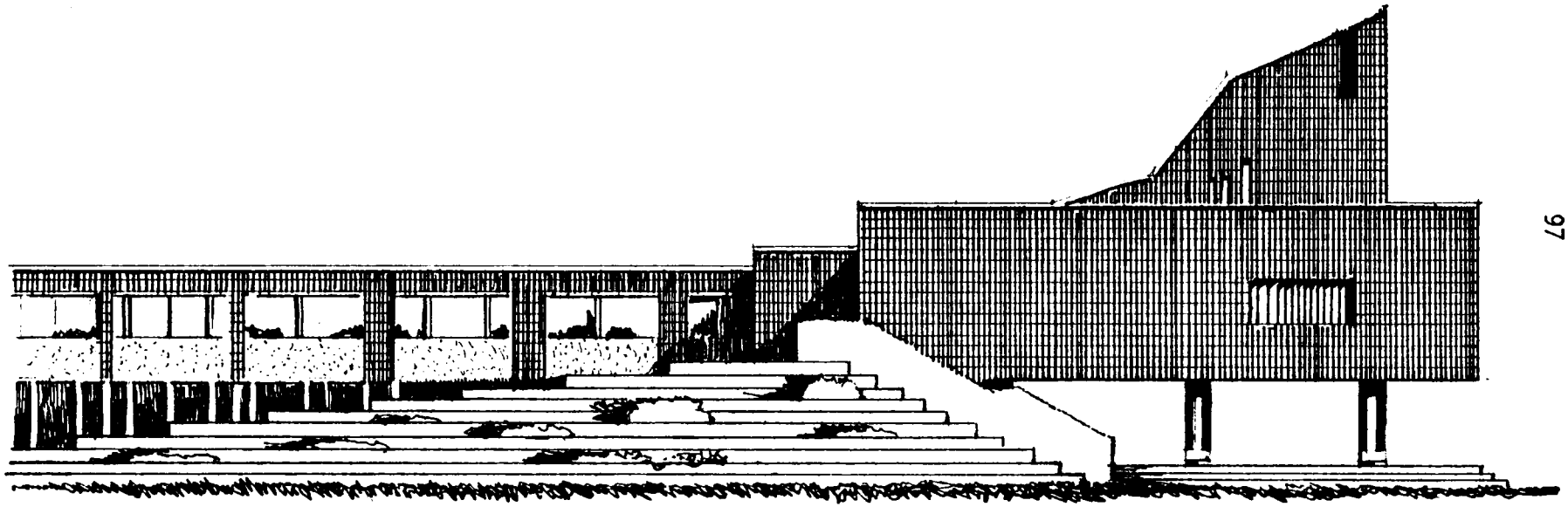


FIGURE 4.17 TOWN HALL AT SEINAJOKE ALVAR AALTO

FIGURE 4.18 MOORE HOUSE I FRANK LLOYD WRIGHT

FIGURE 4.19 STRUCTURE LEVELS IN FOUR FIELDS

| POETRY | LANGUAGE | MUSIC | ARCHITECTURE |
|---|---|---|---|
| LEVEL A: SUPER-SURFACE STRUCTURE | | | |
| POETRY | NONE | NONE | ARCHITECTURE |
| LEVEL B: SURFACE STRUCTURE | | | |
| A PROSE SENTENCE STATING THE IDEA. | A PROSE SENTENCE STATING THE IDEA. | MUSIC | BUILDING |
| LEVEL C: UNDERLYING STRINGS | | | |
| UNDERLYING STRINGS: DEEP-STRUCTURE SENTENCES STATING THE IDEA. | UNDERLYING STRINGS: DEEP-STRUCTURE SENTENCES STATING THE IDEA. | CHOICE OF METER DETERMINES UP AND DOWN-BEATS, TEMPO. FORM STYLE, INSTRUMENTATION | CHOICE OF STYLE AND BUILDING TYPE. |
| LEVEL D: CHOSEN ELEMENTS | | | |
| MORPHEMES, WORDS. | MORPHEMES, WORDS. | KEY WITH ALL RELATED FACTORS: SCALE, TONIC/ DOMINENT, RELATED TRIADS, RELATIVE MAJOR OR MINOR, ETC. | STRUCTURAL SYSTEM, MATERIALS, DOORS WINDOWS, WALLS, STUDS, ETC. |

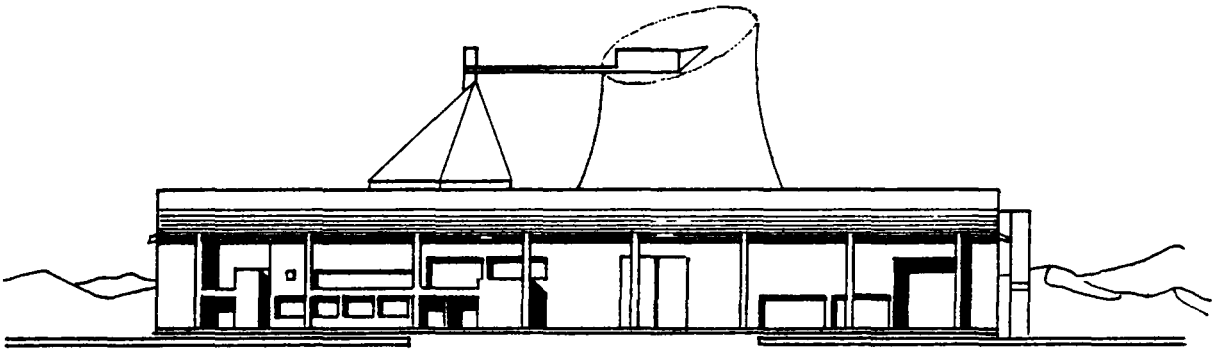


FIGURE 4.20 PALACE OF THE ASSEMBLY CORBUSIER

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# TRANSFORMATION FOR ARCHITECTS

by

Mark E. Schneider

(ABSTRACT)

Transformation has been studied in a number of fields such as geometry, music and linguistics but has never been investigated in architecture even though it occurs there with some frequency. The basic task of this essay is to prepare the way for a study of transformation in architecture through an examination of the nature of transformation as an operation type and through a brief study of some cases of transformation in architecture.

The first part of the paper examines transformation in several fields where it has a history of use, and establishes what it is and what it can be used to do in these fields. From this investigation a series of five characteristics of transformation are developed. In the second part of the paper, a strategy for the investigation of transformation in architecture is developed. In the third and final section, the strategy is applied to a study of a number of types of transformation in existing architecture, and suggestions are made for future research. Proposals are also made for some new uses of transformation in future architectural work.