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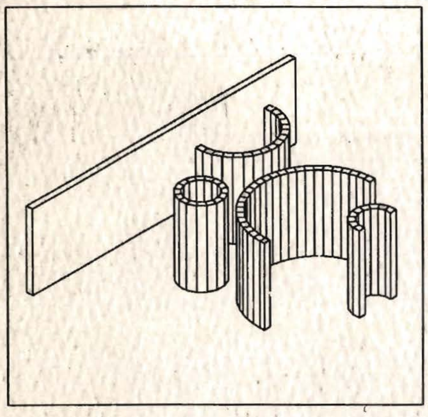
The joy of syntax : workshop



Workshop

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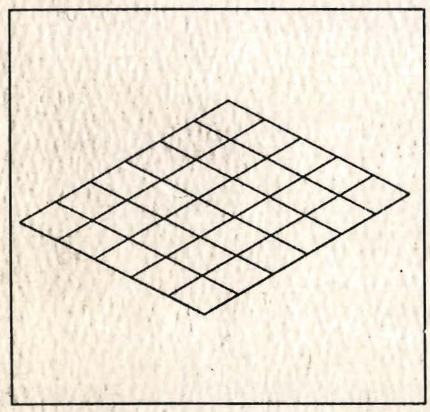

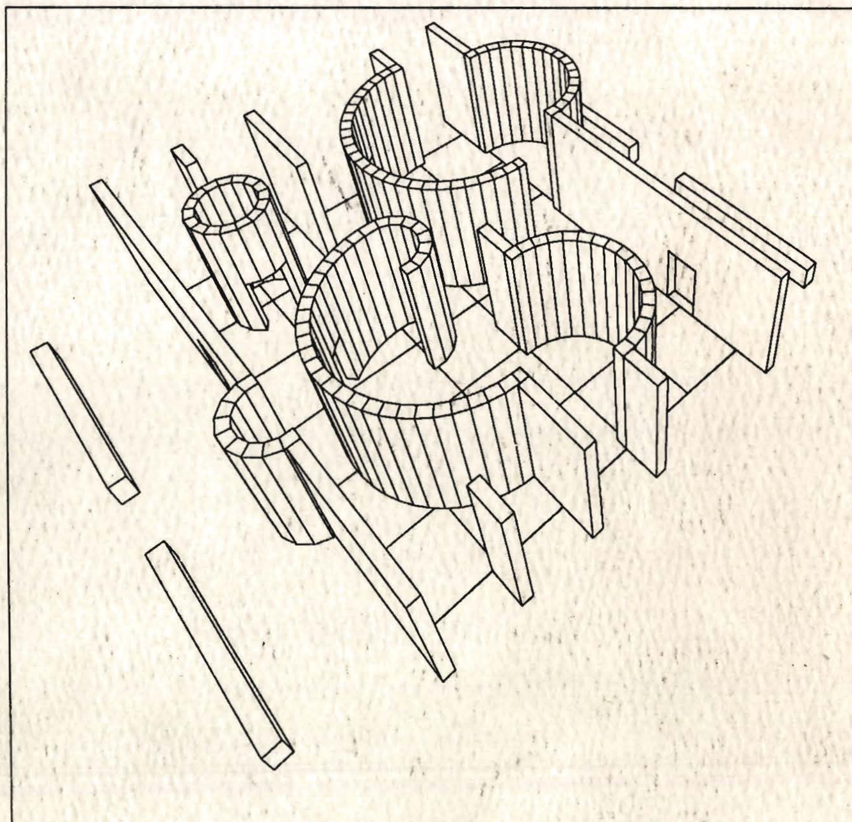

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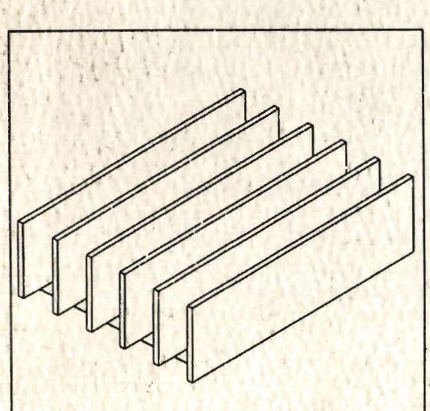

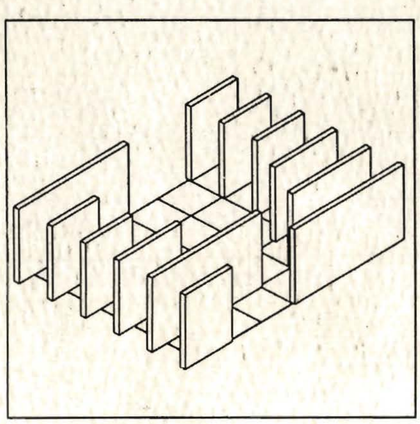

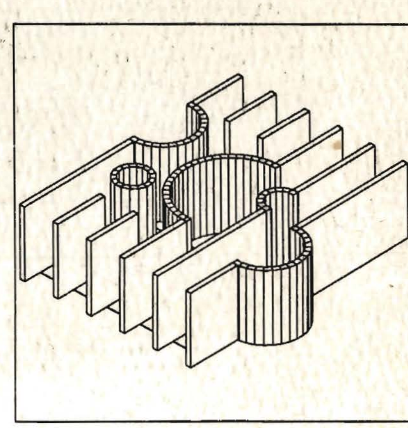

Workshop

The Joy of Syntax

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Workshop
The Joy of Syntax

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A grant of the Eindhoven University of Technology Fund (EUF) provided the faculty of Architecture and Building Science with the possibility to invite Dr. Robert Oxman and Dr. Rivka Oxman to tutor a workshop on Architectural Formal knowledge.
The workshop fits in a long tradition of regular visits from them to Eindhoven in which we benefit from their studies and experiences in the field of Architectural Design in the Technion, Haifa (Israel). We hope to continue this tradition on a year to year basis.
The workshop fits also into the process of growing awareness of the interdependency of three fields of architectural design as represented by the sections GOM (Design Methods), CALIBRE (Computer Aided Design) and VORMLEER (Morphology) of the department of Architectural Design, Urbanistics and Management. The workshop is a very welcome extension of their regular activities and is a platform for the exchange of ideas, both for students and staff.
A reader with 7 articles from our Israeli visitors was prepared to introduce the subject to the students attending the workshop. The introduction to this reader states:
"The main purpose of the workshop is to train students in analysing well known architectural objects in order to discover their constituting elements and the patterns of relations between these elements. These patterns form the focus-point of the analysis; they form the syntax of the architectural language of the building and as such the set of rules determining the structure of the architectural concept. This journey of discovering the essence of architecture is a delightful experience, hence the name of the workshop: The Joy of Syntax".
The results of analysis are applied in simple design tasks. From the very beginning these tasks are carried in a computer environment.
The faculty of Architecture and Building Science is glad to present the lectures given during the workshop and the results of the work of the students in this booklet. We would like to thank Robert and Rivka Oxman for their very stimulating tutorship. We also would like to thank the ETU-fund for their generous support of our work.

Eindhoven, 31 October 1991
Prof. dr. ir. M.F.Th. Bax/ Prof. ir. H. Wagter/ ing. R. Daru arch HfG

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* From these participants there are no results available.

A Seminar Workshop on Architectural Formal Knowledge

In November 1990 a week-long seminar workshop was held at the Eindhoven University of Technology in the Netherlands on the study of architectural knowledge in the environment of the computer. The event was jointly sponsored by three groups of the Department of Architecture: GOM (Design Methods); CALIBRE (Computer Aided Design); VORMLEER (Morphology). During the week, the morning sessions were devoted to lectures and seminar discussions. The theoretical subjects presented were: the role of knowledge in architectural designing; modeling and representing architectural knowledge; and an introduction to knowledge-based systems. These subjects were the introductory material for the afternoon sessions which were held in the computer lab.

The purpose of the work in the lab was to explore the computer as an environment in which to study design principles in architecture, and to work with grammatical approaches to architectural form as a way of representing architecture, as well as a way of doing design. This work also brought forward considerations of architectural and design theories and their relevance to dealing with design in computers.

For certain of the participants this was also an introduction to the computer, and to two and three-dimensional computer graphics programs. As it turned out this was much to squeeze into five busy days. But in the end regardless of the threshold at which the various student's entered the ambience of this work, they finished with some enlightenment regarding the meaning of architectural thinking, and the unique qualities of the computer and its intellectual demands and rewards.

This volume is a record of that one week experience. It contains three parts. The first is an introductory essay on some of the theory which underlies the approach to teaching design principles in the environment of the computer. It is entitled, The Foundations of Design: An Introduction to Formal Knowledge and Design Heuristics. This is followed by an illustrated work on the categories of Architectural and Design Knowledge. It is in draft form, and will be expanded and elaborated for the next generation of the course. These two sections were part of the introductory material which was distributed to the student participants and explained in the lectures.

The third part of this volume is the student exercises. Early during the week, we presented a list of exercises which provided possibilities for each of the students to select one of the subjects which had been introduced in the lectures. Together with the students we built miniature computational research projects which seemed to fit each student's interpretation of what we were trying to convey. Given that they were all different projects, in the compressed time framework of one week, there was relatively little time for each student to be advised on his work. We have to add that we were teaching in what was for them a foreign language (English), and for some, the theory was also foreign. So it was amazing how intellectually stimulating and exhilarating the encounter seemed to be for all of us.

The student exercises were collected, collated and very ably edited by Stan van Kol and Philip van Boxtel.

Robert Oxman   Rivka Oxman

Part 1
The foundations of design

Introduction: Architectural Formal Knowledge in the Foundation of Design

This paper describes an approach to teaching the foundation course in architectural design through the explicit study of formal knowledge and its the graphical representation. In this introduction we argue that architectural formal knowledge is the language of built form which the architect manipulates during design. Design education must address this body of knowledge and the associated heuristic procedures of architectural design as the explicit content of design teaching. We view this as a particularly relevant approach in the introductory course in design, when the student completely lacks the knowledge and experience which underlies the cognitive processes of design.

A basic assumption of this work is the focus upon formal knowledge as seminal among the complex types of knowledge which enable design. We assume that for the architectural designer there is a special importance to the deep knowledge of formal representations of designs, such as plans, and as well to the explicit understanding of design heuristics and design operations. The course develops a knowledge orientation to design teaching, rather than a problem orientation. Design knowledge is the explicit content of the teaching.

In the course the computer is employed as an environment in which to learn the formal principles of architectural design, the knowledge of which once gained, may be applied either with, or without, the computer. We attempt to exploit the unique characteristics of the computer as a medium for conveying knowledge of the formal aspects of architectural design and, particularly, knowledge of the generative processes in designing. The purpose of this course differs from other educational goals of CAD studies in that it explicitly addresses the pedagogical problems of one of the main goals of the architectural curriculum, teaching design. It also focuses on a particularly sensitive period of design education, the theoretical and methodological function of the first year. The purpose of this paper is to review the theoretical basis of this approach to architectural design teaching, and to provide the outline of the foundation course.

Architectural Formal Knowledge

The formal aspects of architecture have historically constituted an independent field of knowledge. In the Classical tradition, the major theoretical source of Western architecture, formal principles provide an important component of the theoretical foundations. The development of taxis patterns , or syntactical ordering principles, has been a significant part of the evolution of Classical theory. Among the various levels of Classical composition, the concept of taxis represents the 'orderly arrangement of parts' (Tzonis and Lefaivre, 1986). Examples are found in the application of geometric principles for the development of schemata for plan compositions in the treatises of the Renaissance theoreticians Cesariano and Serlio. Since the Renaissance, the treatment of formal content as an independent field of study has gained in importance as an integral part of architectural theory. Among various later treatises on composition, Durand's, Precis of 1819 is an example of the use of geometrical subdivision rules as a basis for spatial compositional schemata, such as the 'nine-square' schema. This famous teaching manual of formal principles in architectural design is notable for its applications of such contemporary concepts as modularity, typological classification, and refinement schemata. It is now widely accepted that Classical formal principles, including compositional theory, were of significance in the development of Modern architecture and the formulation of its theory (Collins,1965; Banham, 1960; Colquhoun 1989).

The emergence of contemporary approaches to formal studies has been one of the significant developments in architectural thinking since the Second World War. The foundation of an architectural morphology through the scientific study of architectural form is distinguished by having been astylar and independent from the Classical tradition. The history of this work since the 1960's includes two parallel streams of development of design researchers, on the one hand, and architectural theoreticians, on the other. A source of contemporary formal studies has been the Cambridge school of researchers associated with the Center for Land Use and Built Form Studies (LUBFS), subsequently, the Martin Centre, in which scientific method and mathematical tools were applied to the study of built form in order to establish a 'configurative discipline' for architecture and urbanism. Among the significant publications is the seminal, Geometry of the Environment (March and Steadman, 1971) and Architectural Morphology (Steadman, 1983). The latter is part of the important body of configurative studies which employ graph theory as a basis for formal analysis in architecture and urbanism (Hillier and Hanson, 1984).

The explication of formal knowledge has been one of the important themes of post-war architectural research. The work of Wittkower on the formal principles of Alberti and Palladio (Wittkower, 1949) and the writings of Rowe on formal analysis (Rowe,1947, Rowe and Slutzky, 1963) were seminal in the establishment of a contemporary approach to formal analysis. This work has contributed to the establishment of a vocabulary of formal categories as well as approaches to the graphical analysis of formal characteristics in architecture and urban design (Ching, 1979; Hubbard, 1983; Baker, 1984; Clark and Pause, 1985; Baker, 1989). A more rigorous approach to the analysis of configurative principles in design is the work of Stiny, Mitchell and others on Shape Grammars (Stiny and MItchell, 1978; Stiny, 1980; March and Stiny, 1984). We have differentiated between the larger body of works in formal analysis and rigorous, mathematically-based analyses by referring to the latter as syntactical analysis (Oxman and Oxman, 1989 b). With respect to the scientific foundation of formal studies, both the graph theoretical and shape grammatical researches are of importance. The significance of formal principles, in general, and shape grammars, in particular, to the generation of designs has been demonstrated by various researchers (Stiny, 1975; Gips, 1975) and there is an increasing interest in the role of formal grammars and formal languages in design education and research (March and Stiny,1985; Flemming,1989).

Since the 1960's this research effort has been accompanied by a concomitant effort on the part of design theoreticians to renew the theoretical basis of architecture. The theme of the renewal of disciplinary knowledge in theoretical work such as that of Rossi, Grassi, and Ungers has been a key phenomenon of European Rationalist thought since the mid-Sixties. This has frequently involved the elaboration and formalization of knowledge of architectural and urban form (Krier, 1979, Krier, 1988). It is formal knowledge - the knowledge of built form - which has come to be associated with the term, disciplinary knowledge. That is, not only have formal studies continued to be an important and independent field of study in contemporary architectural theory, but they also occupy the privileged status of constituting the core of disciplinary knowledge. Architectural knowledge is the knowledge and understanding of the language of built form. As compared with general principles of morphological studies (Emmerich, 1967), this is uniquely architectural and urbanistic knowledge, dealing as it does with plan form, formal languages, building types, etc. Through the research activity of the past decades this body of knowledge has become increasingly more formalized. Whether it is legitimate to refer to it as disciplinary knowledge is debatable, if discipline implies the existence of a theoretical foundation as well as a well-formulated body of knowledge.

What is to be noted in this brief historical sketch is that contemporary formal study has emerged as an independent field of research. This has occurred within an epistemology of architectural knowledge in which the elaboration of formal knowledge through the study of precedent is disassociated with specific periods and with stylistic eclecticism. The substantive body of work on the elaboration of architectural formal knowledge also demonstrates the relationship between research and design. Architectural theory as the basis for the integration of research and design is an important issue in current theoretical discourse. Rationalist theory has been explicit with respect to recognizing the integral relationship between analysis and synthesis - between the rational analytical processes characteristic of research and the generative processes of design. In this view of design as research, the analytical elaboration of formal knowledge is an essential stage of design process (Rossi, 1972; Ungers, 1982). In the following section we consider the significance of these ideas in defining the role of architectural formal knowledge in designing, and subsequently, in design education.

Formal Knowledge in Design Cognition: Knowing Designs and Making Designs

Tzonis and Lefaivre point out that though formal aspects of architecture do not provide information on how a building is used, built, or how it derives its meaning, they do help us to understand how buildings are put together from a formal point of view (Tzonis and Lefaivre, 1986). Such configurative knowledge is the dominant content of the early spatial generative stages of the architectural design process, and it is generally important throughout the remaining phases of the design process. In this section we briefly review positions of design researchers regarding the relationship between the 'knowing' and 'making' of designs, that is, between the prior formal knowledge of designs and the ability to do design.

Rowe has defined various heuristic procedures in which prior design knowledge is applied to current architectural design problems. Among these are the knowledge of building types, organizational types and elemental types (prototypes) (Rowe, 1987). He defines another class of design knowledge, formal languages, as the heuristic rules, particularly syntactic rules, of a specific formal repertoire. Types and languages are, therefor, two classes of cognitive formulations of the generic design knowledge derived from experience. Hillier and others have proposed that it is this knowledge of 'informal codes' (heuristics) and genotypes (solution typologies) which enable the prestructuring of the problem that actually makes design possible (Hillier, Musgrove, O'Sullivan 1972; Hillier and Hanson,1984). Schon emphasizes the cognitive role of such knowledge and employs the term, 'design worlds' to define the interlocking processes of perception, cognition and notation in design (Schon, 1988).

There is particular significance to the notation, or graphic representation, of this formal knowledge. Habraken has noted that what architects make is the representations from which buildings can be built (Habraken, 1985). Designs are intermediate objects, or symbolic representations of the artifacts to be produced from them. While formal knowledge may be represented in various media, it is generally the graphic representation which is actually manipulated in designing. The representational notation of formal knowledge is, in itself, a form of knowledge in design. Various researchers have demonstrated the relevance of graphic representations in the cognition of design (Hewitt,1985; Herbert, 1988). MItchell and others have emphasized the significance of the knowledge of formal representations in design. (Mitchell,1985). Among other forms of knowledge, designing requires the knowledge to describe (including representational formalism and annotational technique) and the ability to manipulate the formal representations of designs. Design may be considered the manipulation of these symbolic representations through various types of refinement, adaptation or transformation. This approach is consistent with Flemming's interpretation of design as a form of computation, that is, a sequence of operations being performed on a symbolic representation of the objects being designed (Flemming, 1989). While there as yet exists no well-formulated and comprehensive body of knowledge of formal representations, there now exists a foundation for such a theory (Mitchell, 1990).

Such approaches support the assumption of an integral relationship between the knowledge of designs and the knowledge of designing. "Knowing design" is dependent upon a particular kind of knowledge about designs. As a class, this is knowledge of precedents. But an assumption common to many of the design researchers mentioned is that prior knowledge in design is less a repertoire of explicit 'cases' , than a body of generalized, typified and abstracted knowledge of designs. There is evidence from cognitive science that prior experience becomes the knowledge of precedents through processes of generalization of the specific, episodic cases (Schank 1982; Kalodner,et alia,1985). This supports some of the assumptions of design researchers that the knowledge of formal representations as gained through experience is generic knowledge of the classes or types of representations, for example, of formal aggregations in plan. This generalized state of prior knowledge includes such formulations as the typologies, languages and design worlds proposed by design researchers. Thus the prior knowledge in design which is gained through study and experience is seen as being cognitively formulated as generic knowledge (Oxman,1990). Architectural formal knowledge is the formulation of generic principles in architecture and urban form at a level which captures the salient formal principles. We conclude from this that the knowledge of precedent is the knowledge of generic classes of formal representations, as well as the knowledge of canonic exemples. The generic knowledge of built form has been proposed as that knowledge which underlies the design process and makes it possible (Hillier, Musgrove, O'Sullivan,1972).

Design Knowledge and Design Learning

Any theory of design education must be founded on a theory of design. We have attempted to demonstrate how various researchers view design as made possible by the knowledge of formal principles and their representation, as well as through the operations upon these representations which actually make designs. We have proposed a working definition of architectural knowledge as the knowledge of representations of architectural and urban formal artifacts and of design knowledge as that knowledge which integrates classes of object descriptions with operative procedures in designing (Oxman and Oxman, 1989a). Architectural designing, particularly spatial compositional phases of design, is highly configurative in nature. The designer learns to represent and manipulate the symbolic, usually graphic, representations of designs. It is the classes of the formal representations of designs which we have referred to as, architectural knowledge (Oxman and Oxman, 1989 a). Often in architecture, certain classes of representations, such as plan forms, have inherent procedures for manipulating and refining the representations. For example, there are certain kinds of formal manipulations, procedures for achieving variants, and refinement processes in centralized plan types. If building a repertoire of formal representations may be conceived of as one type of knowledge in design, than the ways in which we manipulate the symbolic representations of architectural designs is another, and related, class of knowledge. We have referred to the integration of knowledge of formal representations with knowledge of design heuristics as, design knowledge, in architecture. Design is goal and value motivated and there are many additional types of knowledge which are applied in interpreting and understanding the semantic dimension of form. However, we propose that an understanding of form underlies the generative aspects of designing.

Learning design may be seen as acquiring knowledge of the classes of design objects, the techniques of their representation, and the strategies of structuring and operating upon these representations (heuristics) in order to achieve a design in a specific problem context. In this interpretation of design learning, a general knowledge of design precedents is necessary to design. From recent teaching experience, it has been demonstrated that this knowledge can be conveyed effectively (Kramel, 1987; Mitchell, Liggett, Tan, 1988; Akin,1989; Cigole and Coleman,1989), and when taught explicitly appears to contribute to sophisticated design behavior on the part of students. This is particularly the case when the teaching content includes formal languages. The student learns to "generate form" relative to this language, by mastering the descriptive representational conventions and formal manipulations inherent in the formal language. However, the real purpose of such studies is much broader. As opposed to the limited goal of teaching a range of languages, it is possible to build up a general body of design knowledge. We view the teaching of architectural knowledge- defined here as classes of representations such as types and languages - as an essential source of knowledge in design generation. Until integrated with other kinds of knowledge such as interpretive and evaluative knowledge, each of which has an important role in design, formal knowledge must be considered simply one of the important components. But without it, both design and learning design are impossible.

The Idea of a Foundation: An Introduction to the Culture of Built Environment as a Foundation of Design

To learn to design is generally acknowledged to be a complex and long-term process. In architectural designing it involves learning a broad range of material including both theoretical and applied subjects. The design studio in which the content is specifically the architectural design process is traditionally the venue in which all of this knowledge is synthesized. Given that the process, by definition, requires the integration of so much knowledge, how do you begin to learn to design ?

This is the question which we would like to address. What are the theoretical, conceptual and methodological foundations of designing ? Is it possible to address the problem of explicitly building a foundation of design for the novice designer. Can we provide an introduction to what architectural designers do and how they think when they are in the process of designing? Can we instill the foundations of knowledge which make architectural design possible? Is it possible to explicitly communicate the foundations of design thinking ? Normally the approach to this problem is to simplify the design task, without qualifying the holistic nature of the design process. We propose an alternative approach to the learning-by-doing orientation of the introductory studio. To summarize the main concept: in contrast to the usual problem orientation of the design studio we suggest an explicit introduction to design thinking through a structured sequenced of exercises. By the term design thinking we refer to the cognitive content and processes of architectural designing, that is, the nature of the knowledge employed in designing, as well as the way in which knowledge is processed in design. This introduction may be seen as an approach to the foundations of design thinking in architecture.

In distinction to the assumption of earlier design theoreticians (Archer, 1969) that it is possible to ignore the specific content of domain knowledge in establishing a body of general principles of design, we build upon the findings of a later generation of theoreticians (Hillier and Hanson, 1984; Akin, 1986; Rowe, 1987) and strongly emphasize the significance of domain knowledge as part of the foundation of architectural designing. In the context of building design, domain knowledge is here interpreted as the knowledge of built form. Various researchers and theoreticians consider built form representations as the disciplinary knowledge of architecture- the language of architecture, if you will (Ungers, 1982; Mitchell, 1990).

Certain classes of representations may be paradigmatic, and from them spring a rich source of derivation. The most notable example is the nine-square representation, long an archetype of spatial organization in architectural design. Such archetypal classes of formal representations are particularly important in design. They have also been relevant in design education, in which they lend themselves to teaching the process of design derivations and refinements from precedents. We propose to make the study of classes of formal representations the explicit content of this introduction.

The Computer as an Environment for Learning Formal Knowledge

According to the theory of knowledge in design which we have outlined, built form is the knowledge of the symbolic representations of classes of designs; that is, a generalized, or generic level, of formal knowledge. We have defined design knowledge as the knowledge of how to represent design objects syntactically and how to operate upon them in design. This includes design moves and heuristic strategies, that is, the typified classes of operations on form which produce designs. We have postulated that this knowledge is structured and that this structure has cognitive significance in design (Oxman, 1990). Formal knowledge has been advanced here as the the cognitive essence of architectural designing. We propose that it should become the explicit content of design teaching. Researchers such as Flemming have employed grammar and language descriptive techniques in order to develop general languages of design which can be employed in teaching design (Flemming, 1989) and others are beginning to classify the complex heuristics operations which designers employ. Despite the current lack of scientific formalization of syntactical knowledge in design, the approach has given indication of promise with respect to design education. In this section, we analyze the characteristics of the computer and current computer graphics programs as an environment for teaching architectural and design knowledge.

Architectural knowledge is an implicit form of knowledge in design. The ways in which we represent form in order to deal with it during designing are not necessarily apparent in the final design, or in the building. It is in design computation that these representations and operations become explicit and the processes of composition become transparent. Knowledge derives from the understanding of, and interaction with, the electronic processing of form rather than in the formal results. Learning how to model form in order to achieve a particular design result, learning about classes of formal models and kinds of computational operations which produce classes of formal entities, or how to achieve variants within a formal language are all aspects of formal knowledge which can be gained through computer graphics programming and in working with existing graphics application programs (Mitchell, Liggett, Kvan,1987; Schmitt,1989).

Since the computing of design makes explicit the structuring and ordering logic inherent in formal models and makes transparent the operations upon objects which result in designs, the computer provides a unique pedagogical environment for teaching the principles of designing. A formal model, such as a design language, is a set of objects and an underlying structure of relationships. Working in the computer on the classes of structures inherent in composition and design generation is an effective means of learning the principles of design by observing and controlling formal operations in electronic formal processing. This teaches about the formal ordering principles implicit in compositions and the implications of the inherent logic of formal representations for the potential of creating designs within that logic. For example, this knowledge may be elucidated in the modeling and analysis of design precedents in which the student decomposes the example, formulates a possible vocabulary of elements and rule set, and may even extend the language of the precedent.

The structuring of formal representations and the sequencing of operations are the pedagogical content of design teaching in design computation. The computer environment necessitates an awareness of the syntactic principles of architectural form in order to model form. The student develops notational conventions for representing classes of form and gains experience in ordering processes of transformation according to the rule system of the class. The logic of the selection of formal elements for modeling architectural configurations as well as of the graphic processing operations are immediately observed. From an educational point of view, learning to understand the implications of formal modeling upon the ability to process form is more significant than the graphic, or design, product. Therefor, such courses, though they explicitly face issues of design, are best seen as theoretical courses and supplementary to the design studio.

We have proposed that learning the representations of formal knowledge is one of the foundations of design. This may be dependent upon the existence of a well-defined body of formal knowledge. But even in the current situation in which a comprehensive theory and a well-formalized body of knowledge is lacking, the computer and computer graphics applications function well as an environment for the acquisition of design knowledge through both the analysis of architectural precedents and the creation of new designs.

In our previous work (Oxman, Radford, Oxman, 1987), the computer functioned as a teaching medium and a self-learning environment as well as the tool which produces designs. In the Language of Plans the computer was a vehicle for teaching about the characteristics of plans and the nature of the planning process. This study program has now been employed several times at the Universities of Sydney, Adelaide, the Technion and elsewhere, and has proved an effective educational medium for conveying knowledge of design in a rich and articulate manner. The work has been documented in a teaching text and the experience analyzed in various papers (Oxman, Radford, Oxman, 1988, 1990). The Language of Plans was followed by a second generation of courses, The Joy of Syntax and Architectural Formal Modeling.

The present course is an attempt to reconsider the potential of self-learning through computers in design studies and to identify certain directions for development of a foundations program. The exercises should be based upon the operational logic of computer graphics programs and an understanding of the design structure inherent in the software. Conveying the inherent logic of the programs, and its implications for the structuring and processing of formal elements in design, is part of the learning experience. The various computer graphics application programs may also project their own inherent logic upon the modeling process, and it is significant to compare various programs.

A planned sequence of exercises is designed to enable the student to gain design knowledge by "doing design" through the analytical and generative operations which make designs. He gains insight into the construction of complex formal objects, such as plans and elevations, as well as the operations underlying their construction. Learning the methods of formal representation, the sequences of characteristic operations which generate compositions, understanding the formal processing capability of the computer provides a knowledge-rich learning environment for the study of architecture. Representing designs as formal languages within the computer becomes a means of accessing design knowledge. Composition, long unfashionable for its formalist connotations, has in contemporary design and design theory become a meaningful subject of inquiry. The concept of an architectural syntax as the rigorous approach to composition, including a well-formulated vocabulary of elements and operations, seems to us one of the essential form of disciplinary knowledge in architecture. Among other subjects, the course emphasizes the learning of the compositional aspects of designs through the interaction with computer graphics programs.

The content includes a range of subjects which provide a foundation of knowledge to support the making of architectural form. The exercises are conceived of in terms of providing knowledge of kinds of generative potential through an understanding of structuring and ordering devices and the structures of architectural knowledge. The students explore the implications of these systems of order for the generation of designs. They manipulate these representations and learn about the types and sequences of operations which make, modify and refine designs. The content of explicit formal knowledge includes categories of formal analysis; the relationship between analysis and synthesis in design and methods of decomposing form into elements which can be later incorporated in the generation of designs; the understanding of ordering and structuring principles, operations and transformational rules. The underlying rules of grammars and languages, and the formal implications of classes of rule sets are an important part of the content. These exercises include basic architectural morphological principles as well as specific stylistic languages. Learning to represent form as languages and to annotate it, or encode it graphically, in order to achieve a desired design result is among the objectives of the course.

Introduction to the Course

An objective of the program is to exploit the teaching potential of a new generation of Macintosh graphics software. Though not yet dedicated software for architectural formal processing, it provides a sophisticated range of operations upon form, much expanded from the first generation of Paint/Draw programs. We will experiment with the application of Superpaint and Canvas to the teaching of formal knowledge. Superpaint can be used as an introductory program providing both Paint and Draw operations with two layers. Certain facilities such as rotating, nudging, reversal of figure-ground are useful in illustrating configurative properties of designs. We also use Canvas 2. which provides a range of formal processing capabilities as well as an unlimited number of layers. These programs limit us to two-dimensional analysis and design. We will also experiment with the teaching possibilities of Architrion as an environment for dealing with the three-dimensional representations of designs.

The course is organized in three sections. The first of these provides a general introduction to certain fundamental concepts, terms and tools in architectural design. It introduces some bases for conceptualizing architectural design as well as the accepted graphic representations for making and symbolically representing designs. The second section introduces certain major classes of representations of architectural knowledge. These are the structures of generalized knowledge such as the knowledge of building types which the architect learns and upon which basis designing is possible. The third section treats of the classes of design heuristics, the procedural aspects of designing. In this section we consider the ways in which architectural knowledge is manipulated in design. Each of these sections has a brief verbal introduction and graphic examples which illustrate the concepts.

Conclusions

The further development of the course is dependent upon the formalization of the body of architectural knowledge. Even lacking this material in a rigorous and comprehensive form, the study of a sophisticated range of formal questions through the interaction with a new generation of graphics software will be a stimulating and intellectually rewarding experience for the student. Formal studies show promise of revolutionizing design teaching, and the computer is beginning to prove an effective pedagogical environment for this new generation of design studies. Future generations of students who have been trained in design thinking and in design generation in the computer will naturally continue to exploit the compositional and design generative capability of the computer in their professional activities.

Perhaps the most suggestive and promising potential of this experimental program is the validity and power of thinking and designing with formal structures. This body of knowledge is part of the theoretical foundation of design teaching. The integral relationship of analysis and generation, so central a theme of current design, is fundamental in formal study. There is a capability to understand and control formal generation which comes of acquiring this knowledge. It is in this way that the secrets of architectural design can be elucidated for the novice student designer, and that he acquires the foundations of design.

Acknowledgements

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An Introduction to Architectural Knowledge

This section provides an introduction to fundamental concepts of architectural knowledge, as well as related terms and tools in architectural designing. We introduce certain bases for conceptualizing architectural design as well as provide a theoretical introduction to the traditional graphic representations for making and symbolically representing designs. The mechanisms of order are also a part of what we consider general architectural knowledge. These concepts are part of a general architectural morphology. This may be compared to the specific structures of architectural knowledge of the second section. These are classes of typological representations which are highly domain specific.

1. An Introduction to Basic Concepts

2. The Architectural Representations

3. Organization and Composition

4. Geometrical Order

1. An Introduction to Basic Concepts

scale and measures
- ergonometrics
- standards, norms

activities and space: space and activities
- elements generating spatial volumes
  - classes of activities
  - elements and equipment
- spatial volumes as constraints
  - packing
  - geometric constraints in volumes
  - physical constraints in volumes: boundaries, height, services.

functional space

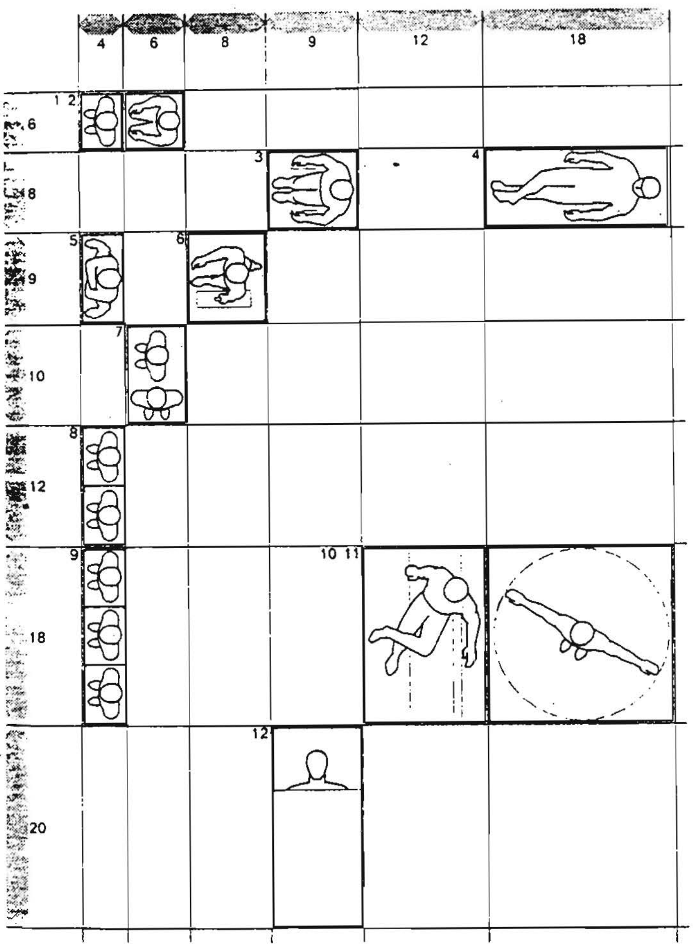
the in-between: non-functional space
- concepts of spatial form
  - transition
  - sequence
  - emphasis

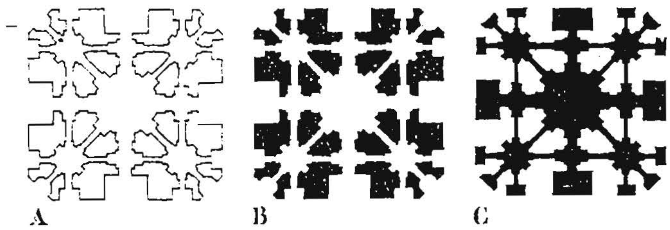
ordering the material
- system and structure
- space and building form
- tectonic expression
  - vocabularies of tectonic elements
  - tectonic languages and expression
- material elements and the syntax of space
  - the syntax of material elements: structure-partition-sheltering wall
  - classes of Modernist space
  - syntactical elements: De Stijl
  - Corbusian space

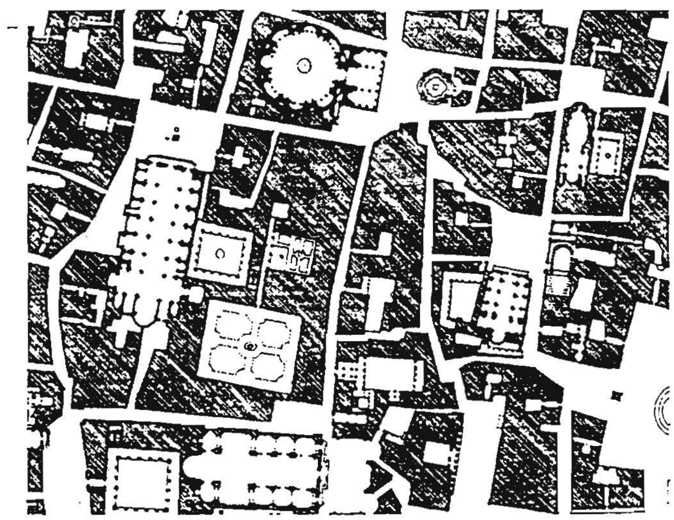
Architectural Knowledge

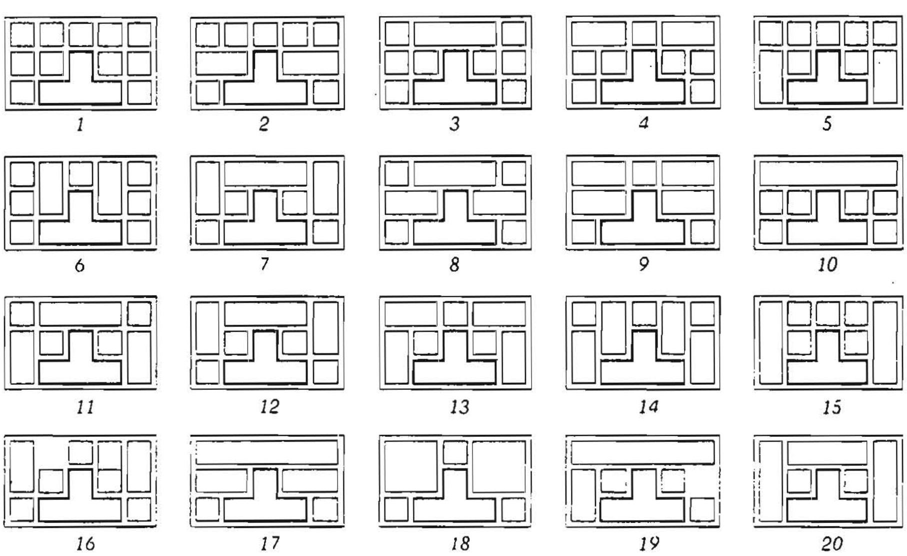
1. An Introduction to Basic Concepts

'Functional modular sizes'. From Bussat, *Die Modul-Ordnung im Hochbau*

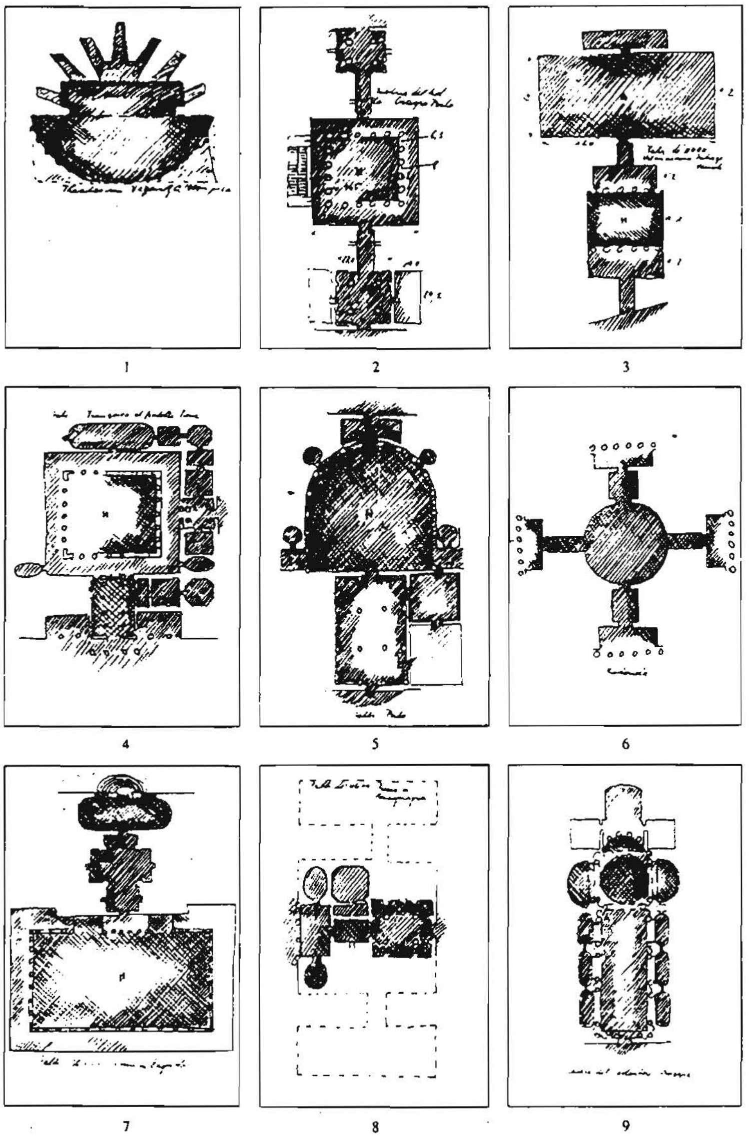


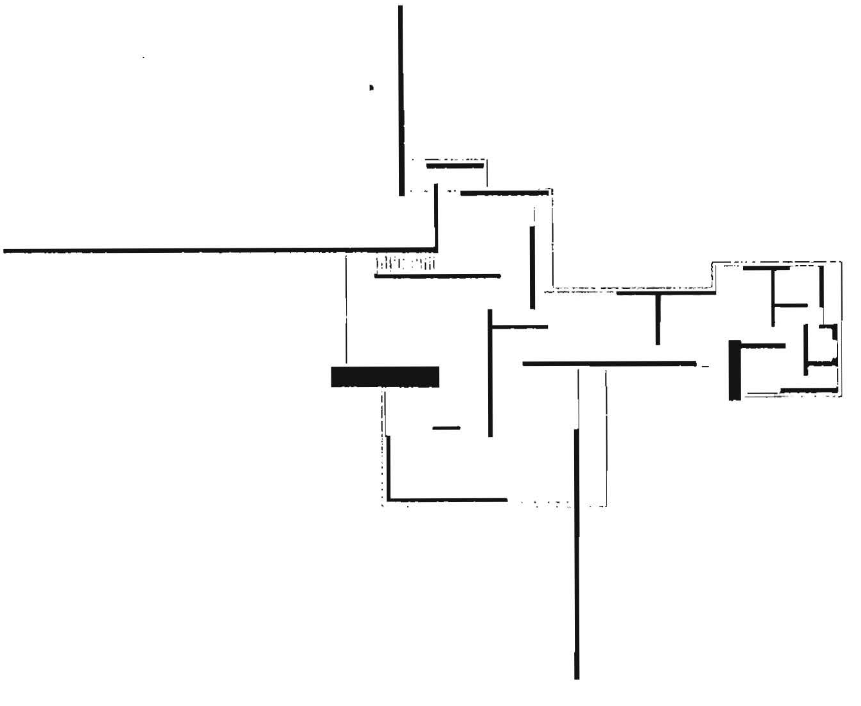






Diagrammatic interpretation of Palladio's ground-plans explaining spatial relationships





9. Brick country house (project), by Ludwig Mies van der Rohe, 1923

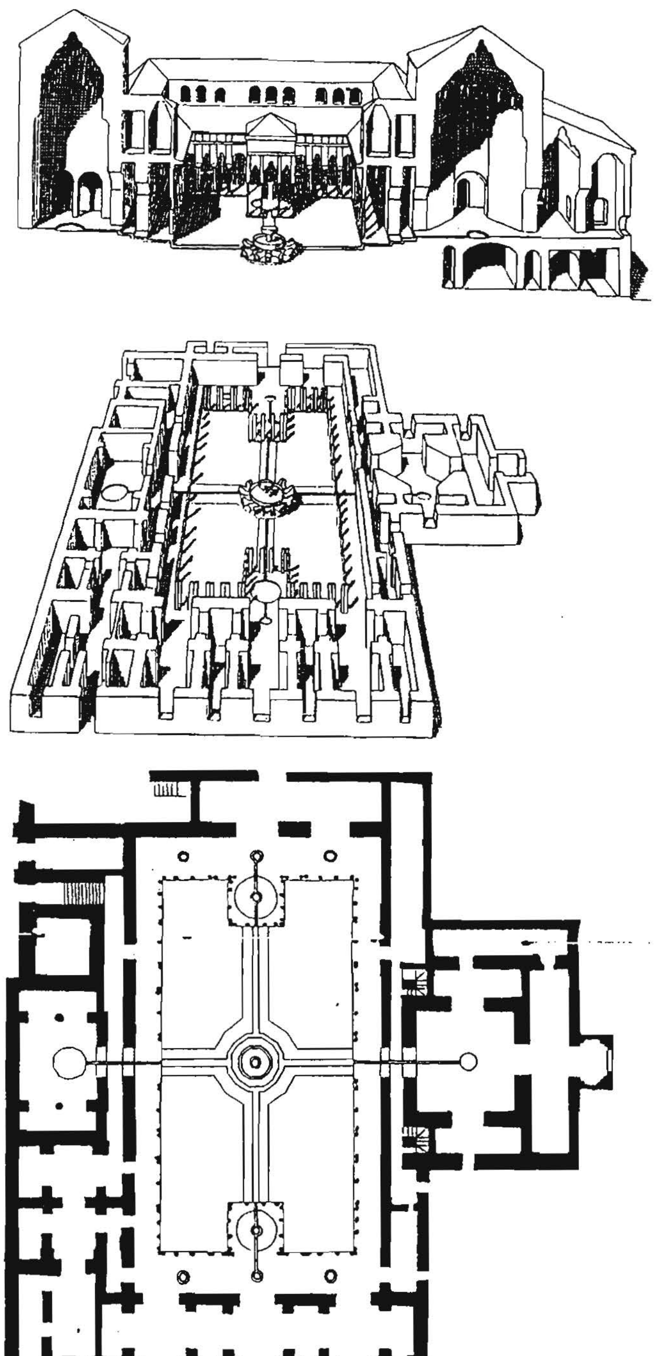
2. The Architectural Representations

architectural representations

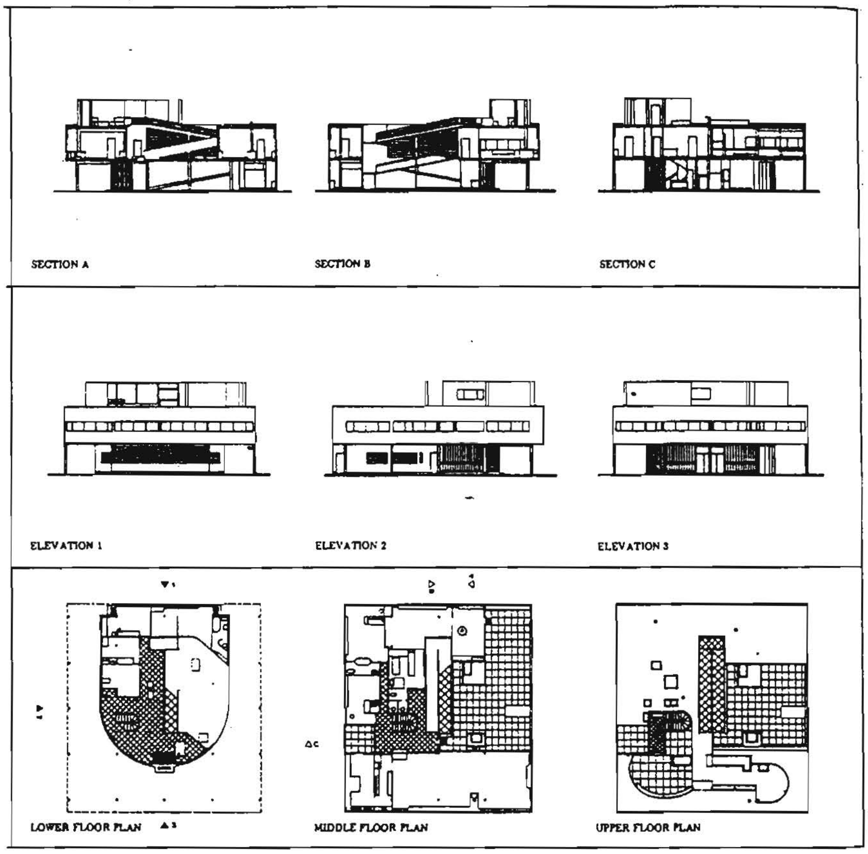
- the historical development of the concept of symbolic representations of designs
- architectural drawing
    - technical drawing
    - the sketch
- syntax of architectural representations
    - the meaning of syntax in the representations
- plans
    - the content of plans
    - plan form
    - plan types
    - spatial qualities in plans
- planning
    - classes and styles of planning
    - historic versus modern planning
    - Classical planning
- section
    - the spatial qualities of the section
    - elements and classes
- elevation
    - formal qualities
    - elements and classes
- projections
    - representing three dimensions through the projections
    - representing mass and joint

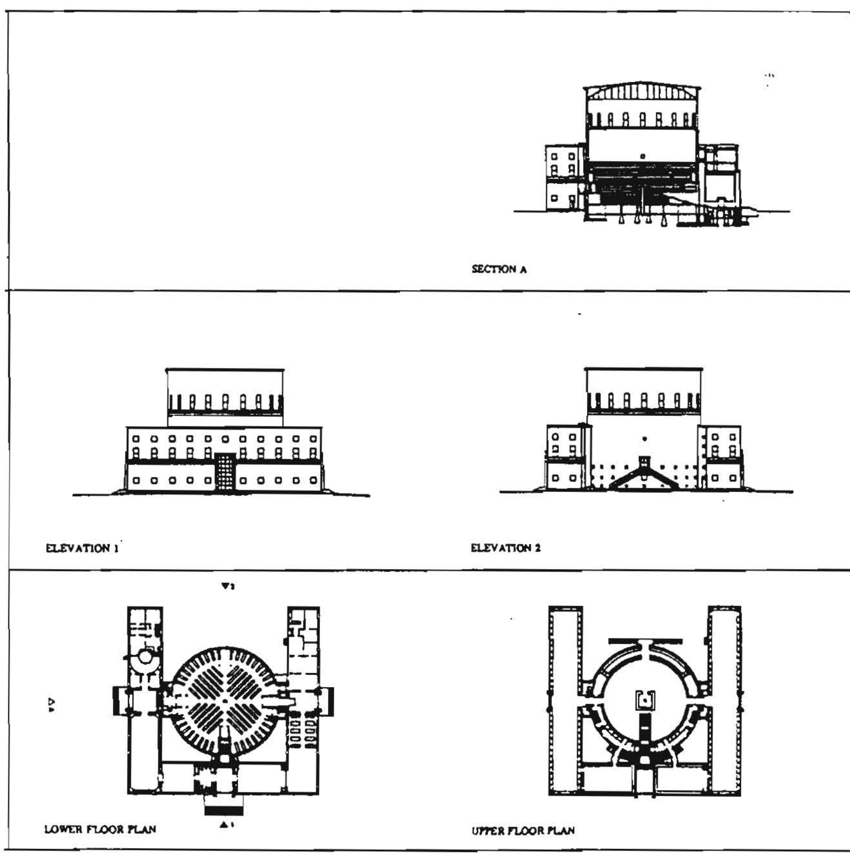
Architectural Knowledge

2. The Architectural Representations



2 La Alhambra, Palacio de los Leones


SECTION A
SECTION B
SECTION C
ELEVATION 1
ELEVATION 2
ELEVATION 3
LOWER FLOOR PLAN
MIDDLE FLOOR PLAN
UPPER FLOOR PLAN


SECTION A
ELEVATION 1
ELEVATION 2
LOWER FLOOR PLAN
UPPER FLOOR PLAN

3. Organization and Composition

the concepts of organization and composition

principles of spatial order in architecture

- morphological principles
  - symmetry
- order through geometric media: axes, grids
  - Classical architecture
- order through zoning
- order through pattern

organization

- spatial organization
- functional organization
- the network of movement
  - representing network structures
  - figure and ground representation
- organizational strategies
  - zoning, bi-nuclearity, polarity
- organizational classes

design concepts related to organizational properties

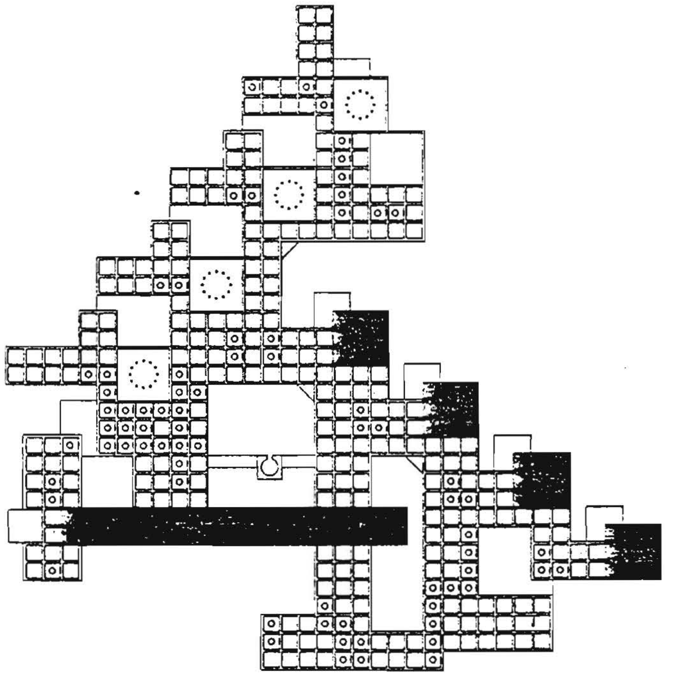
- environmental structure
  - the environmental scale
  - above-on-below the ground
  - public-private

patterns

schematic modeling of relational properties

- connectivity: representing connectivity - Venn
- constraints: introducing constraints -relative size and proportion - Packing & Grating
- relationships:representing physical relationships - Graphs, Matrices
  - functional relational diagrams - sets, access, service

Architectural Knowledge
3. Organization and Composition



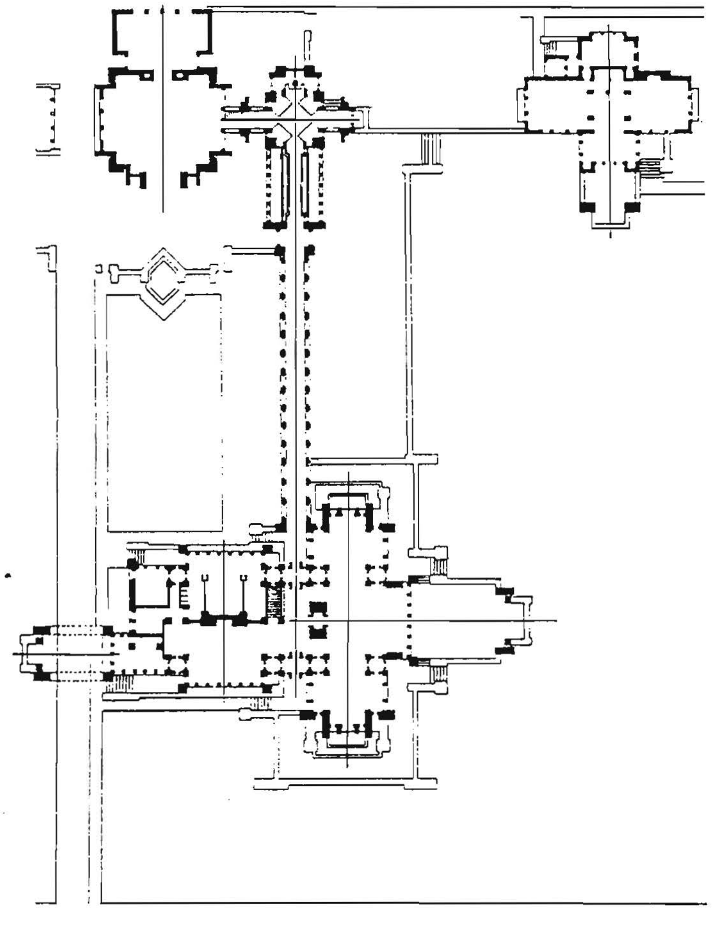
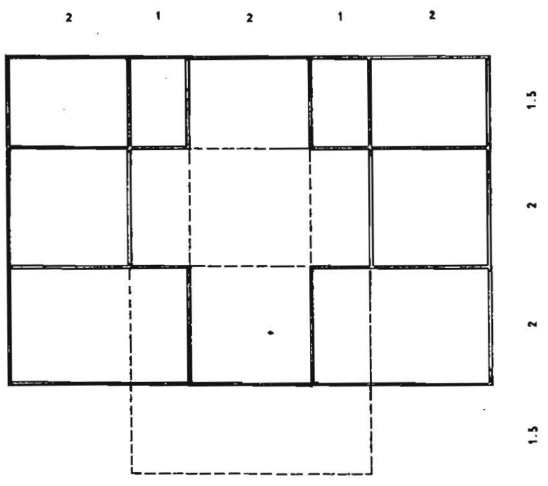


Figure 2.7
The sparkling *poché* of the Darwin D. Martin House, Buffalo, New York, 1904, demonstrates Frank Lloyd Wright's mastery over the Beaux Arts tradition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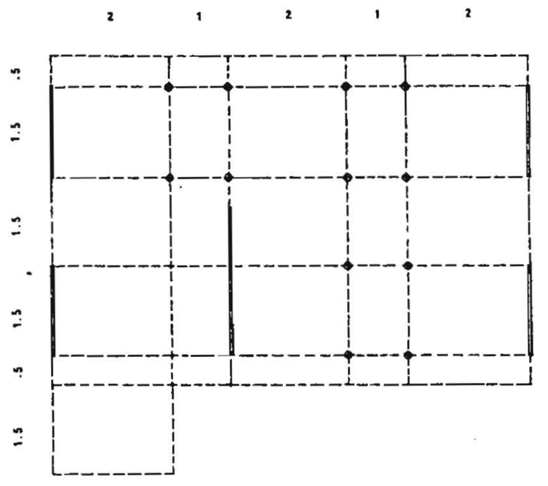
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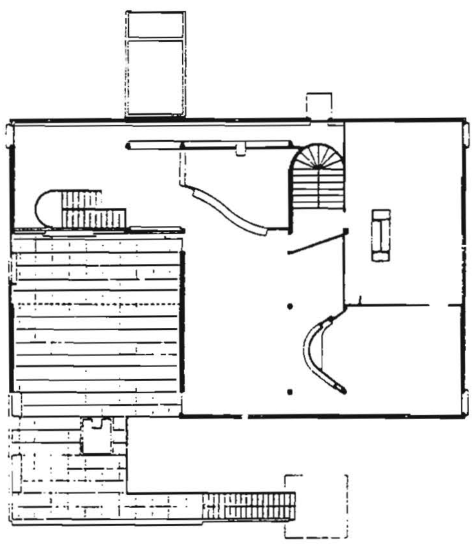
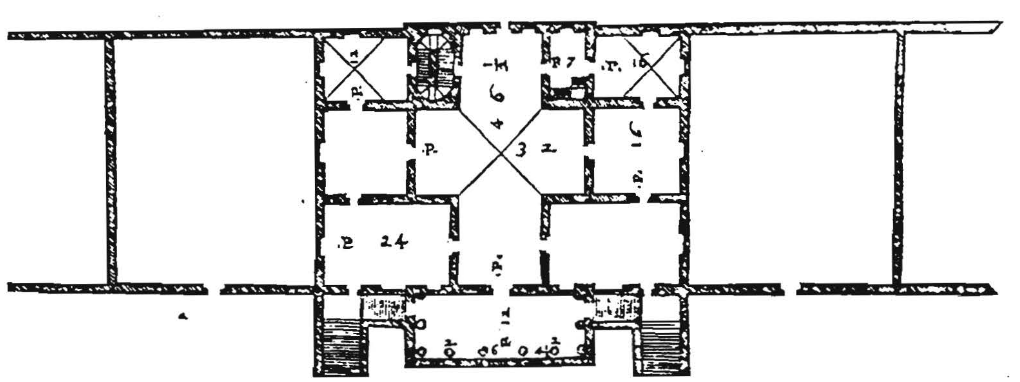
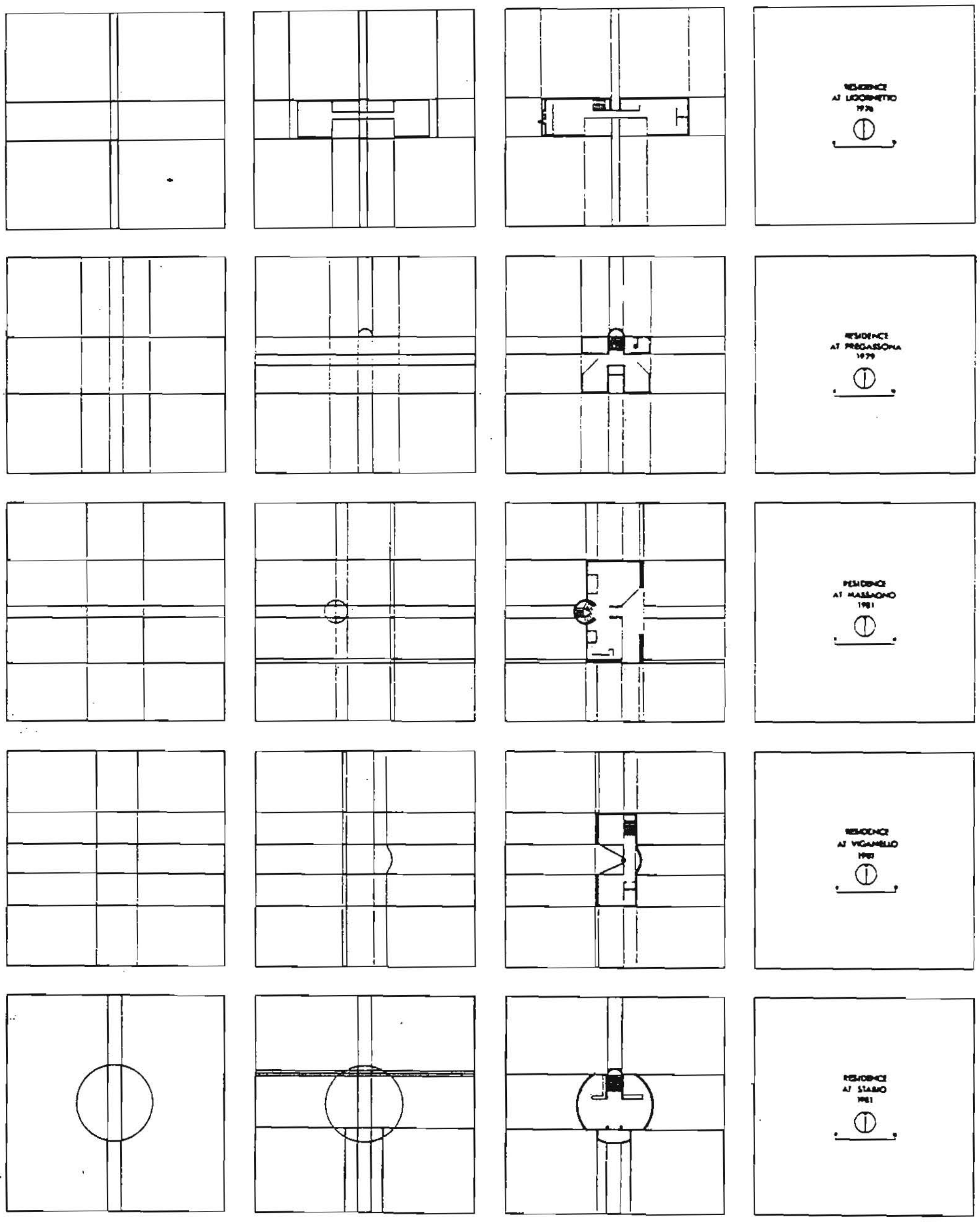
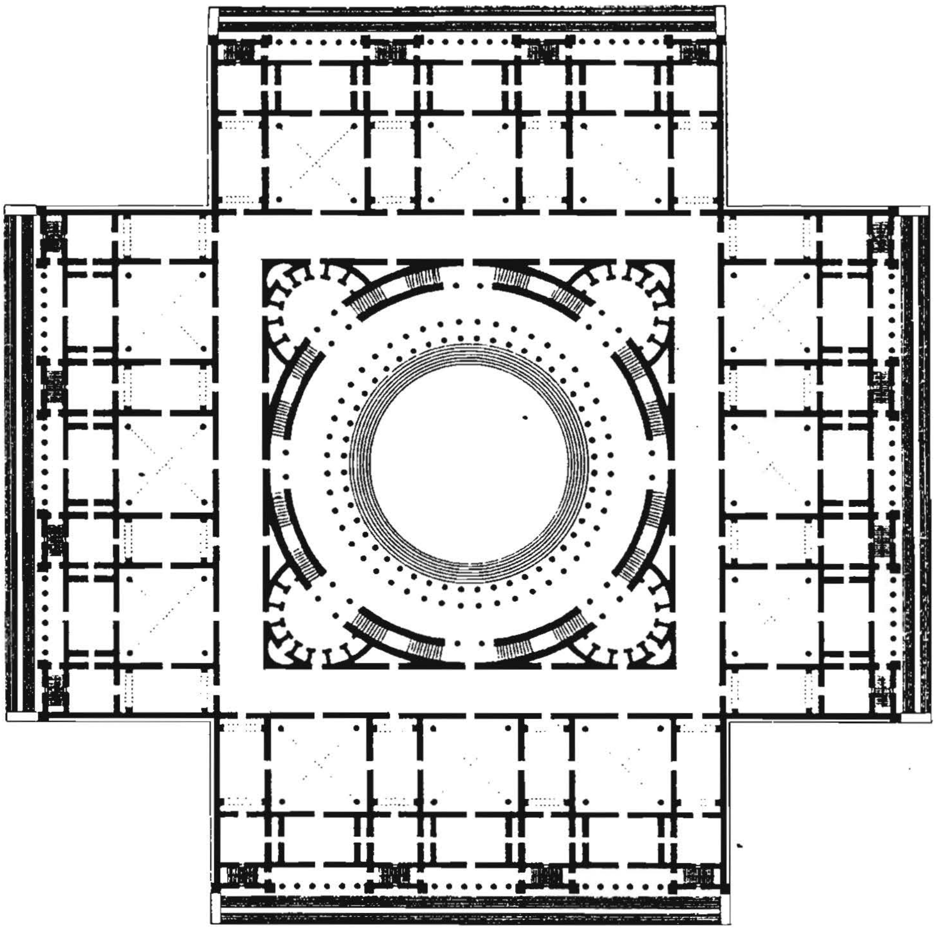
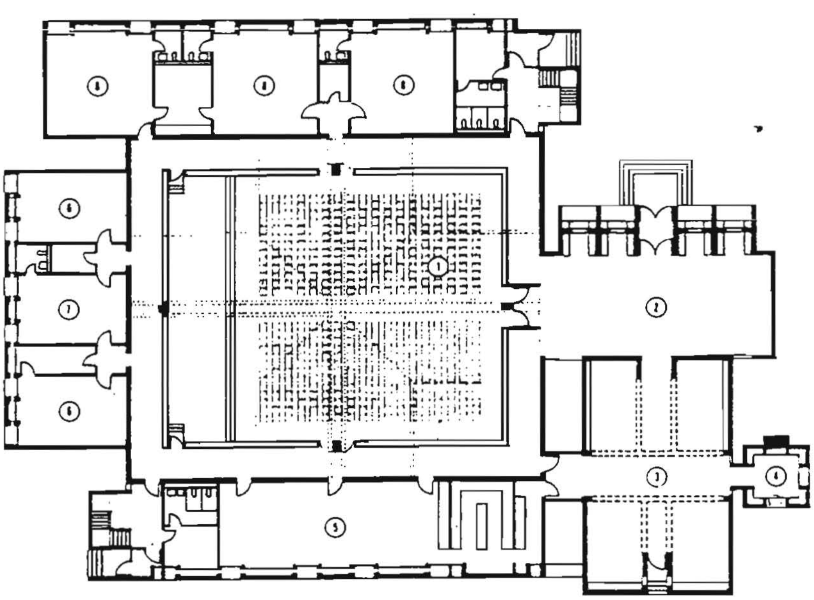
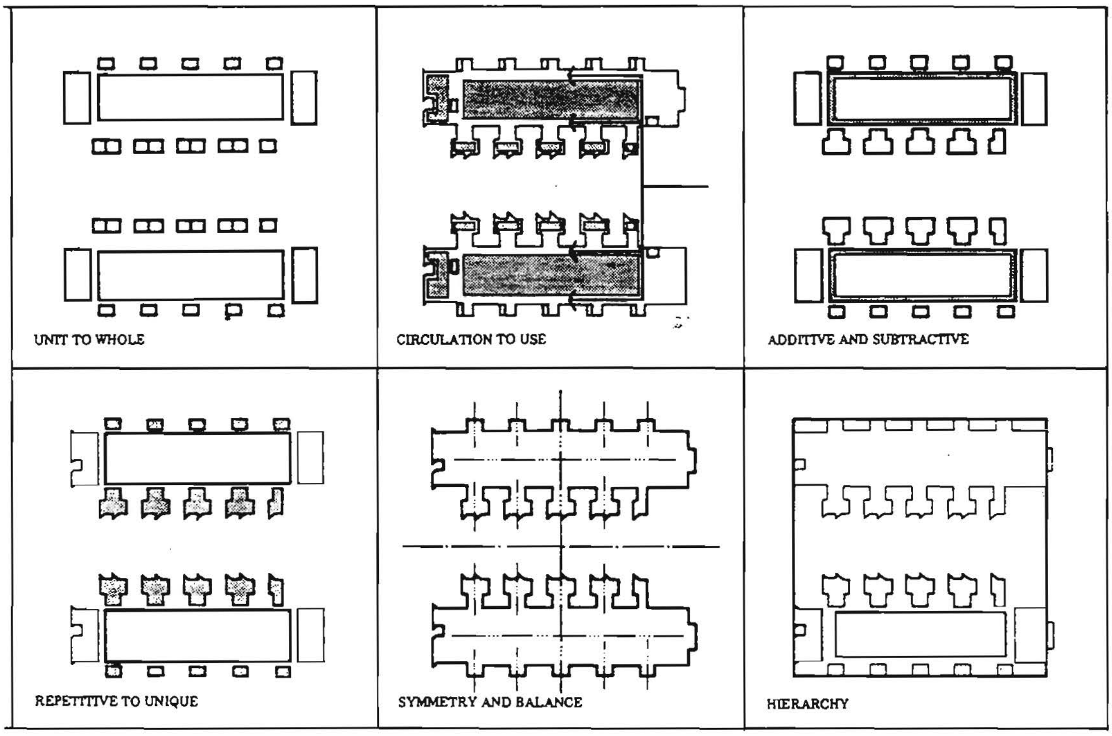


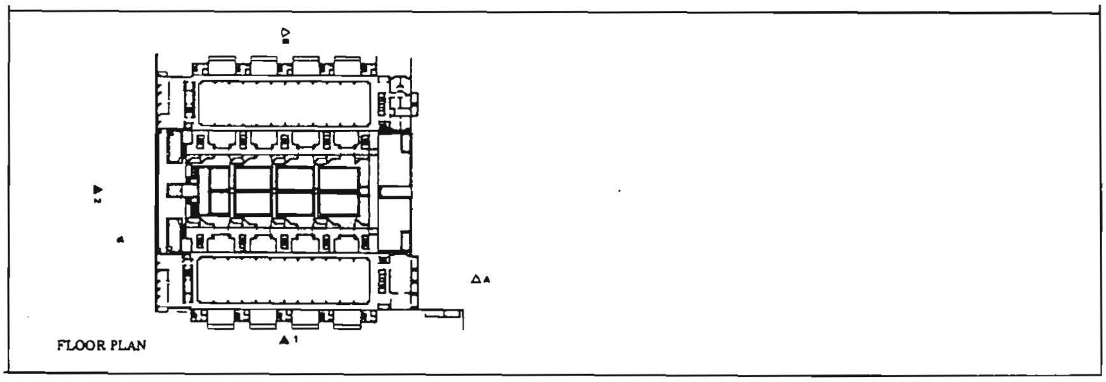


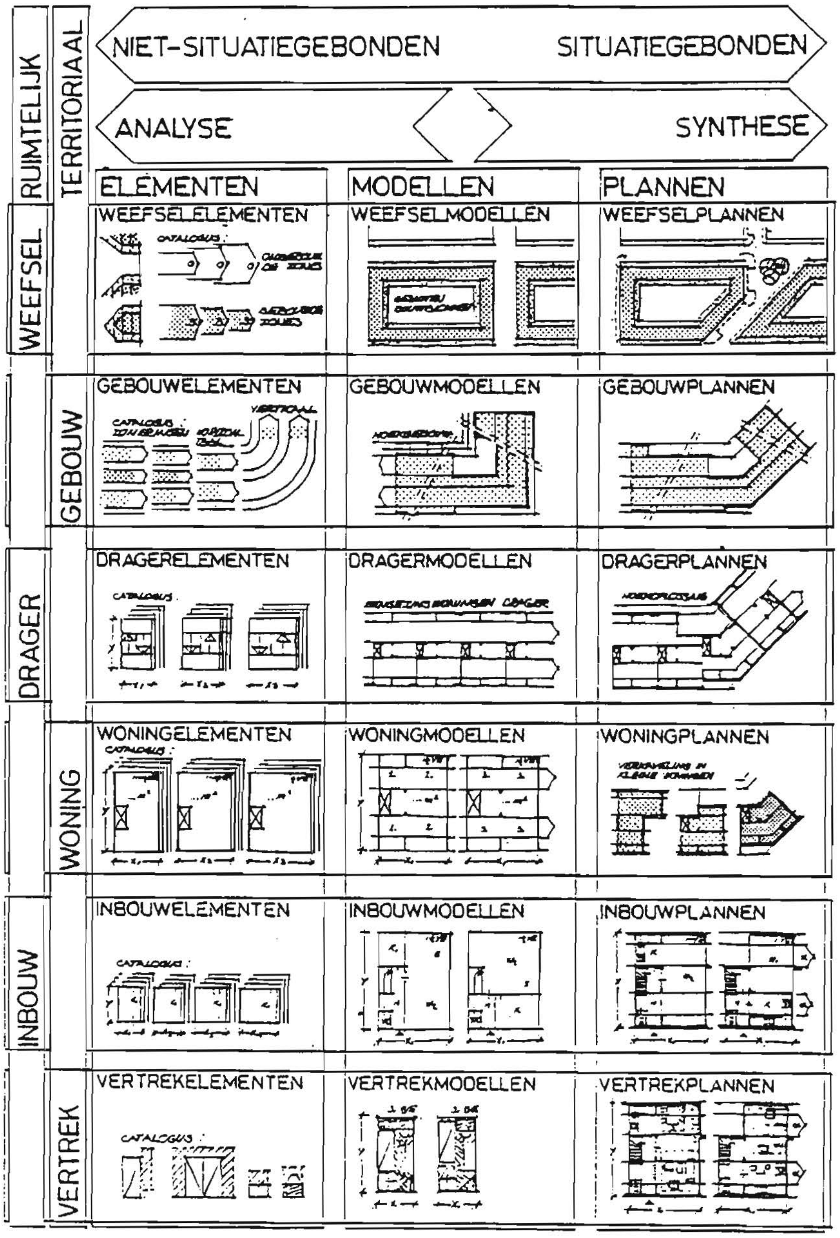

AT PREGASSONA
1979
AT MASSAGNO
1981






UNIT TO WHOLE
CIRCULATION TO USE
ADDITIVE AND SUBTRACTIVE
REPETITIVE TO UNIQUE
SYMMETRY AND BALANCE
HIERARCHY


FLOOR PLAN


RUIMTELIJK
TERRITORIAAL
NIET-SITUATIEGEBONDEN
SITUATIEGEBONDEN
ANALYSE
SYNTHESE
ELEMENTEN
MODELLEN
PLANNEN
WEEFSEL
WEEFSELELEMENTEN
WEEFSELMODELLEN
WEEFSELPLANNEN
GEBOUW
GEBOUWELEMENTEN
GEBOUWMODELLEN
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DRAGER
DRAGERELEMENTEN
DRAGERMODELLEN
DRAGERPLANNEN
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INBOUW
INBOUWELEMENTEN
INBOUWMODELLEN
INBOUWPLANNEN
VERTREK
VERTREKELEMENTEN
VERTREKMODELLEN
VERTREKPLANNEN

4. Geometric Order

grid structure as formal matrix
- the uses of geometric ordering
  - underlying order versus geometric form

modularity as an ordering principle
- types of modular systems

modular and geometric families

the Platonic solids as design primitives
- elementary geometry in architecture
  - the case of ground plans

cubic architecture
- syntax of the square
- the cube
- cube and grid

circular and spherical architecture
- syntax of the circle
- curvilinear form

radial forms

non-orthogonal grids
- octoganal systems
- hexagonal systems

free form

external determination of geometry

combinations of systems
- combinations of geometric systems
- geometric systems and spatial organizational strategies

Architectural Knowledge

4. Geometric Order

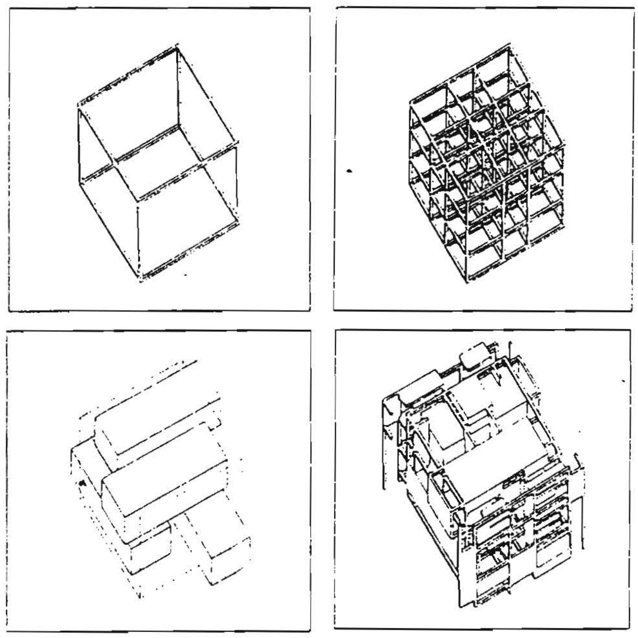


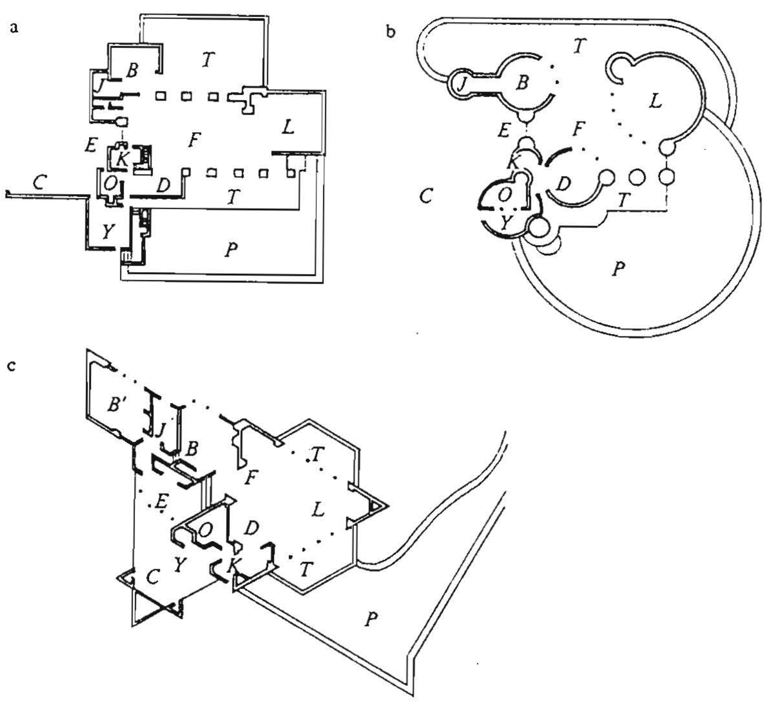
Figure 1.13
Three house projects by Frank Lloyd Wright:

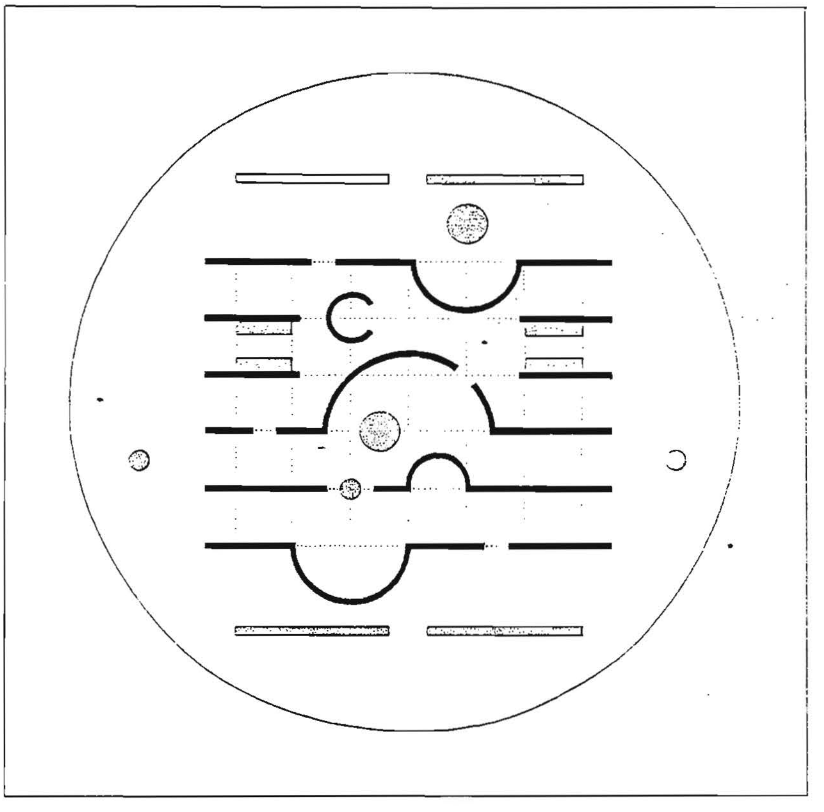
a, *Life* 'House for a family of $5000–$6000 income', 1938

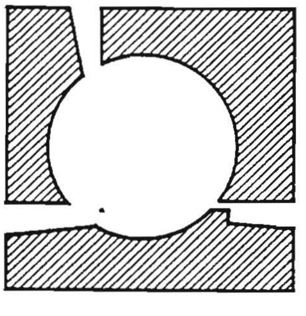
b, Ralph Jester House, Palos Verdes, California, 1938

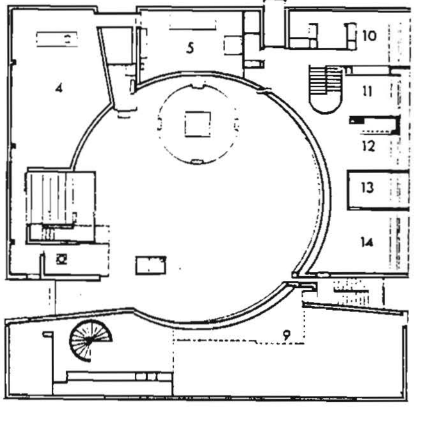
c, Vigo Sundt House, near Madison, Wisconsin, 1941

B bedroom
B′ Sundt bedroom
C car port
D dining-room
E entrance
F family room
J bathroom
K kitchen
L living-room
O office
P pool
T terrace
Y yard





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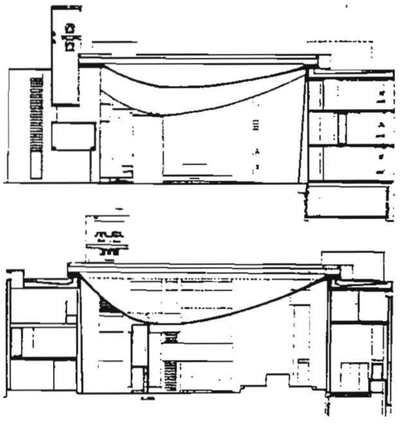
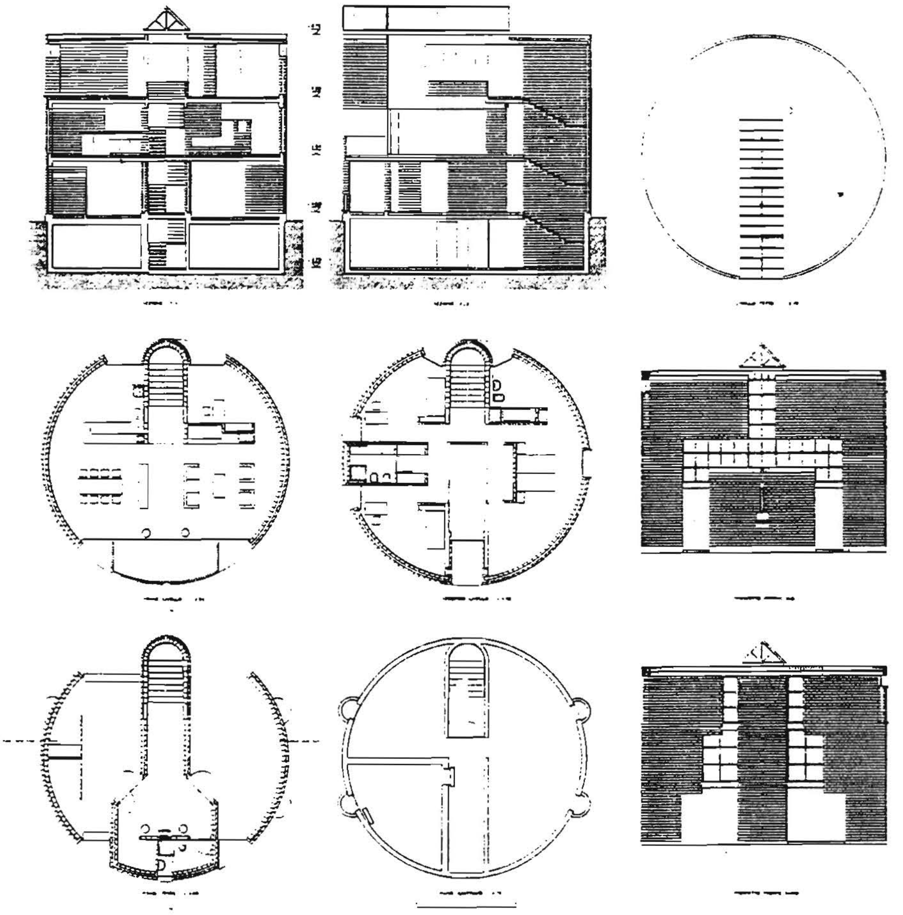
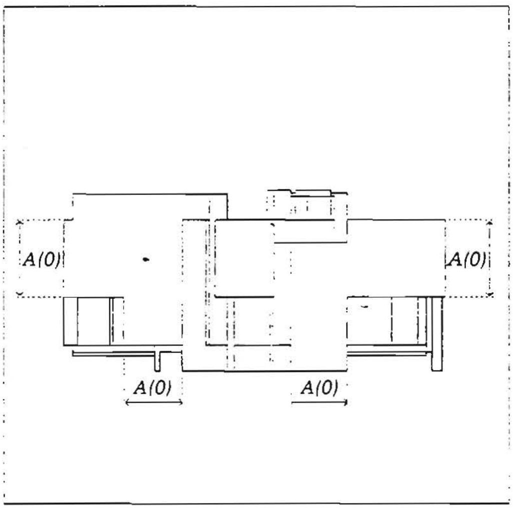
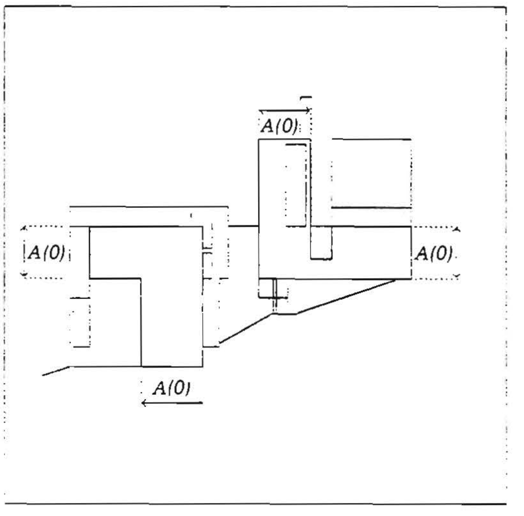


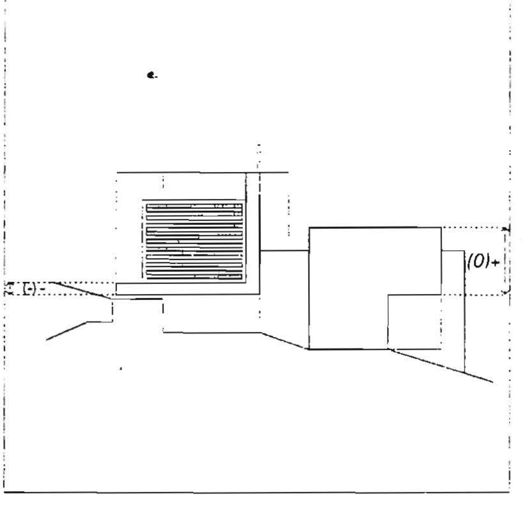




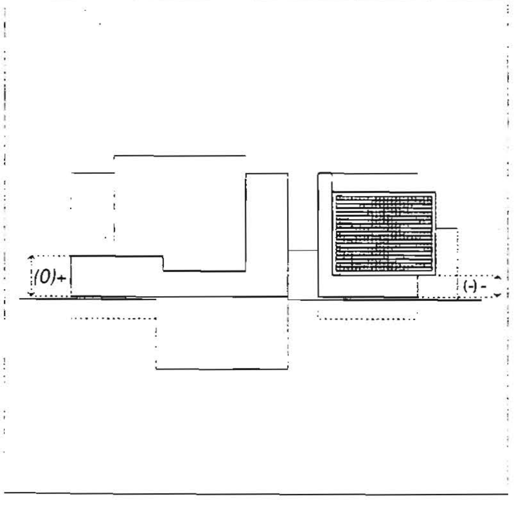
North elevation



West elevation



East elevation



South elevation

Architectural Knowledge

This section introduces certain major classes of architectural formal knowledge. These are highly domain specific structures of knowledge which are essentially typological in nature. They are means of representing typological classes of knowledge in architecture, and in certain cases, such as grammars, also provide means of annotating these descriptions graphically or otherwise. As high-level, domain specific knowledge, these structures of knowledge are part of the cognitive content of designing. Their role in the processes of designing which we term, design knowledge, appears in the part 3.

5. The Formal Elements

6. Types

7. Languages and Grammars

8. Formal Models

9. Themes

10. Paradigms

5. The Formal Elements

the definition of the formal elements in the Classical Tradition

the concept of vocabularies of formal elements in design
- historical examples of element vocabularies
    - Durand
- contemporary examples of element vocabularies
    - Ehrenkrantz: sub-systems
    - Thiis-Evensen: floor, wall, roof
    - Krier: the elements of architecture
    - Eisenman
    - Ching: formal elements
- urban element vocabularies
- computational element vocabularies

formal elements and formal qualities
- spatial and formal qualities: Norberg-Schulz

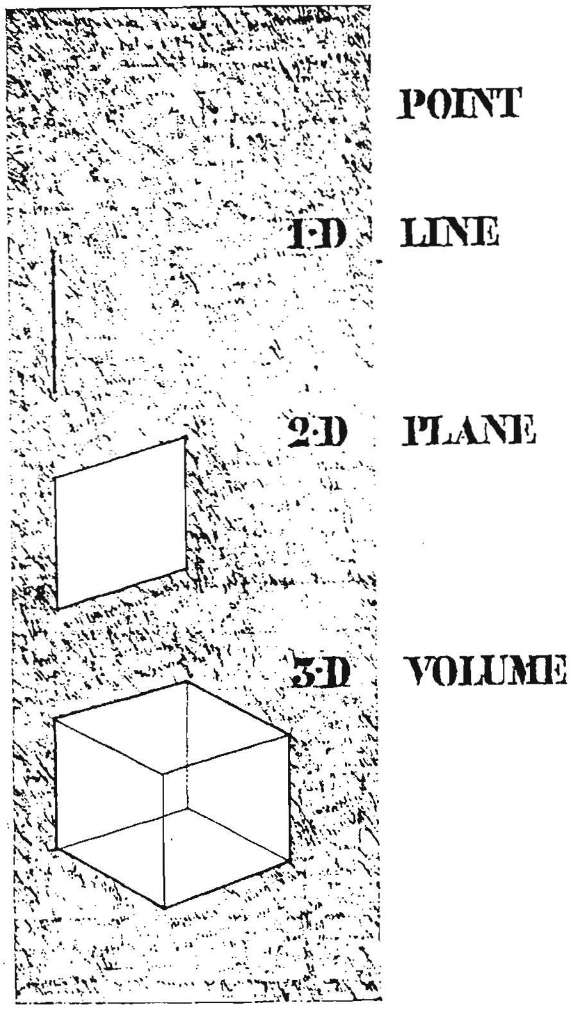
formal analysis
- Baker's categories

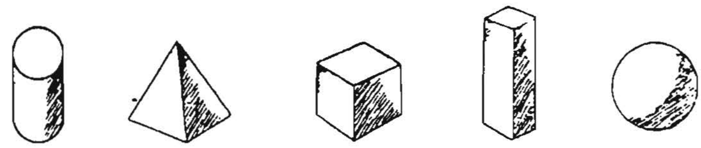
form writing: basic operations on formal elements
- symmetry operations
- replacement, scaling,nudging, etc.
- constrained operations

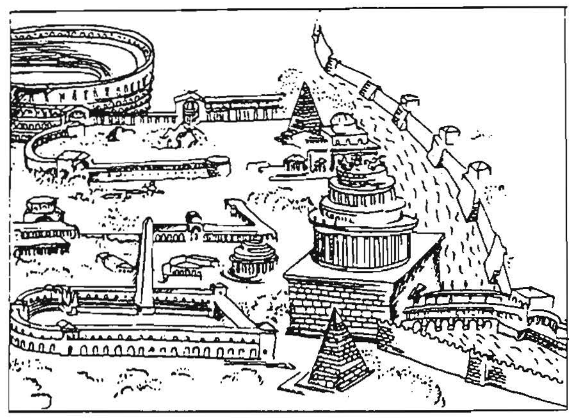
composition and syntactical operations
- treatises on composition
- historical examples of composition
    - Gaudet and Elementary Composition
- composition as the formalized relationships of an element vocabulary
    - formal vs spatial composition
    - hierarchical order
    - nested operations and sequences
    - compositional systems and styles
- contemporary composition

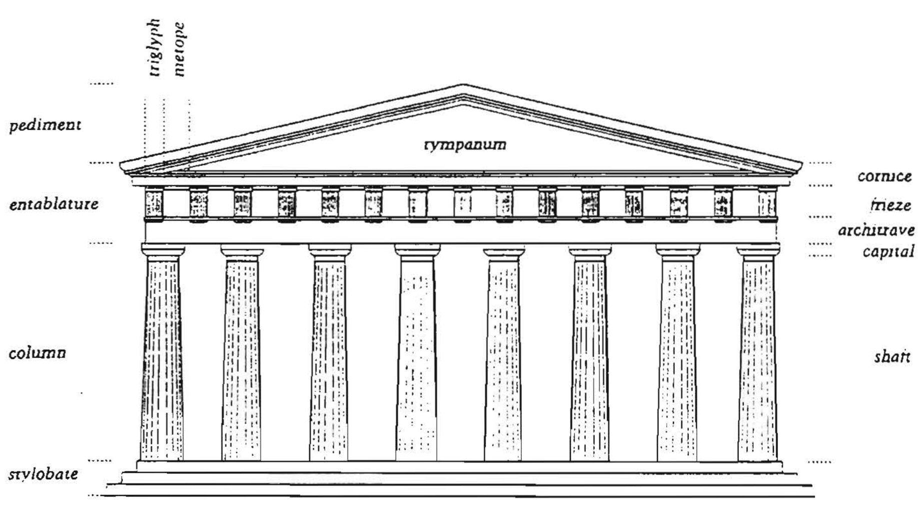
Architectural Knowledge

5. The Formal Elements

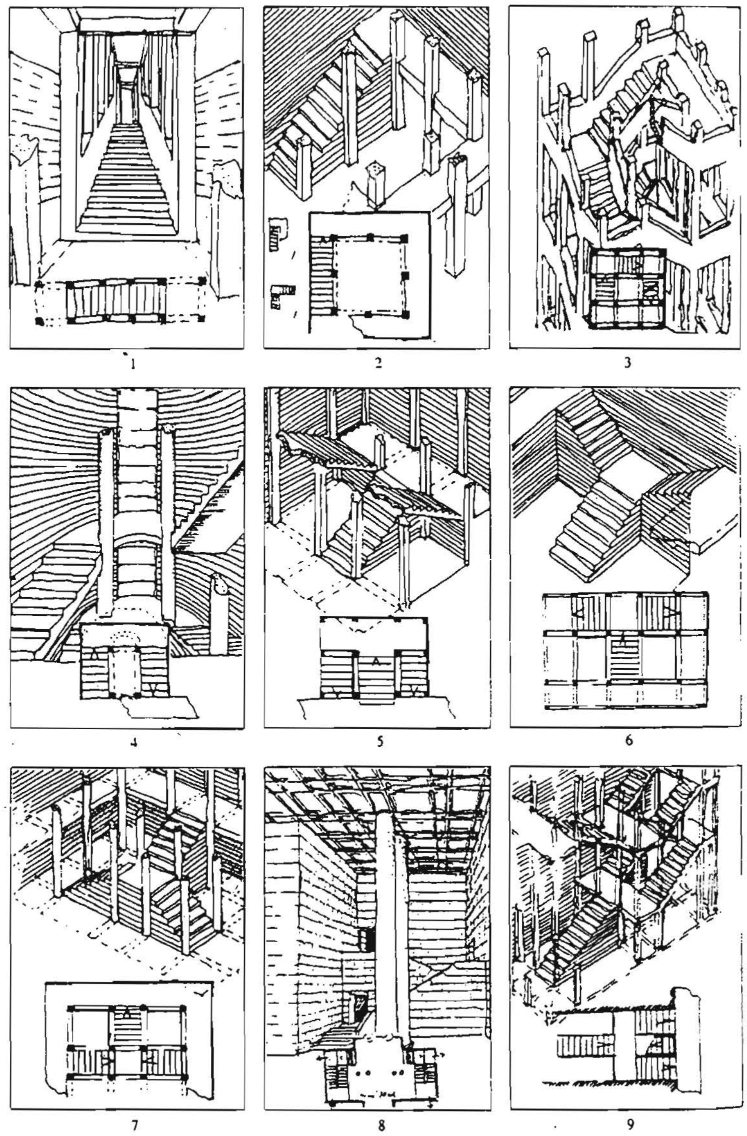


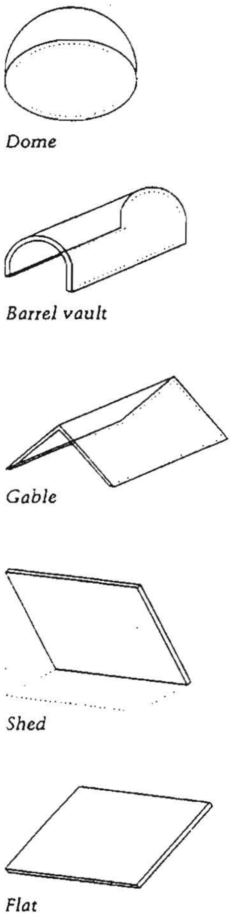




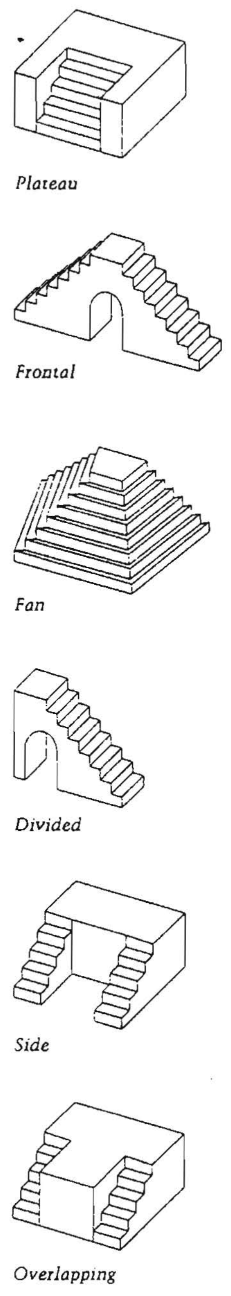


1.18
Decomposition of the Parthenon into
primary and secondary parts

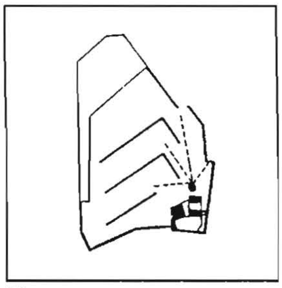




6.10
A vocabulary of roof themes (after Thiis-Evensen, 1988)



6.11
A vocabulary of stair motifs (after Thiis-Evensen, 1988)



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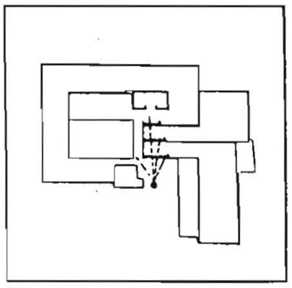

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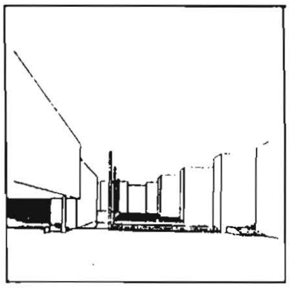

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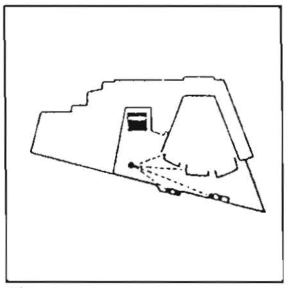

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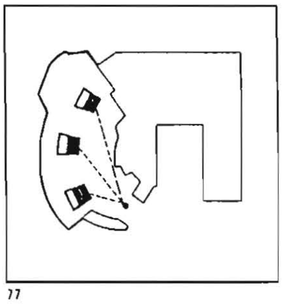

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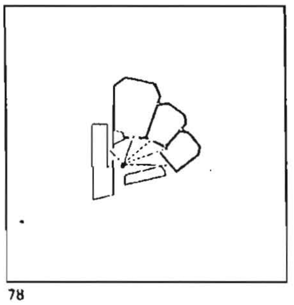

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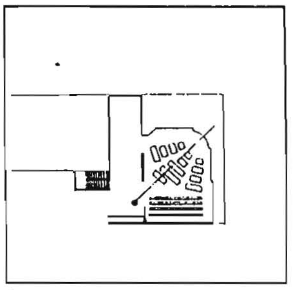

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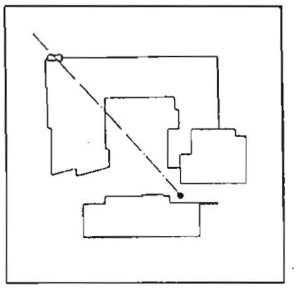

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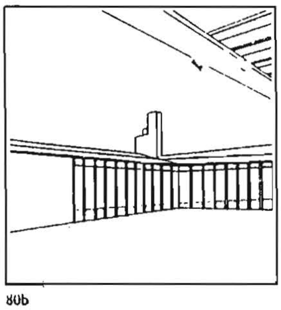

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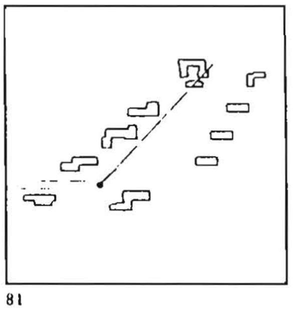

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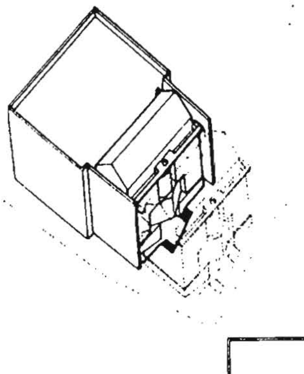
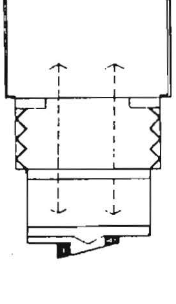


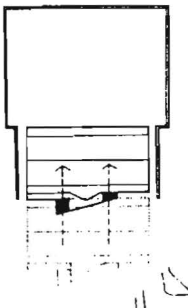


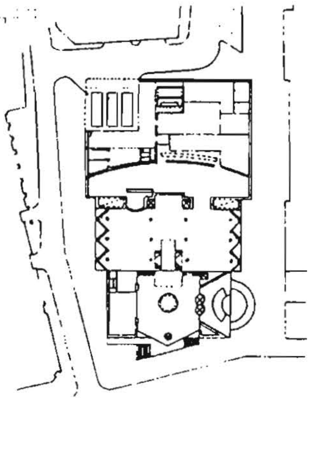
Sliding boxes

The echelon form may be read as three boxes, each capable of sliding into the one behind. As if in acknowledgement of this possibility the centre box has its edge in the form of a zig-zag at entry level, this 'concertina' allowing the forward pavilion to slide back into the main slab.

This sliding is held by the rows of columns in the foyer which pin the box in position. The columns continue down to the baseline below pavement level, their symmetry and shape signifying on the one hand circulation zones and on the other the structural principle of the building, which is to have a reinforced concrete frame and floor slabs with certain loads transmitted through columns.

The regular columnar rhythm of the foyer gives it a 'hypostyle hall' reading which combines order and formality with structural logic. Within a series of multivalent boxes the columns stabilise literally and metaphorically.





6. Types

the concept of type as wholistic classification of building form
- type as principle and framework: defines elements, variables, characteristics, relationships

• historical
- typology and imitation
- the theory of precedent

• contemporary approaches to type
- Rationalist Architecture

theories of types and typology

• Rossi, Moneo

types of types: introduction to architectural typology

• typology as architectural morphology
- the classification of morphological types: Grassi, Scolari

• urban morphology and the morphology of types
- arcades; covered streets ; urban blocks; urban fabric; quarters
- figure ground

• building types: morphological classes of functions
- buildings of repetitive functions
- programmatically diverse buildings
- buildings of controlled movement

• building functional types
- Pevsner

• archetypes
- Lethaby: myth and archetype
- the classes of archetypes: Arnheim, Purves, Lobell
- the annotation and refinement of archetypes : Durand; Eisenman
- archetype and variations

construction and type

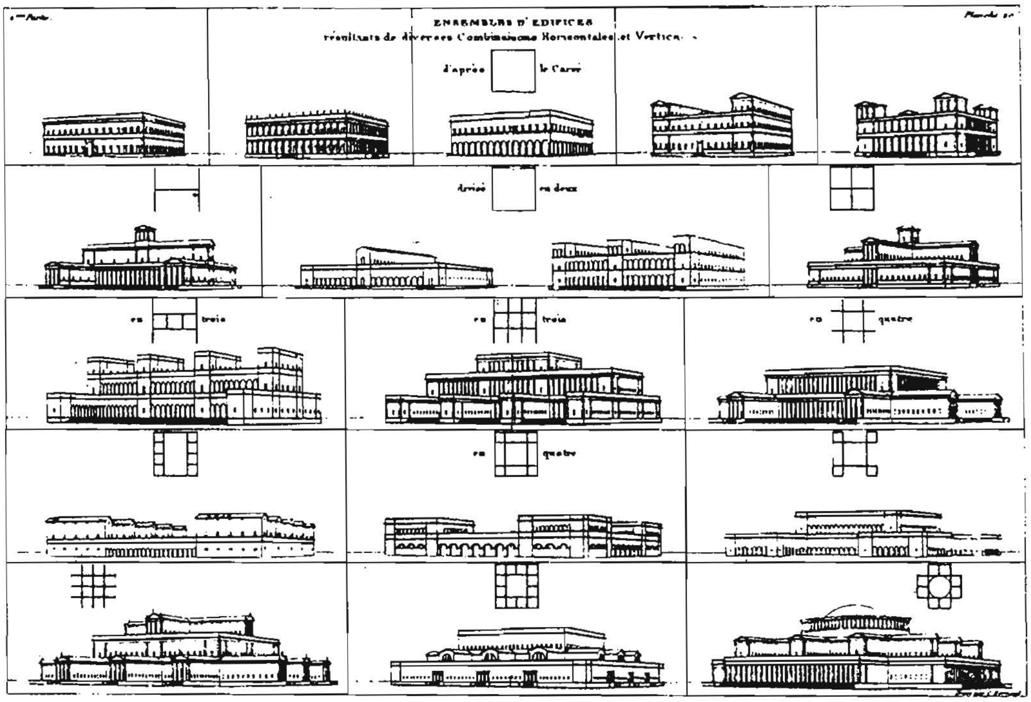
typological analysis-urban typological analysis

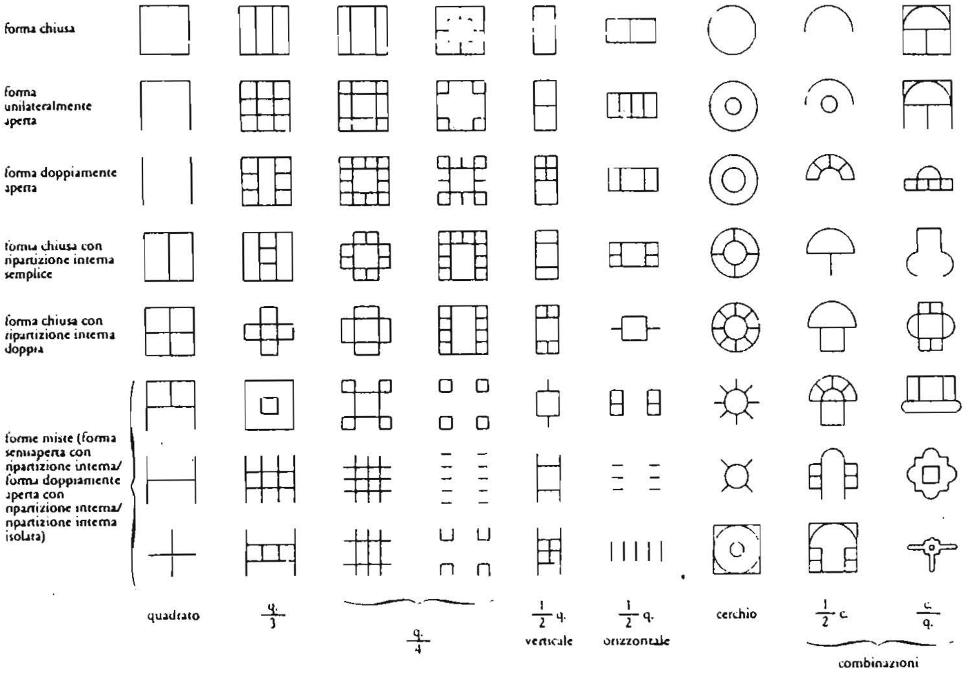
the representation of knowledge of types: prototypes

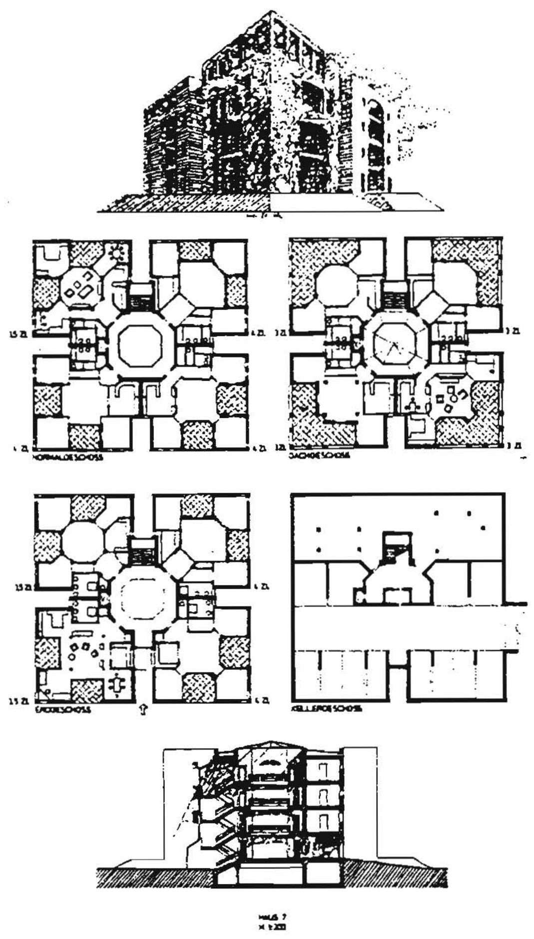
the graphic annotation of typological knowledge

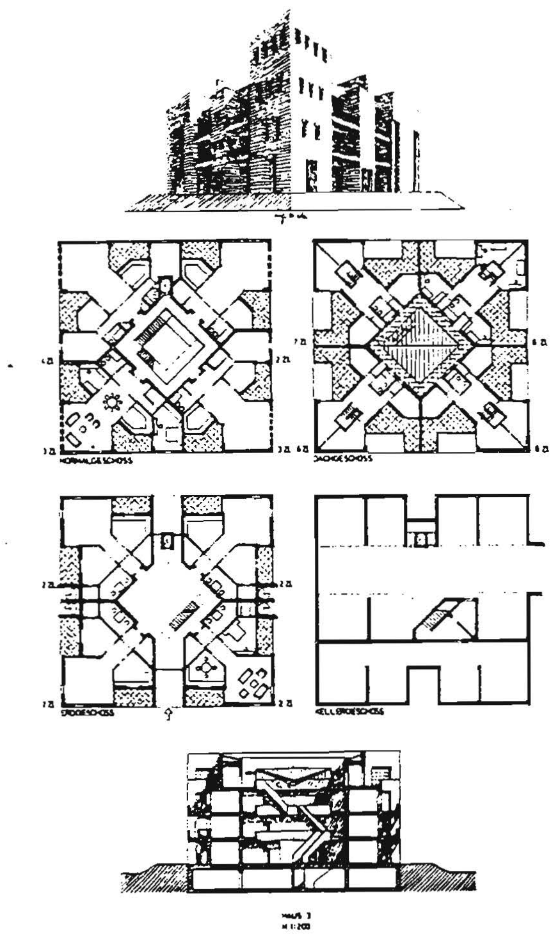
Architectural Knowledge

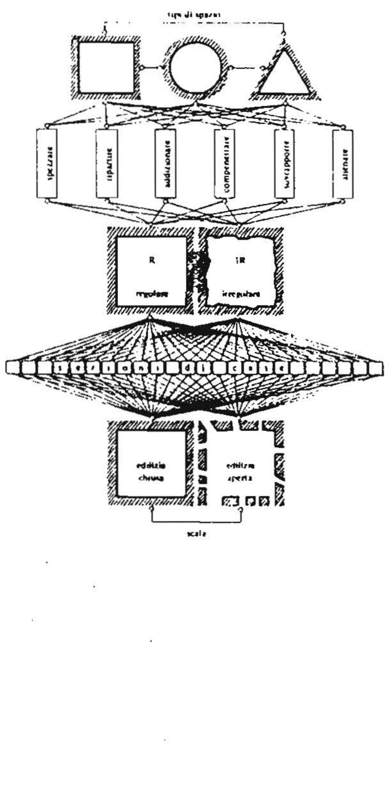
6. Types







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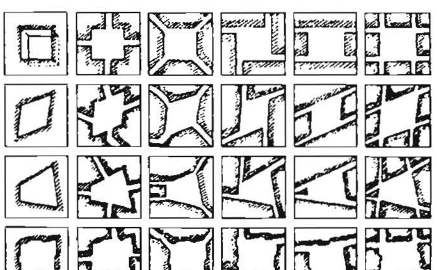
edilizia aperta
scala

1



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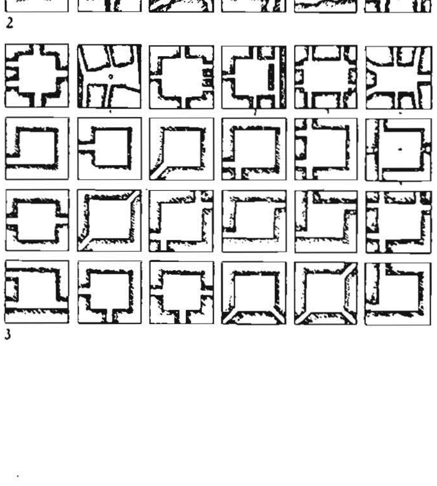
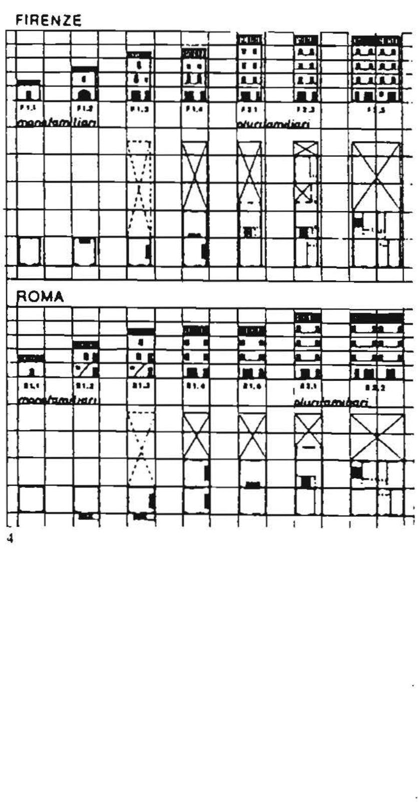


3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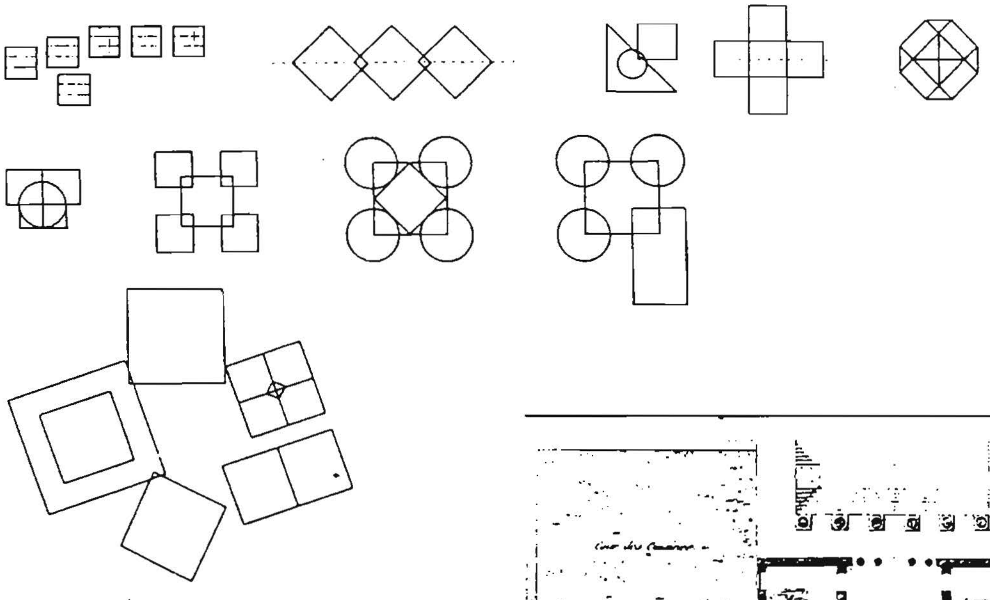
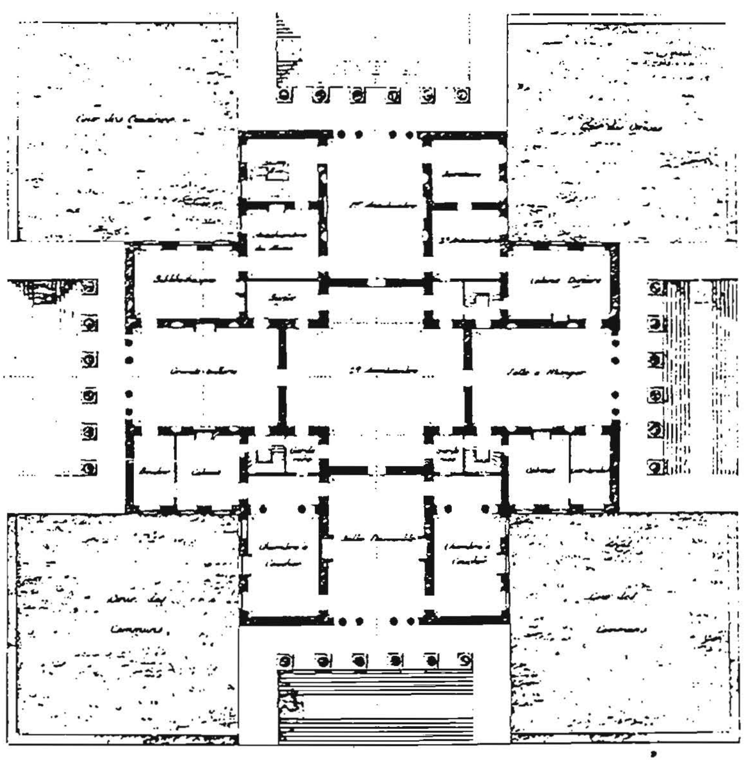
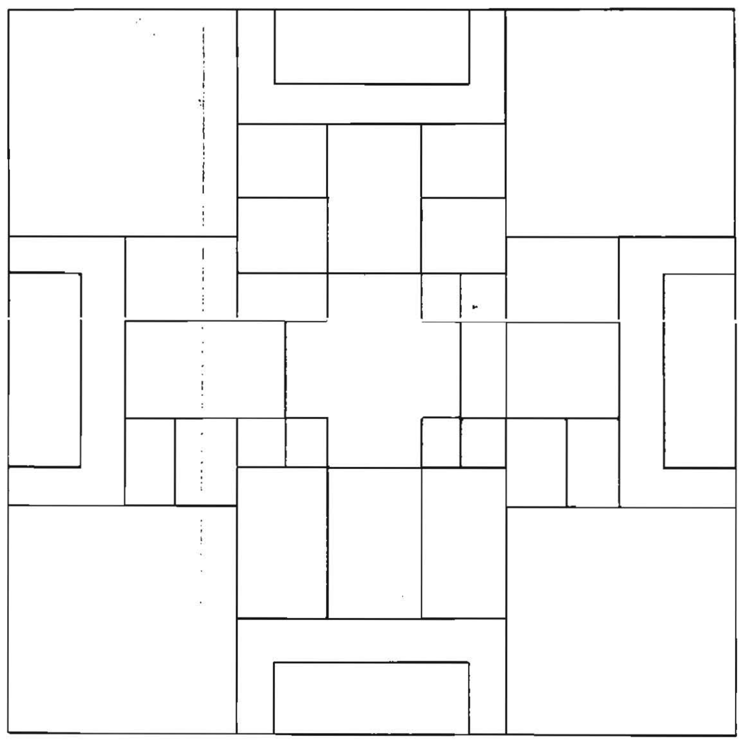
plurifamiliari

4







7. Grammars and Languages

formal descriptions: algebra, grammar and language

Mitchell's definition of formal grammars

- "syntactic rules governing a design world establish an architectural type"
- an encoding of a typological definition which assigns syntactic structure to the type and which can generate instances of the type
- vocabulary of elements (labeled shape vocabulary)
- rules for instantiation; assembly; transformation; scaling; replacement
  - prescriptive rules; replecement rules; recursive replacement rules
  - Moghul Gardens
- top-down and bottom-up rule systems
  - Durand
  - The Palladian Language (Stiny and Mitchell)

Stiny's parametric shape grammars

- two paradigms of shape descriptions
- the history of formalized shape descriptions
  - Wrightian Languages
- some paradigms of formal generation in grammars
- transformational languages
  - Weissman-Knight
- three dimensional shape grammar
  - Froebel gifts
  - towards three-dimensional shape descriptions
- general shape grammar

Flemming's architectural syntax

formal languages

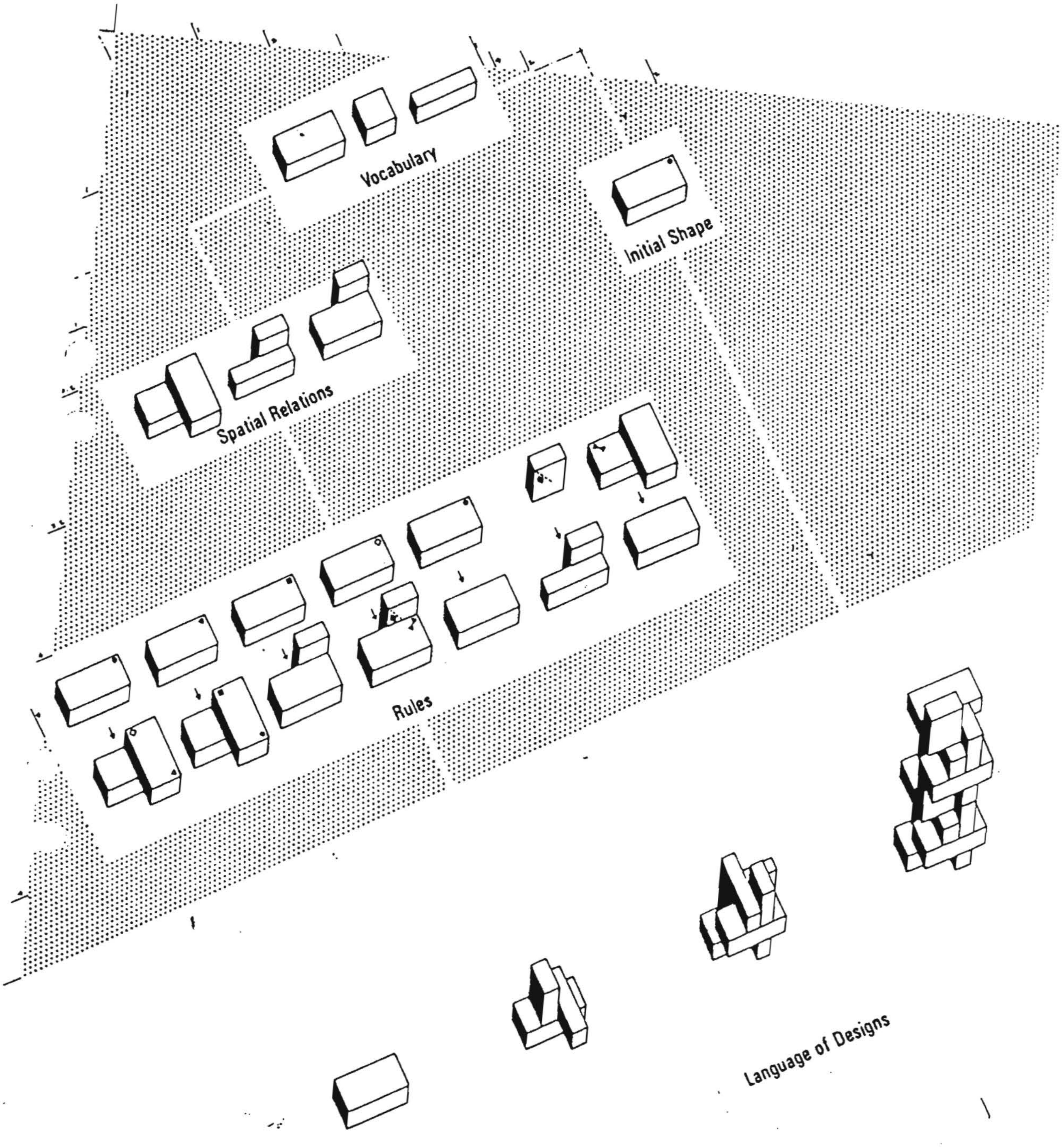
- language as world of all possible designs specified by a grammar

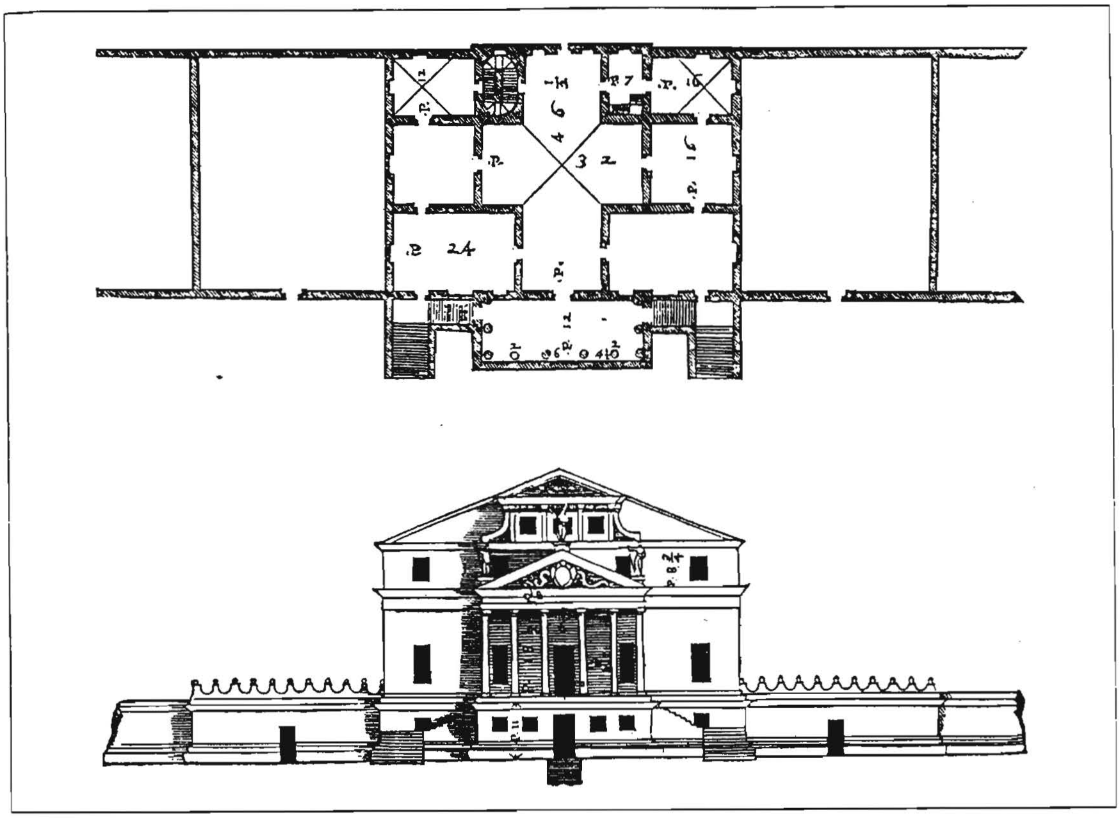
non-syntactic formal language

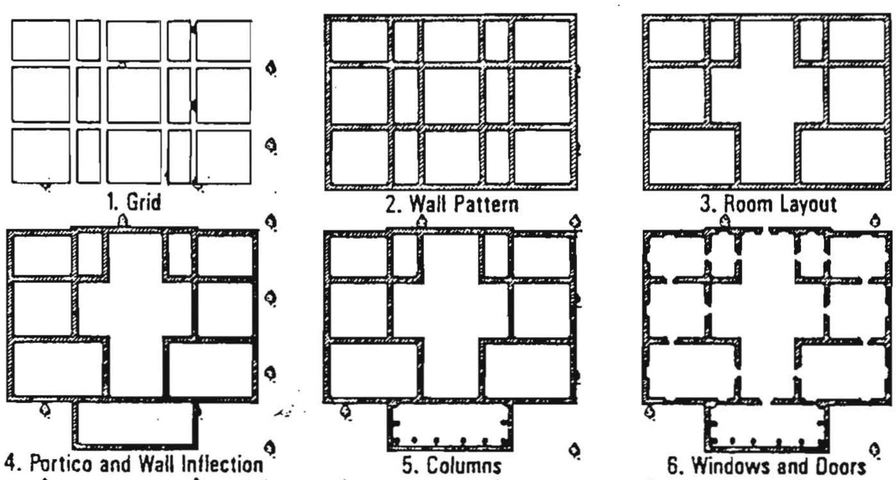
- Duany on Aalto

formal analysis through shape grammars

Architectural Knowledge
7. Grammars and Languages






1. Grid
2. Wall Pattern
3. Room Layout
4. Portico and Wall Inflection
5. Columns
6. Windows and Doors

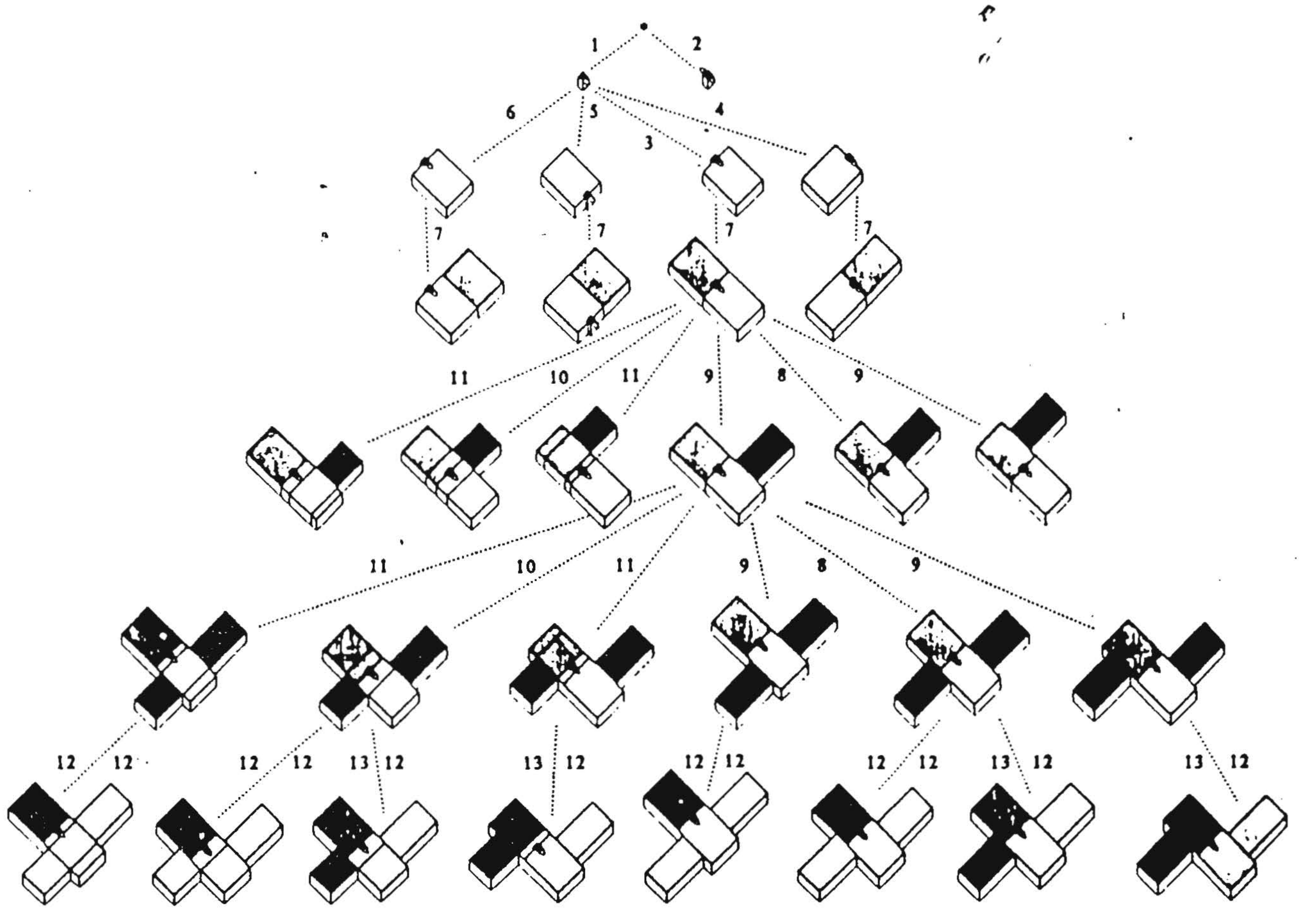
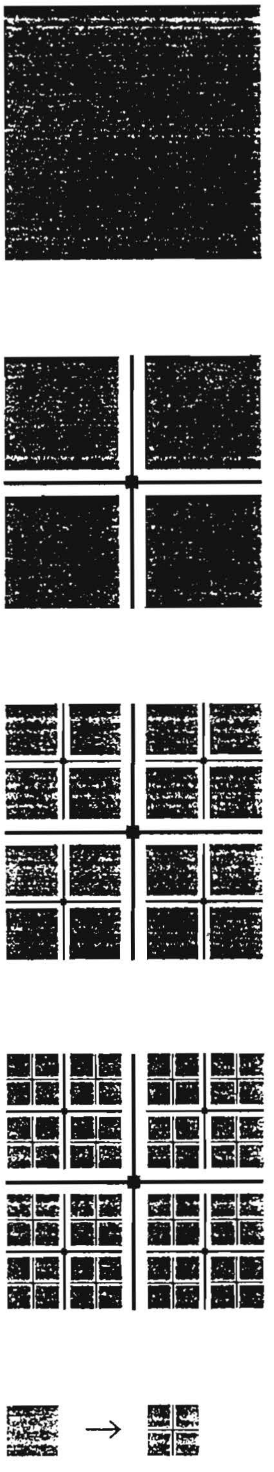
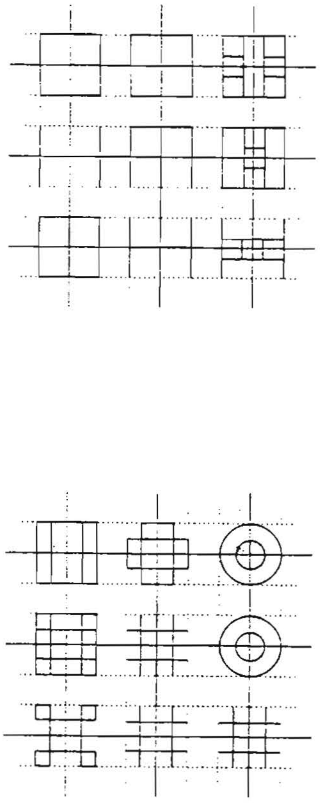


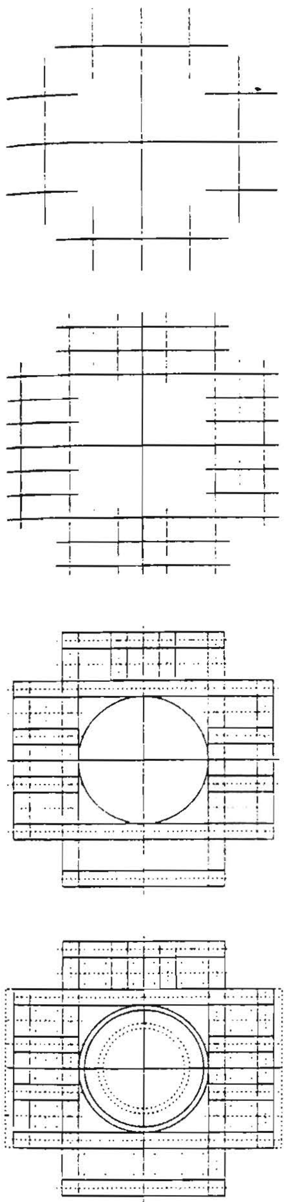
Figure 10. Part of the tree showing admissible sequences of shape rule schemata applications used to generate basic compositions. Numbers on the branches indicate the schemata applied.



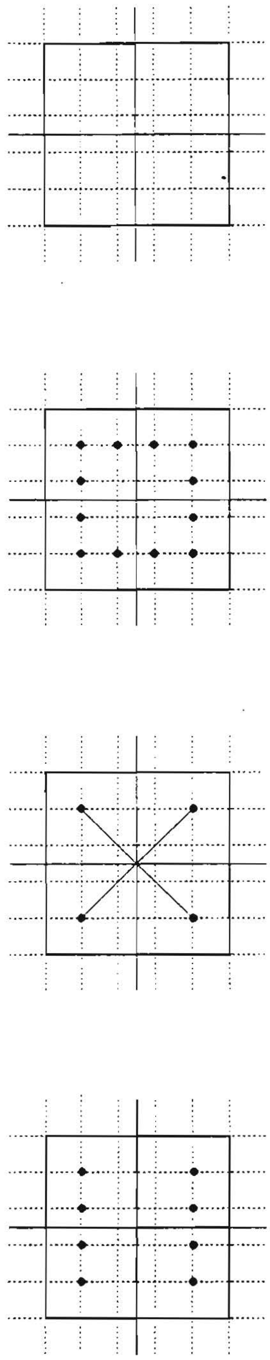
8.6
The Islamic garden rule, as used in the garden of the Taj Mahal



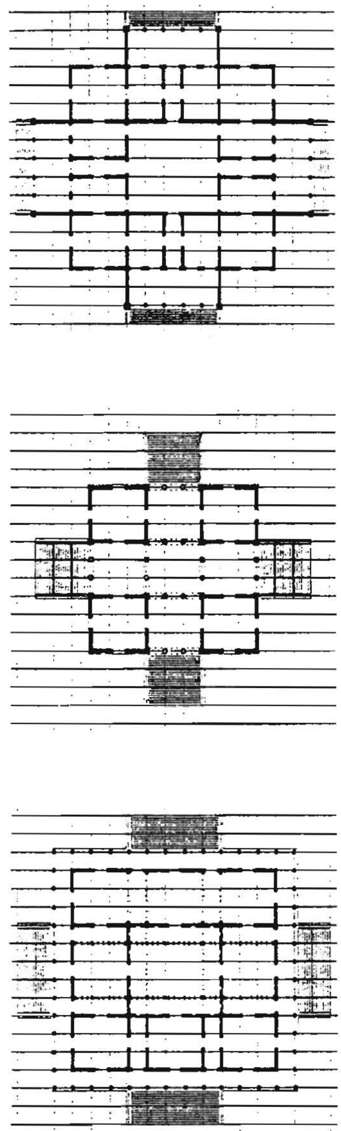
8.25
Skeletons of plan construction lines (after Durand's *Partie graphique des cours d'architecture à l'Ecole Royale Polytechnique*, 1821)



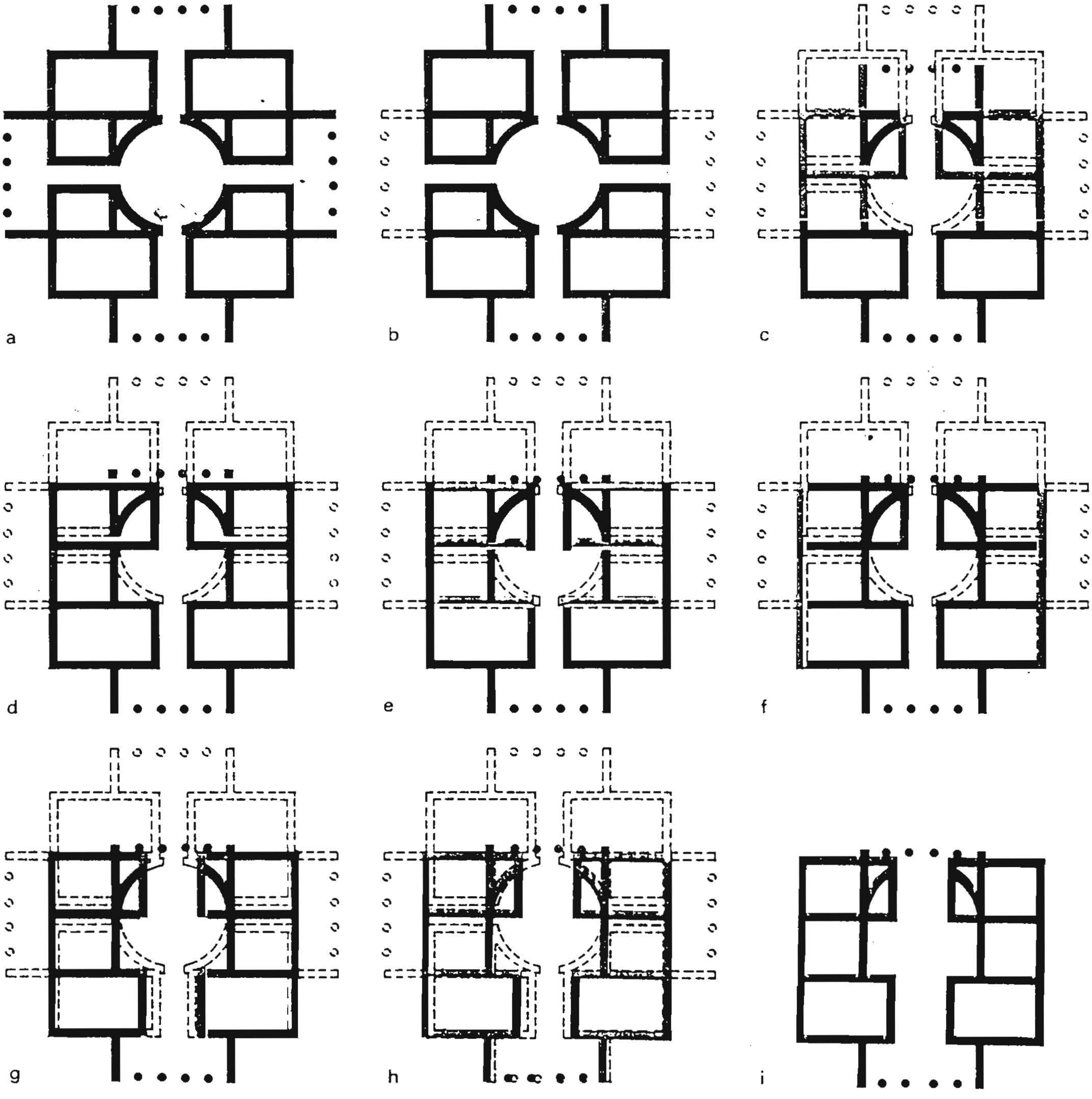
8.26
Steps in the top-down process of refining a skeleton into a fully detailed plan (after Durand's *Précis des leçons d'architecture*, 1802–5)

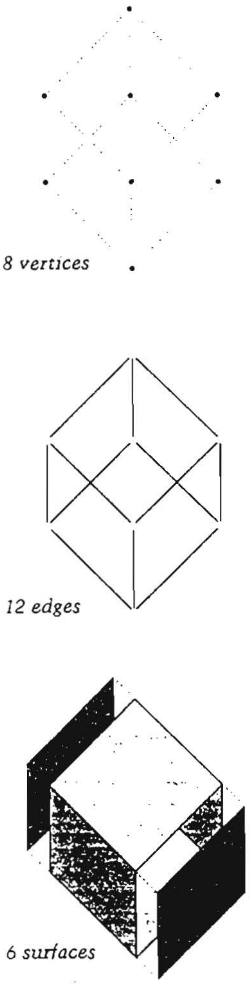


8.28
Alternative substitutions from the classical architectural lexicon (after Durand's *Partie graphique des cours d'architecture*)

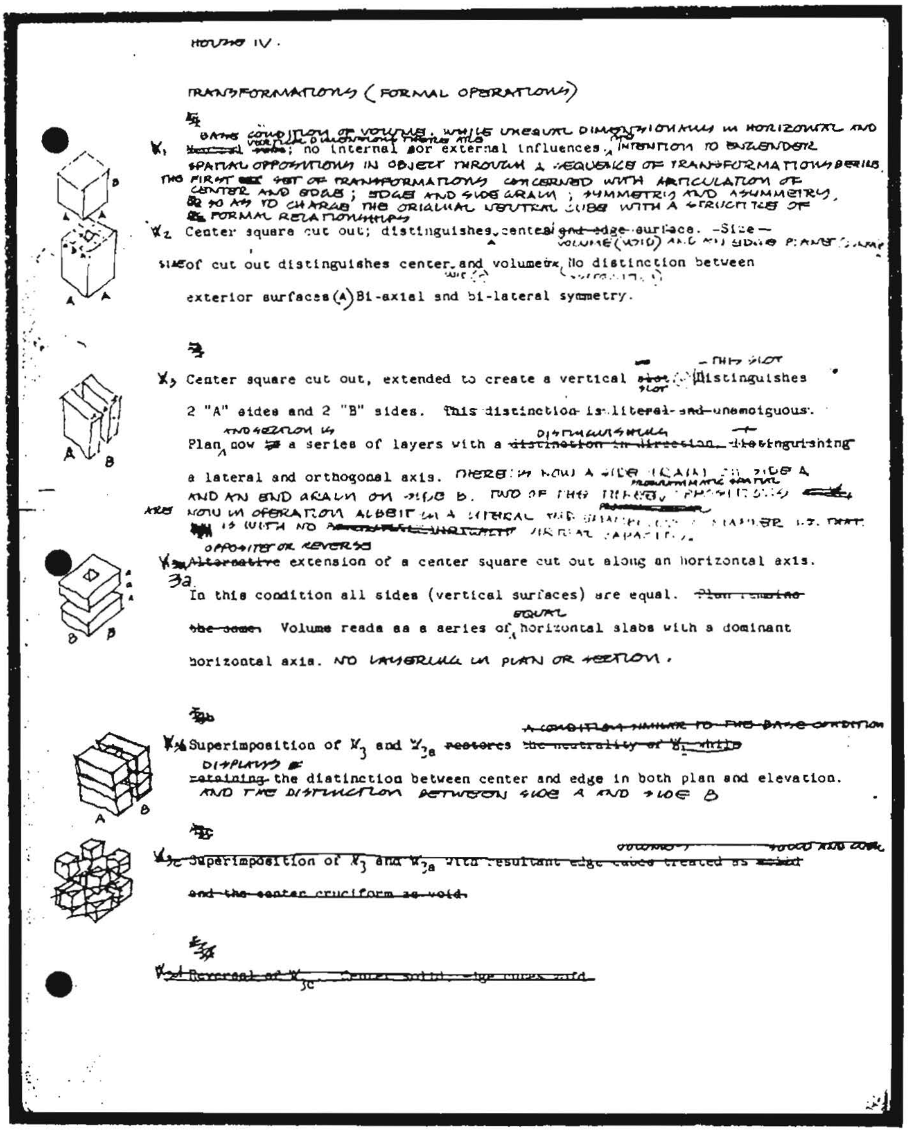


8.29
Examples of syntactically correct compositions (after Durand's *Partie graphique des cours d'architecture*)


a
b
c
d
e
f
g
h
i



3.17
Point, line, and surface boundary models of a cube



HOUSE IV.

TRANSFORMATIONS (FORMAL OPERATIONS)

1. BASE CONDITION OF VOLUME. WHILE UNEQUAL DIMENSIONALLY IN HORIZONTAL AND VERTICAL DIMENSIONS THERE ARE ~~neutral~~ ~~cube~~; no internal nor external influences. INTENTION TO ENGENDER SPATIAL OPPOSITIONS IN OBJECT THROUGH A SEQUENCE OF TRANSFORMATIONS SERIES. THE FIRST SET OF TRANSFORMATIONS CONCERNED WITH ARTICULATION OF CENTER AND EDGE; EDGE AND SIDE AGAIN; SYMMETRY AND ASYMMETRY, SO AS TO CHARGE THE ORIGINAL NEUTRAL CUBE WITH A STRUCTURE OF FORMAL RELATIONSHIPS

2. Center square cut out; distinguishes center ~~and edge~~ surface. —Size— VOLUME (VOID) AND ... SIDING PLANE ... SIZE of cut out distinguishes center and volume. No distinction between exterior surfaces (A) Bi-axial and bi-lateral symmetry.

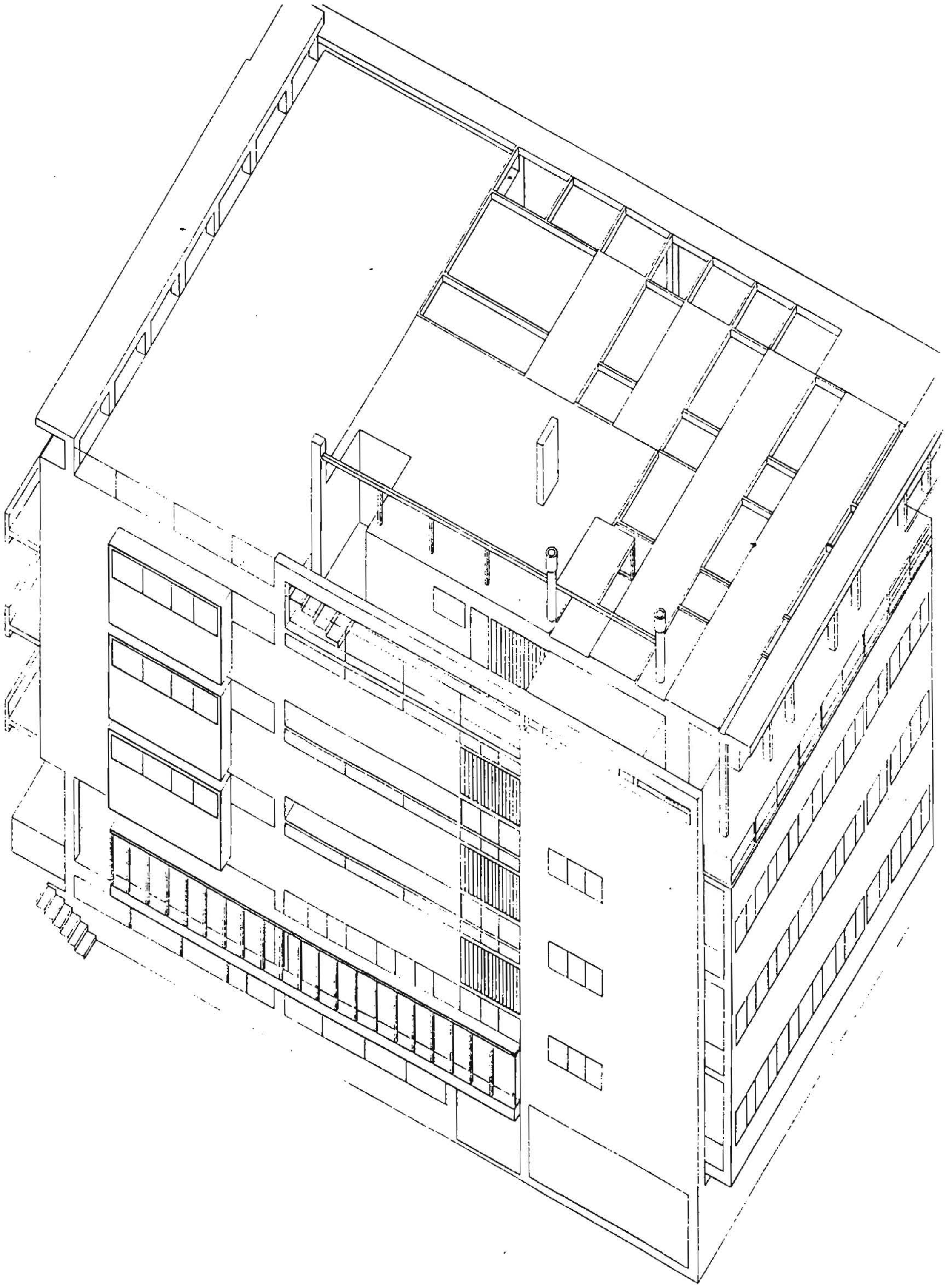
3. Center square cut out, extended to create a vertical ~~slot~~ SLOT — THIS SLOT distinguishes 2 "A" sides and 2 "B" sides. ~~This distinction is literal and unambiguous.~~ Plan AND SECTION IS now a series of layers with a ~~distinction in direction.~~ DISTINGUISHING ~~distinguishing~~ a lateral and orthogonal axis. THERE IS NOW A SIDE AGAIN ON SIDE A AND AN END AGAIN ON SIDE B. TWO OF THE THREE ... ARE NOW IN OPERATION ALBEIT IN A LITERAL ... IS WITH NO ... VIRTUAL CAPACITY.

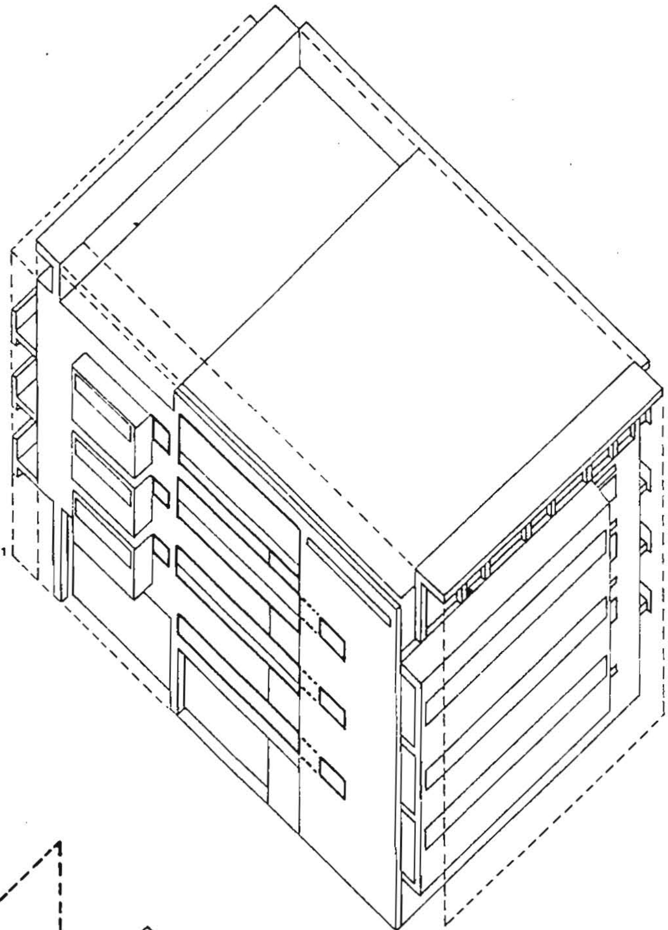
3a. OPPOSITE OR REVERSE ~~Alternative~~ extension of a center square cut out along an horizontal axis. In this condition all sides (vertical surfaces) are equal. ~~Plan remains the same.~~ Volume reads as a series of EQUAL horizontal slabs with a dominant horizontal axis. NO LAYERING IN PLAN OR SECTION.

3b. Superimposition of X_3 and X_{3a} ~~restores~~ ~~A CONDITION SIMILAR TO THE BASE CONDITION~~ ~~the neutrality of X_1 while~~ DISPLAYS ~~retaining~~ the distinction between center and edge in both plan and elevation. AND THE DISTINCTION BETWEEN SIDE A AND SIDE B

3c. ~~Superimposition of X_3 and X_{3a} with resultant edge cubes treated as solid and the center cruciform as void.~~

3d. ~~Reversal of X_{3c}. Center solid; edge cubes void.~~





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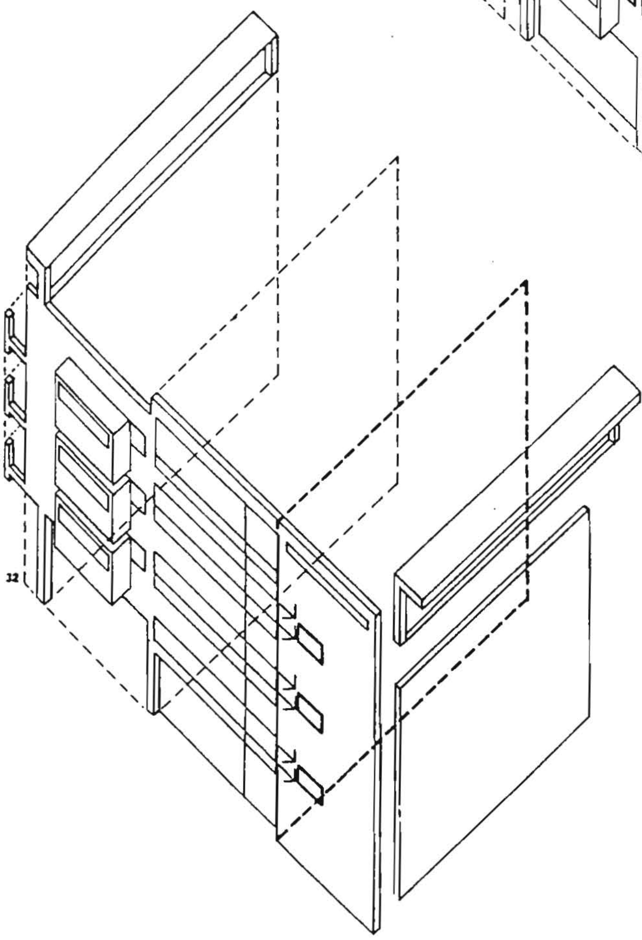

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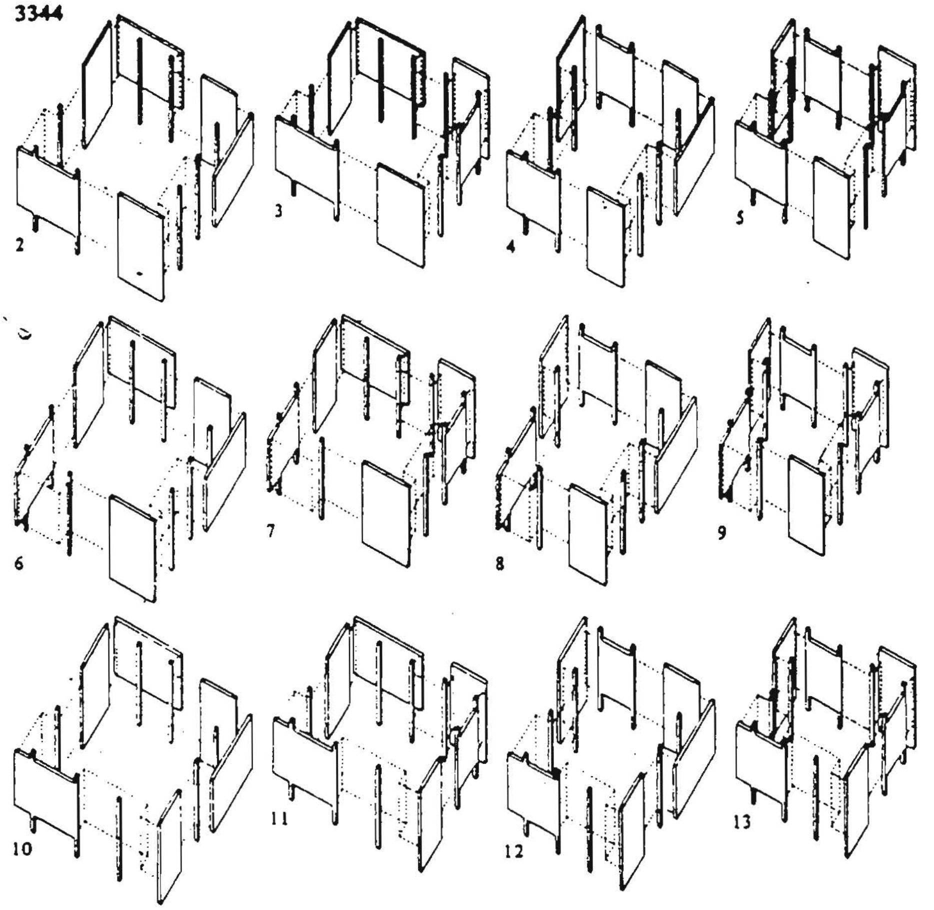

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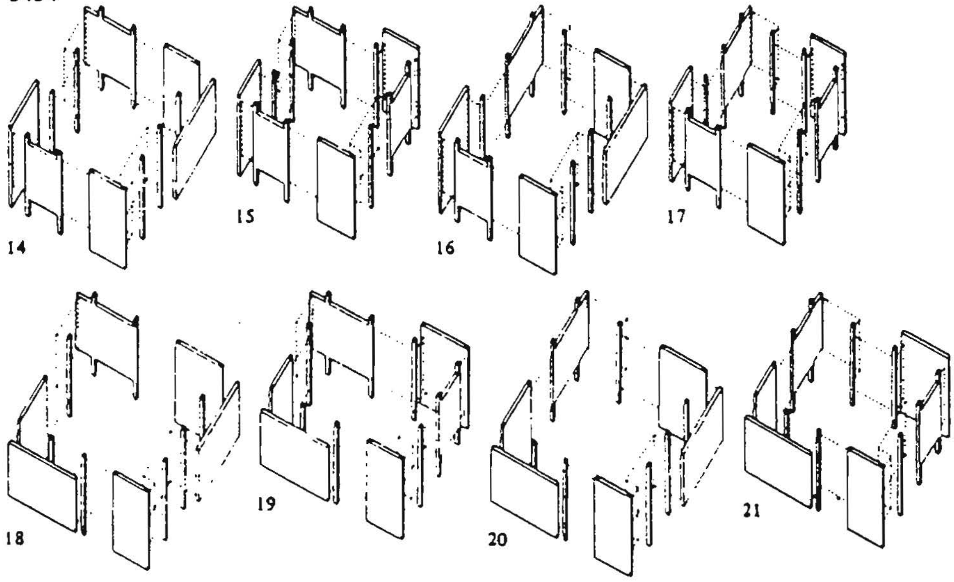
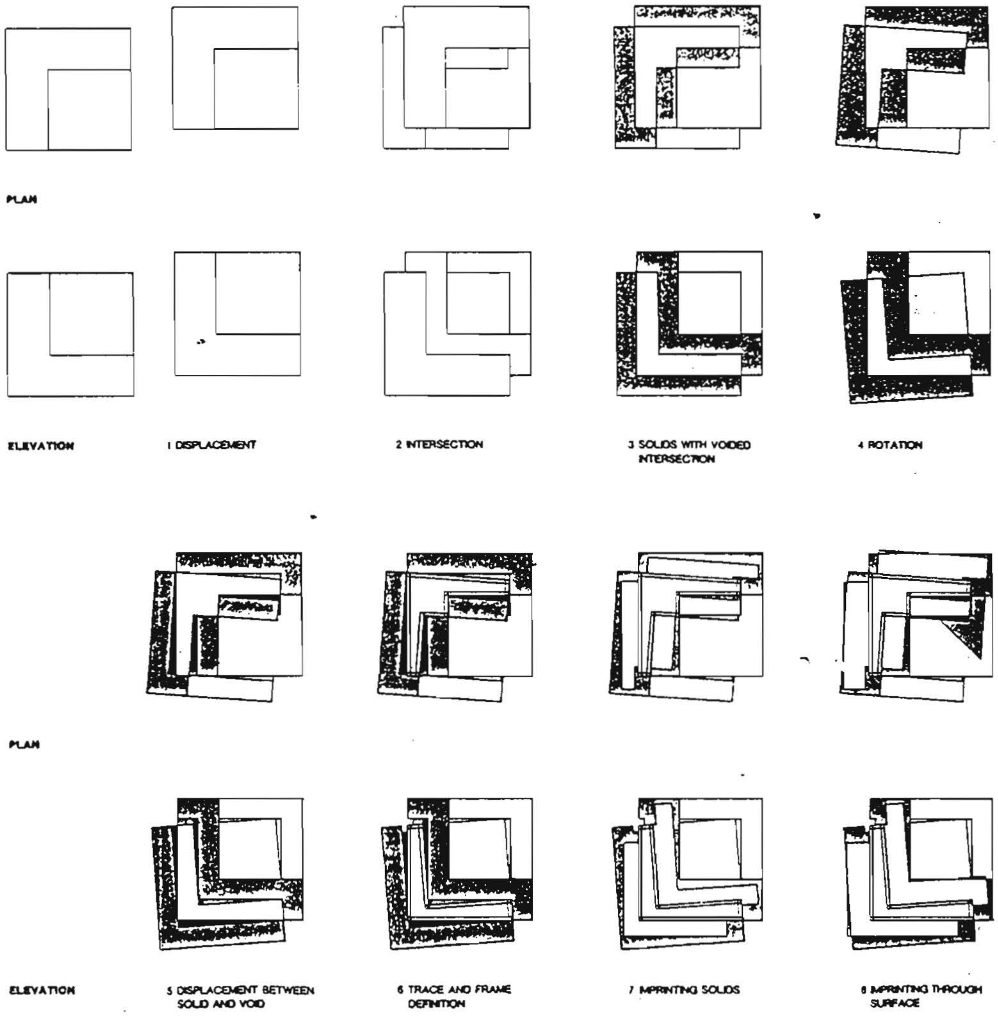
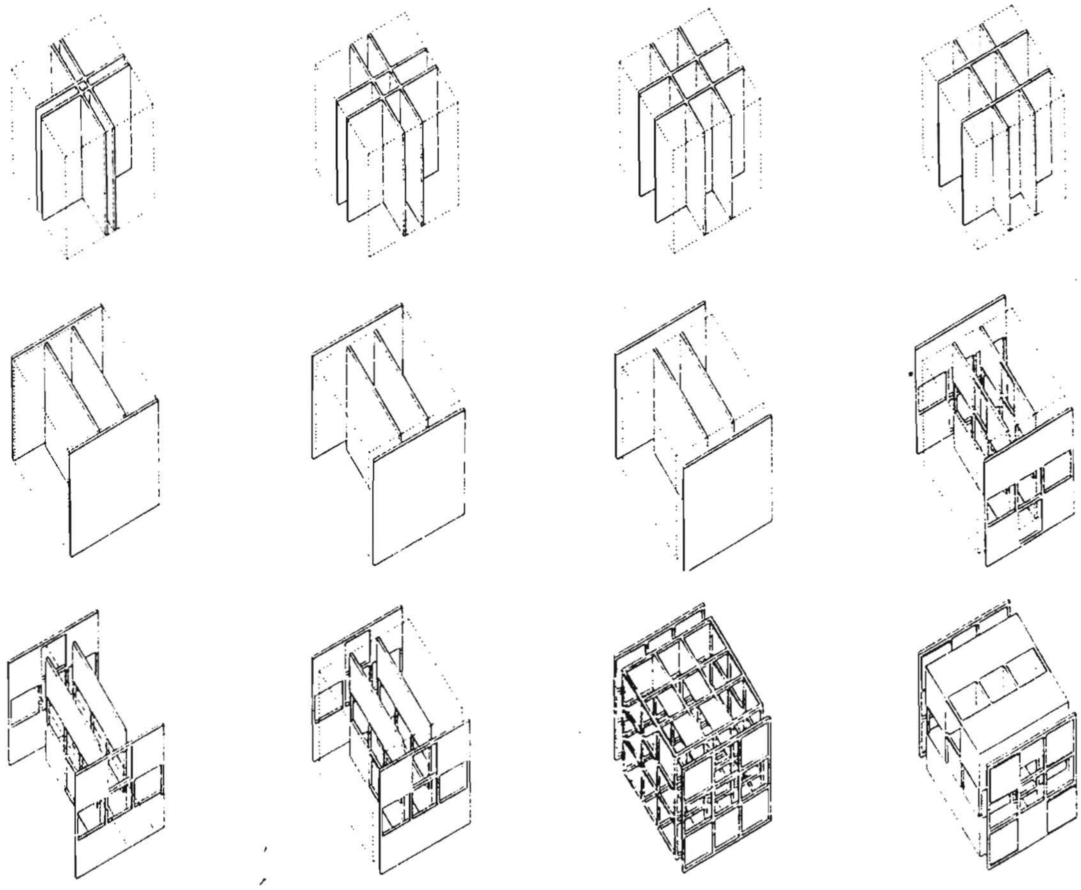



PLAN
ELEVATION
1 DISPLACEMENT
2 INTERSECTION
3 SOLIDS WITH VOIDED INTERSECTION
4 ROTATION
PLAN
ELEVATION
5 DISPLACEMENT BETWEEN SOLID AND VOID
6 TRACE AND FRAME DEFINITION
7 IMPRINTING SOLIDS
8 IMPRINTING THROUGH SURFACE



8. Formal Models

formal models: modeling the languages of design

- Flemming's concept of architectural syntax
- the major classes of architectural formal languages
- three-dimensional formal languages and the rigorous description of three-dimensional syntax
- formal languages
    - pedagogical role
    - form generative role

formal models: the element vocabulary and rule system

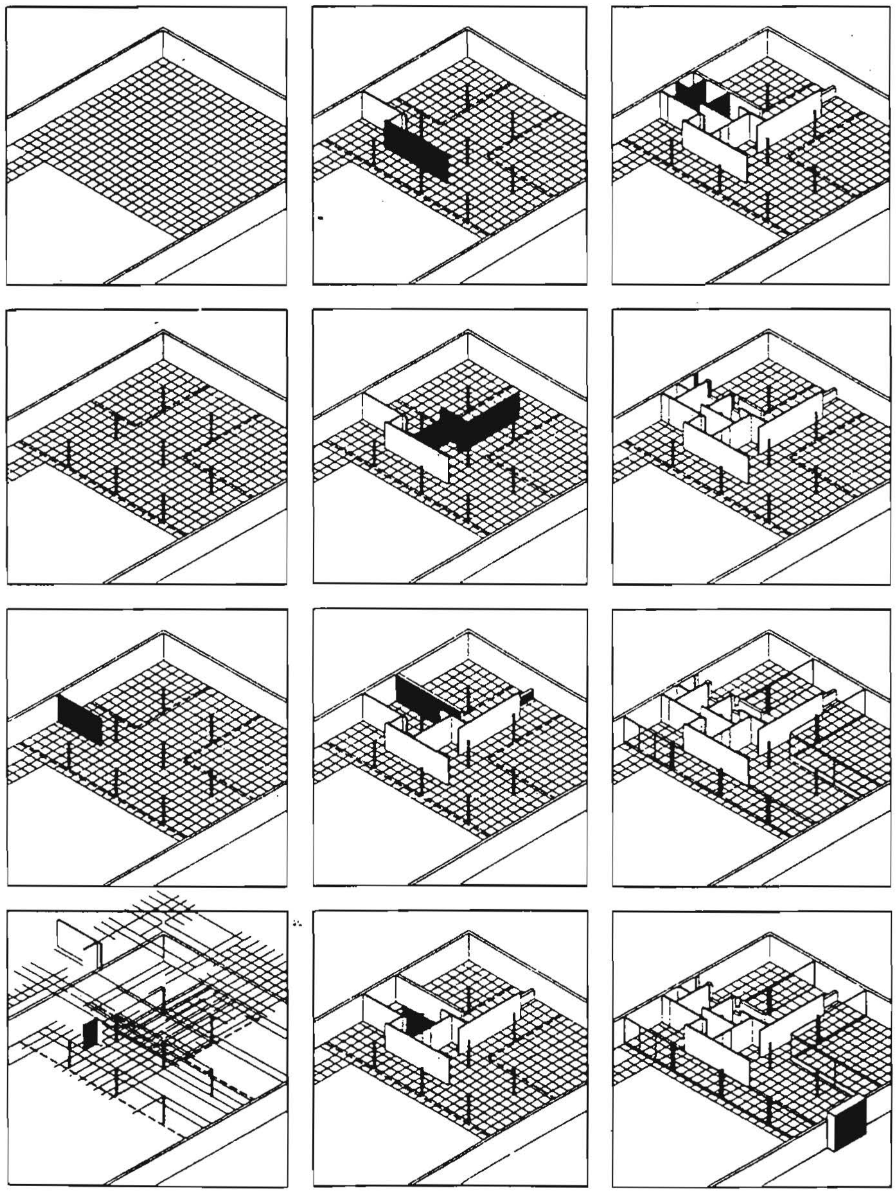
- compositional style; recurrent form

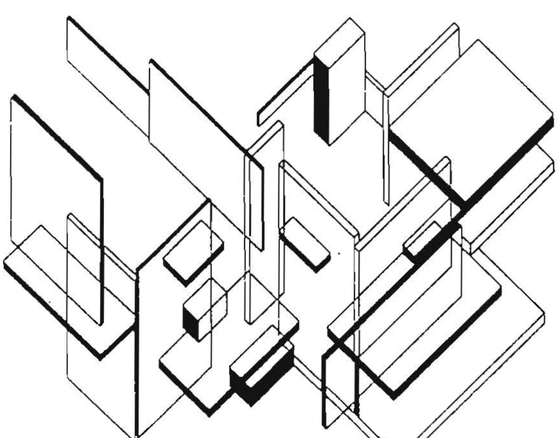
selected classes of formal models

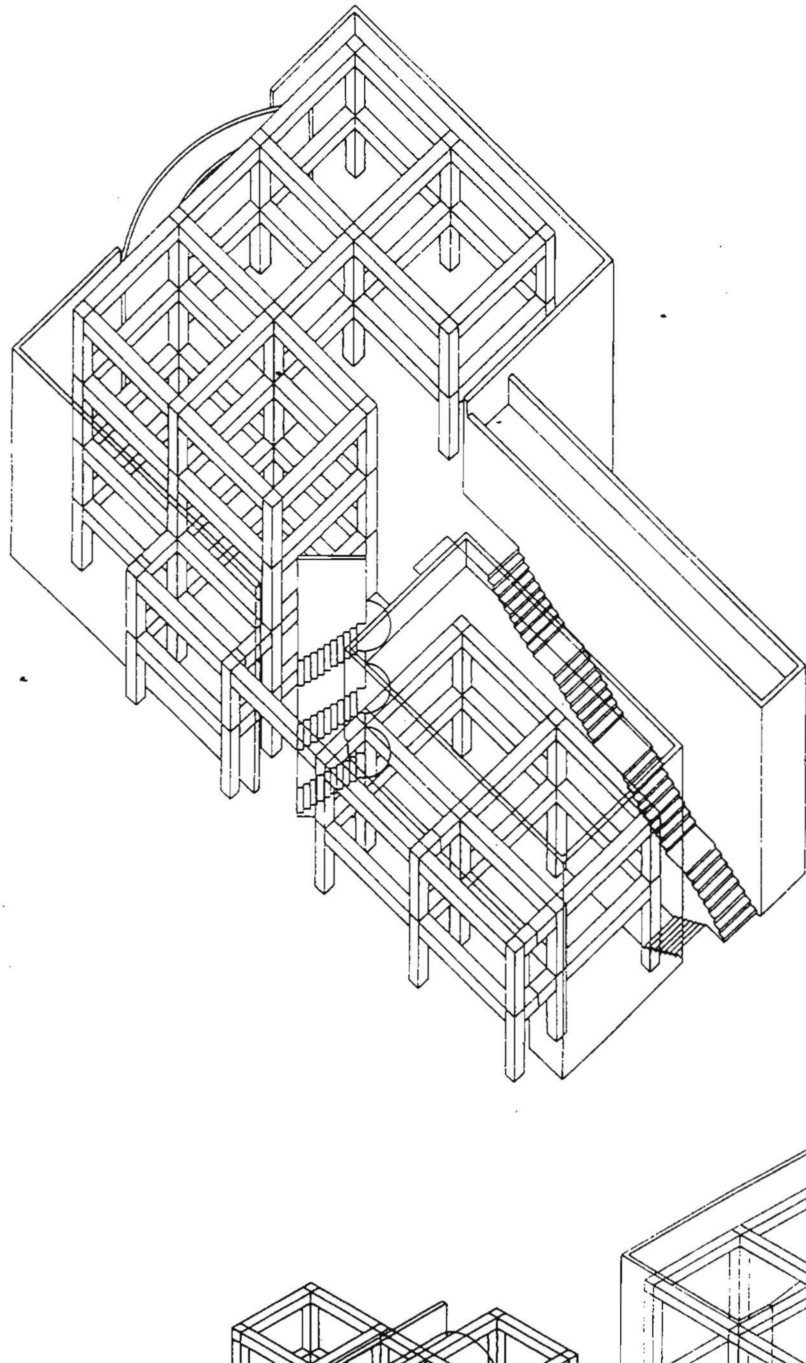
- planar architecture: plane as spatial modulator
    - wall types
    - boundaries; joint types; openings
    - Miesian examples
- mass, or volumetric, architecture
    - volumes and masses of the Beaux Arts system
    - Rational architecture: Scolari, Botta, Aida
    - plan of volumes:Loos
    - plan as generator; structured space; Kahn
    - massing and joint rules: Malevich; Soane; early Wright
- layered architecture
    - theoretical background
    - rules in vertical and horizontal layers
- grid architecture
    - expressed spatial matrix
        - structure - infill: Ando
    - the open plan as variant of grid architecture
- modular architecture
    - structuralist architecture
- hybrid formal classes

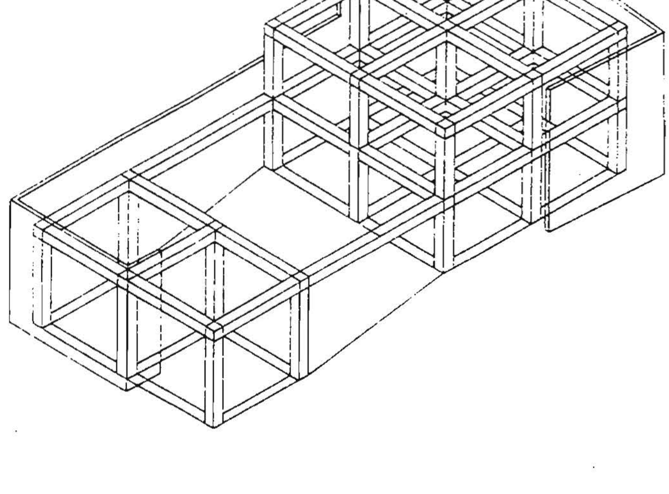
Architectural Knowledge

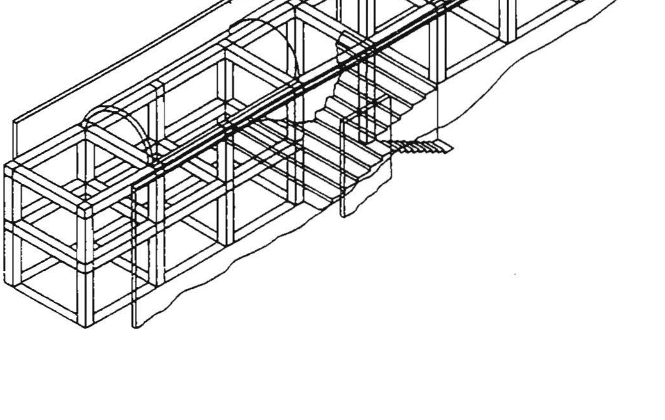
8. Formal Models

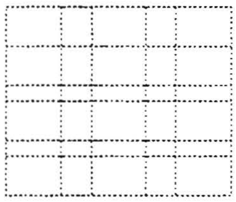




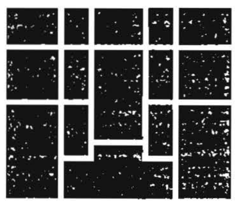




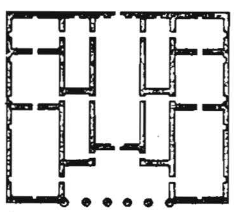




Grid



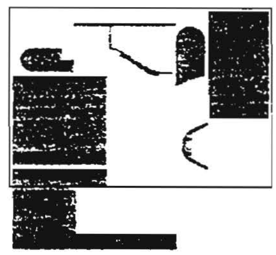
Room layout



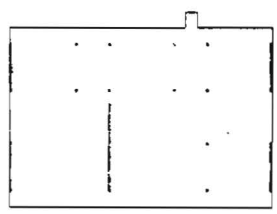
Structure

10.15
Stages in working out the details of a villa plan

Grid



Plan figures



Structure

10.16
Le Corbusier's rules lead to different development of space and structure

9. Themes

introduction: themes as generic architectural form
themes as higher level knowledge than types

Habraken: theme as mophological framework
- methodology of the theme
  - inherent logic of the theme; the rule system
  - sub-classes; variations; use capabilities; realizations
- introversion in fabric: the patio house theme
  - properties of the theme:
  - organization; typology; combinations; use; definition of basic elements

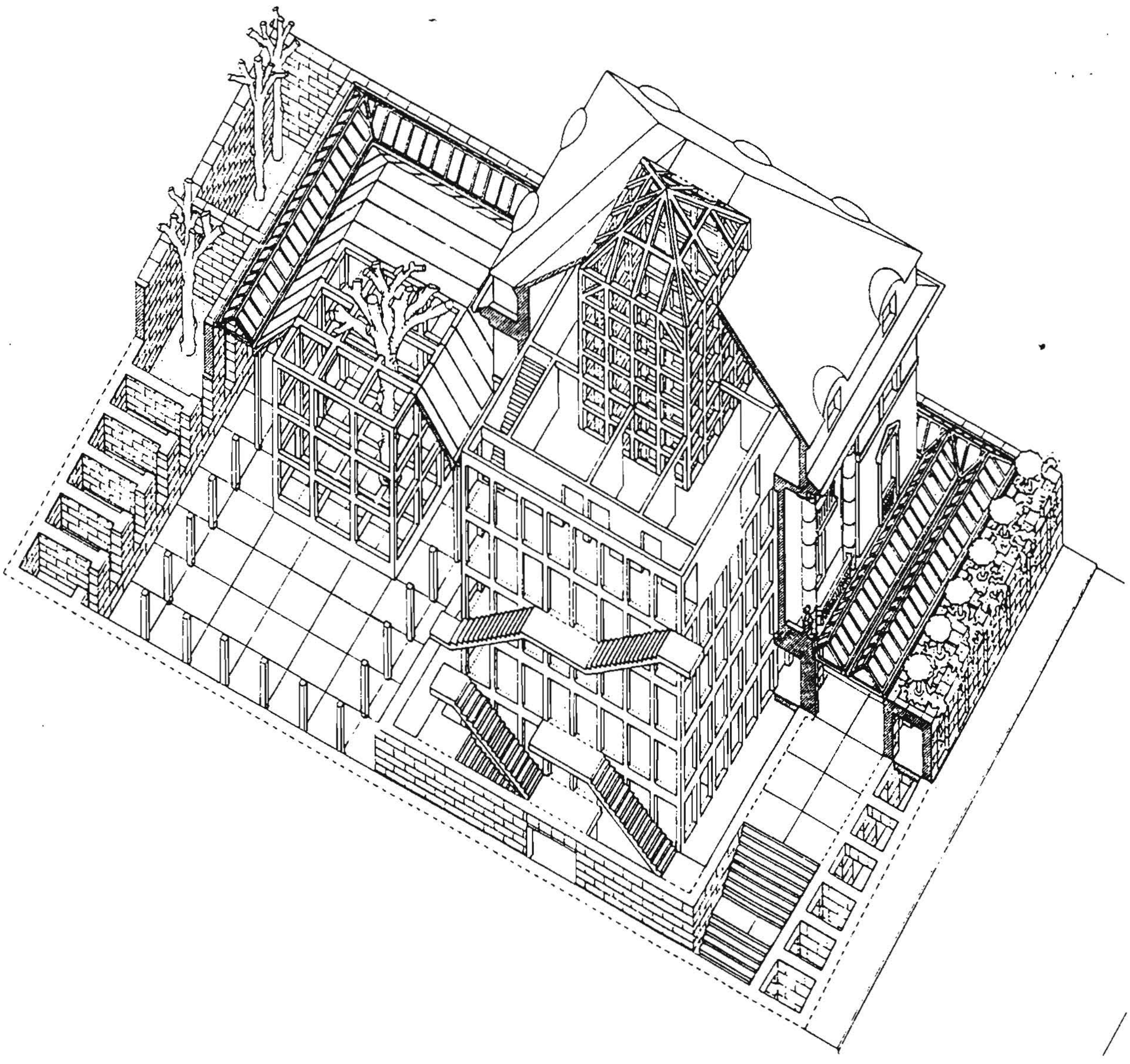
Ungers: theme as underlying principle of design
- the principle of transformation
  - transformation as an instrument of design
  - the morphological series
  - metamorphosis of spatial organizational principles; use transformation
- assemblage: the coincidence of opposites
  - composition of diverse parts; fragments; discontinuity; contradiction
- the theme of incorporation (Russian Easter egg)
  - elements of continuity; house inside a house
- assimilation: the adaptation of the genius loci
  - thematization of the architectural and typological vocabulary of place
- the theme of imagination: the world as idea
  - conceptual images, or analogy as theme
- twin houses; house as village; miniaturized copies

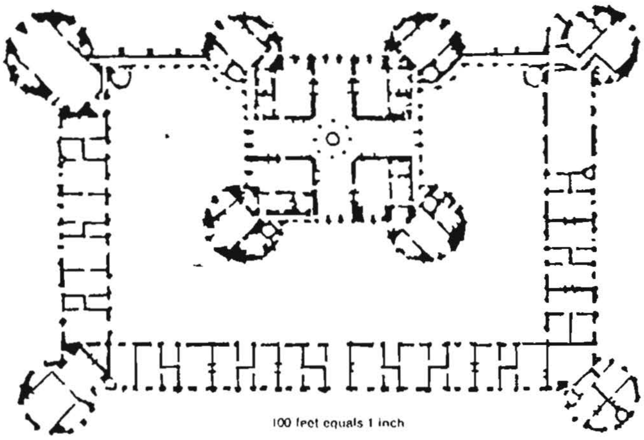
research and design; design as research
- research into precedents; rules; variants

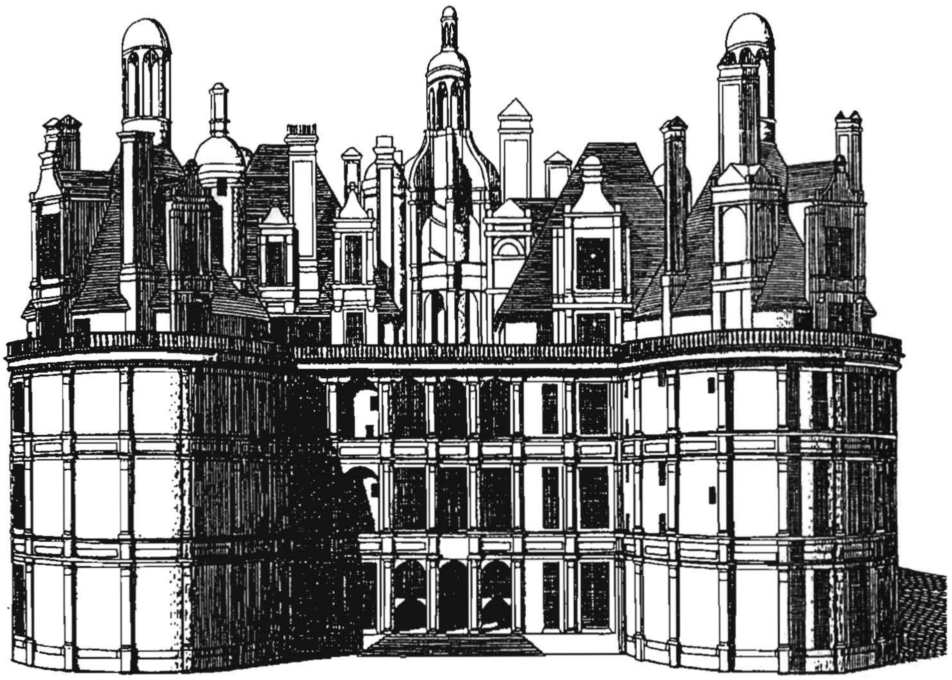
the interweaving of themes

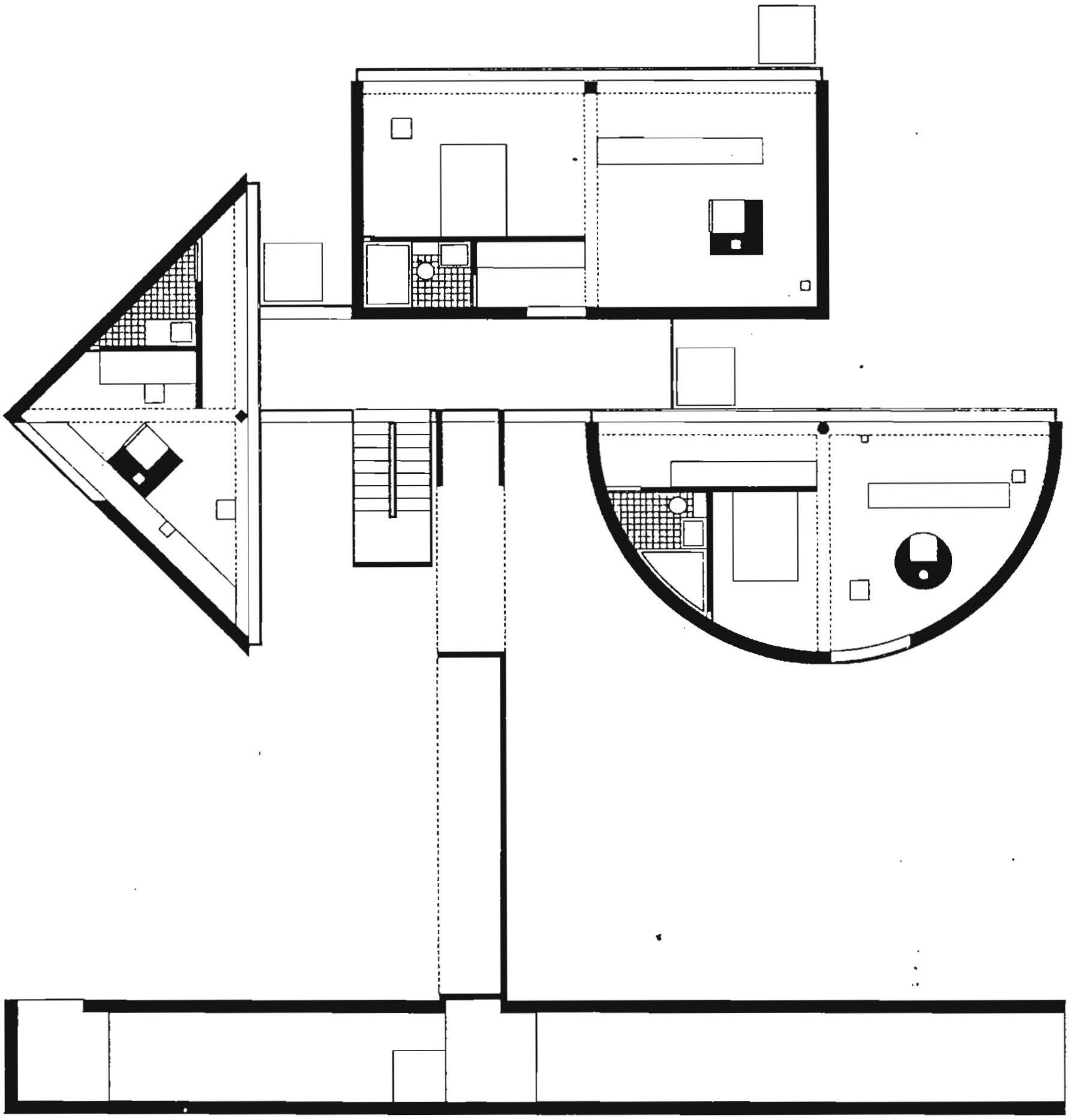
Architectural Knowledge

9. Themes




100 feet equals 1 inch





PART ONE

theme

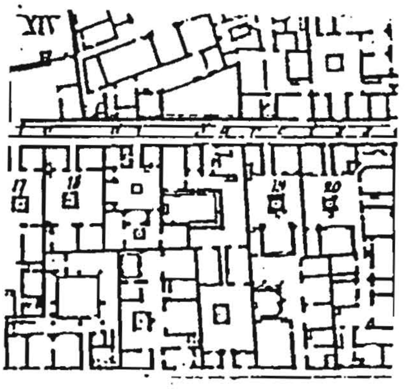
The theme is introduced by way of a well known house type: the courtyard house.

From the type the single cell is taken as the smallest spatial unit that exists in a specific relation to an outside space.

By further combinations of the cell and by elaboration of its relation to the outside the elements (dwellings, outside spaces, streets) are found that may make together an urban continuity.

1

The Courtyard type.



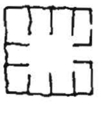
The idea of the courtyard house was first presented and discussed. The plan of Pompeii was analyzed.

What are the characteristics of this type? What principles of spatial organization are involved?

What territorial divisions are made possible by this type?

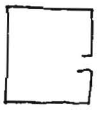
1.1

house as a cell/courtyard unit



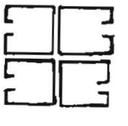
1.2

introvert closed off from outside



1.2.1

allows for back-to-back packing



10. Paradigms

The Paradigms of Design: Ways of Putting Things Together

morphology of elements; morphology of composition
additive architecture
- addition
    - vocabulary + rules
    - morphological ordering
        - linear additive types
            - single loaded/ double loaded
    - campus plans

systematic repetitive architecture
- system
- element(s) + repetition rules
- major and minor
- dominant repetitive function

the orders of subdivision
- subdivision of wholes
    - underlying pattern as archetype; geometric figure as subdivision
        - bi-nuclearity, bi-polarity
        - vertical separations

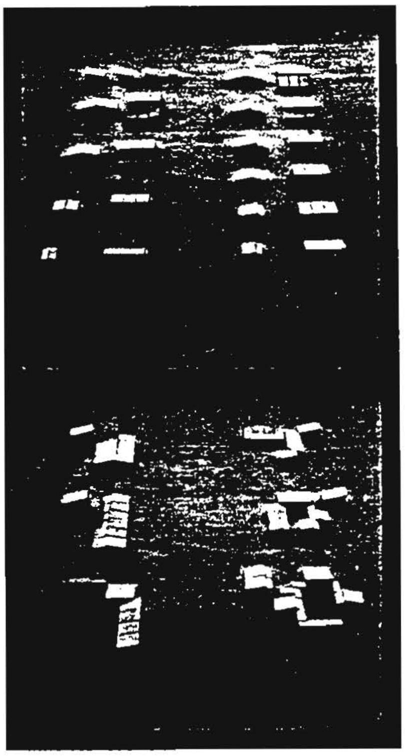
centrality and cluster
- the great space
- multi - nodal
- the spatial sequence

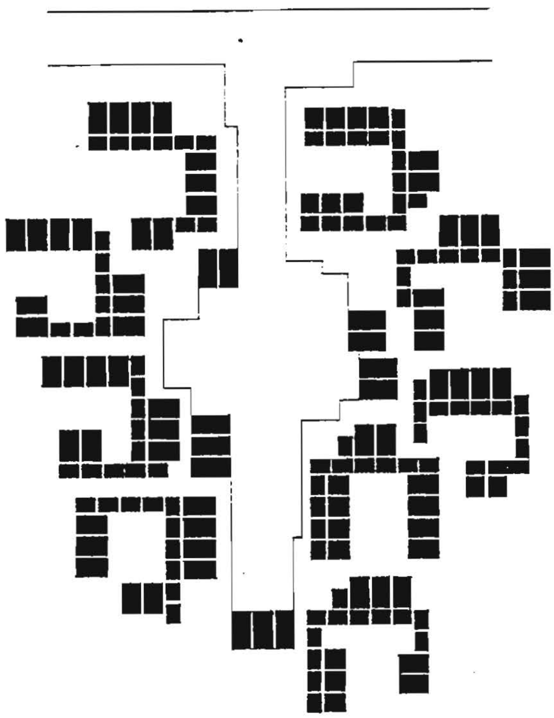
inside - outside
- maximum transition at boundary
- outside on inside

dominant orientation
- front - back

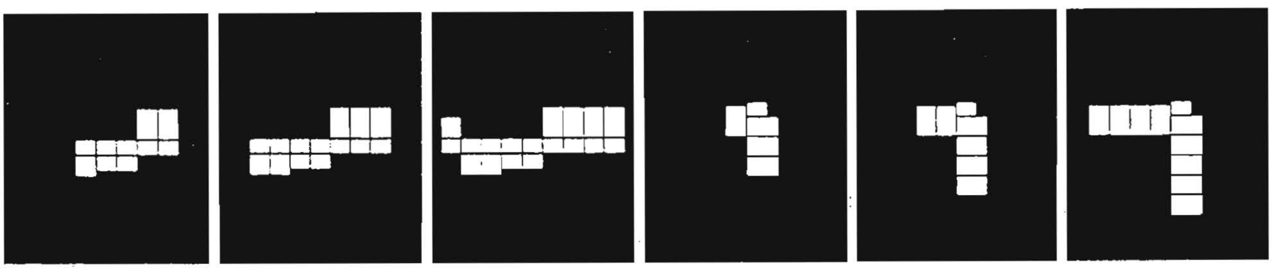
analogies and hybrids

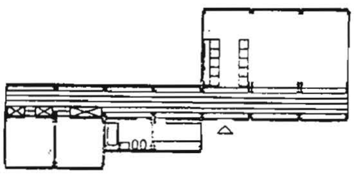
Architectural Knowledge
10. Paradigms

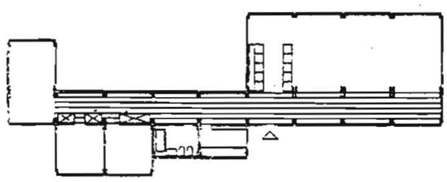




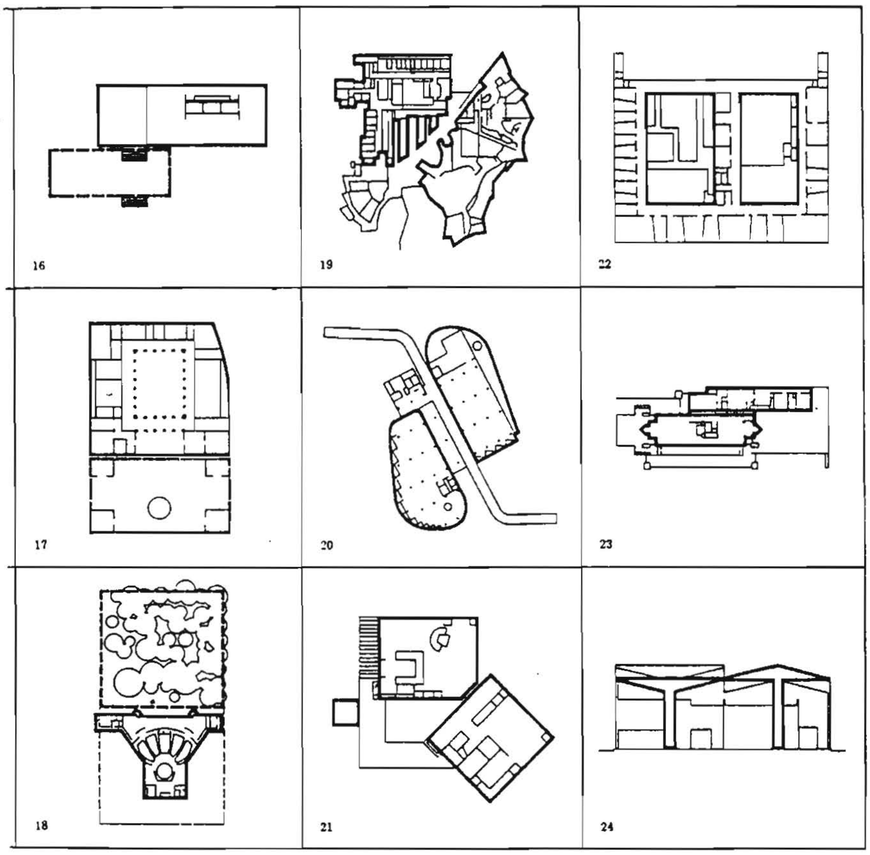
■ *Individually designed houses, forming part of a group which, in spite of major variations in layout and facade design, will form an integral unit because of the kinship of the forms recurring in all the houses.*

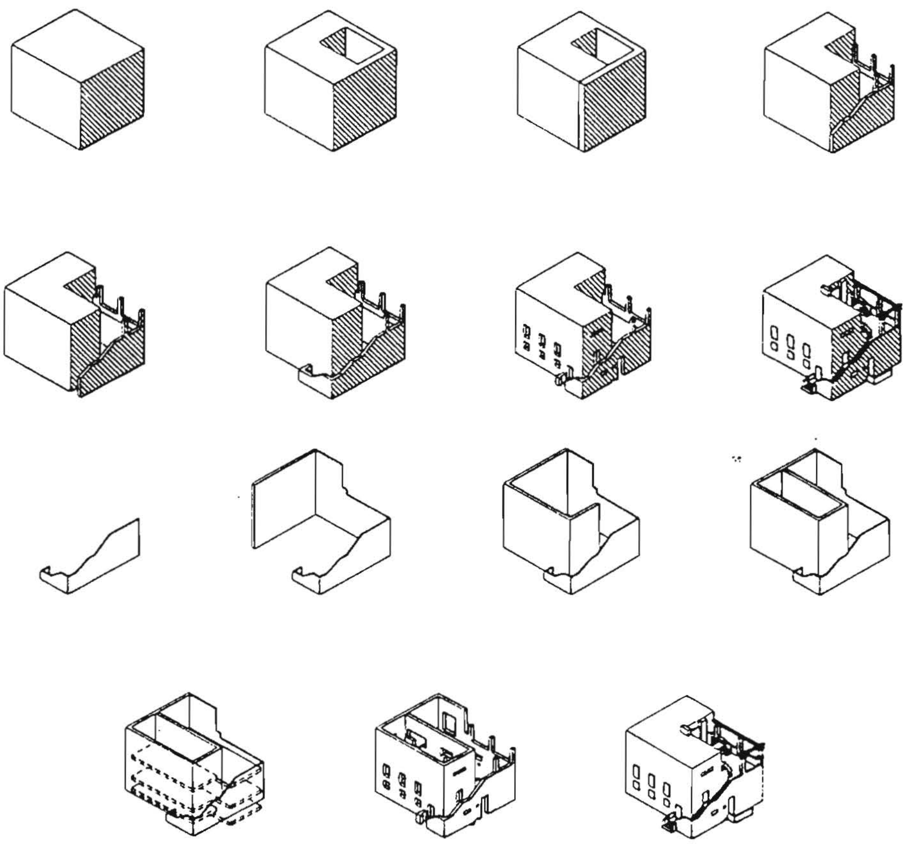






16. FARNSWORTH HOUSE
LUDWIG MIES VAN DER ROHE
1945–1950
17. THE AMERICAN ACADEMY IN ROME
McKIM, MEAD, AND WHITE
1913
18. POWER CENTER
ROCHE-DINKELOO
1965–1971
19. DIPOLI CONFERENCE CENTER
REIMA PIETILIA
c. 1966
20. CARPENTER CENTER
LE CORBUSIER
1961–1963
21. NORMAN FISHER HOUSE
LOUIS I. KAHN
1960
22. LANG MUSIC BUILDING
ROMALDO GIURGOLA
1973
23. FREDERICK C. ROBIE HOUSE
FRANK LLOYD WRIGHT
1909
24. EXHIBITION PAVILION IN ZURICH
LE CORBUSIER
1964–1965





Design Knowledge

An Introduction to Design Processes and Heuristics in Architectural Design

This section introduces the procedural aspects of designing. Basic concepts such as constraints and situations are introduced, and their possible role as operators of modifications in knowledge structures is suggested. Levels of design heuristics in architectural designing are proposed from typified moves through the highest level of heuristic strategies. In design heuristics architectural knowledge as the content which is manipulated.

11. Constraints and Situations

12. Introduction to Design Heuristics

13. Precedents: the Use of a priori Knowledge in Design

11. Constraints and Situations

constraint-based reasoning: control in selection and generation

- architectural design constraints
  - relational constraints
  - minimization; optimization: goals and constraints
  - conditional constraints: if-then
  - functional constraints
  - design constraints: net -to - gross ratio
  - symbolic constraints
  - privacy
  - territoriality
  - problem scale
- typification of constraints
  - functionalism as constraint-based design paradigm

situations: the syntax and semantics of sites

- situation
  - formal syntax of sites
  - geometry and size
  - slope and topography
  - directionality: access, orientation, views
  - service
  - physical factors and plant materials
  - climate and time -related factors
- context and place
  - boundaries: open; closed; scale interaction
  - architectural character; scale
  - urban form; spatial types
  - immediate physical context
  - extended context : character of place; genius loci; contextualism; making place
- typification of situations

12. Introduction to DesignHeuristics

design moves: basic operations on elements

- symmetry operations: stringing, flipping, rotating
- operations of replacement and modification: replacement, scaling
- transformations
- subdivision rules

design procedures: compositional or syntactic procedures

- vocabulary of syntactic procedures
  - sequences and nested procedures
  - hierarchical subdivision
  - vertical separation; zoning
- compositional order
  - geometrical ordering media; gestalt
- compositional languages and styles
  - extrusion
  - layering and transparency: slippage; overlapping; interpenetration; shear

heuristic strategies

- generate and test
- breadth first versus depth first
- bottom-up
- top-down: generic design; refinements: top-down addition of levels of detail
- space to material; material to space
- decomposition and componentizing
  - space first
  - dominant element first
- relational constraints design: from inside -out
- formal constraints design: from outside-in; formal language as heuristic

- **design paradigms**
  - heuristics, procedures and moves as defined by and fitting to the paradigm
  - heuristics without paradigms

- **hybridization; fragmentation; adaptation**

13. Precedents: the use of *a priori* knowledge in design

selection of precedents

- typification
  - problem- program typification
  - situation-context typification: organizational,spatial,climatic types
  - analogy - multiple analogies - fixed analogies : Utzon

mechanisms of variations within typological schemata

- theme as constant and variation
- strategies of variations:
  - modification ; replacement ; transformation

geometric orders as organizational or compositional system

- spiral museum; Durand's systems of refinement

theory of precedents

architectural knowledge of precedents

- formal elements
  - element vocabularies and ordering principles
- types
  - knowledge, rules, and heuristics of the type (grammar of the type)
  - typological design: selection, adaptation, refinement, hybridization
  - sub-type; new type
- languages and grammars
  - procedural grammars versus descriptive languages
  - language and style - classical language and variations
- formal models
- themes
  - theme and variations
- paradigms
  - paradigms of planning
  - functionalism as a design paradigm

urban form and architectural form

- urban analogies; urban formal morphology; archetypes

The plan of the ESTEC-building, by Aldo van Eyck

The purpose was to find the principle of ordering of the plan, the typology of the plan, and how in this typological form spaces exist. It appears that the form is not as forcing towards the space as it seems at first view.

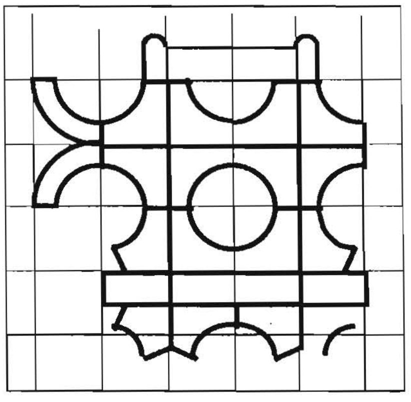


fig. 1 - The form of the shape placed on a grid. It is basicly a composition of circles and circle-parts, inclosing the space. This principle is not sufficient to see what happens.

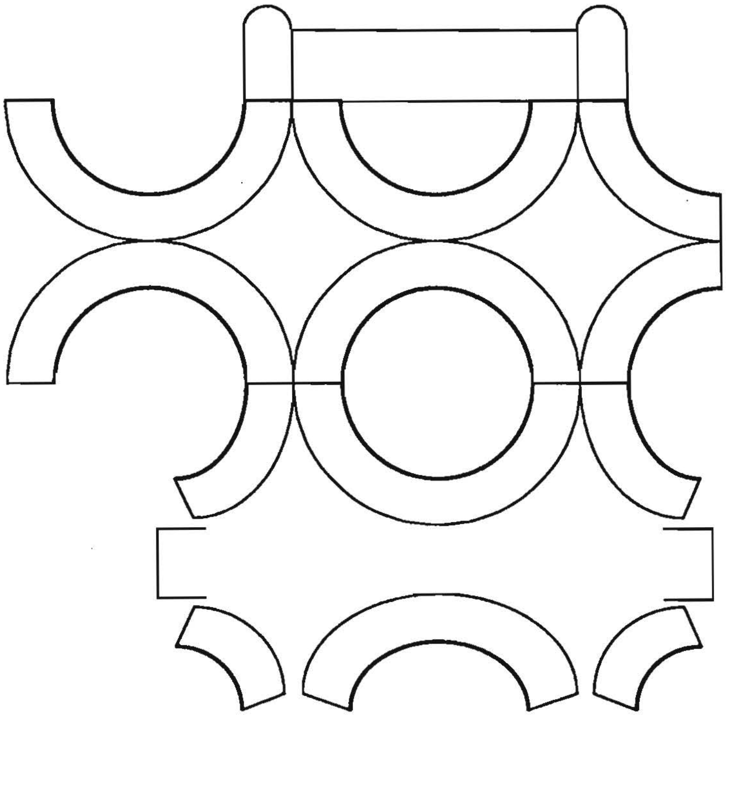


fig. 2 - The form is represented by tire-shaped circle-parts placed against each other. The remaining square-shaped spaces are the spaces where the activities start, which happen in the building. In these square spaces any form can be placed, this form can slip in or through the tire-shaped area. It is the spaces between the tire-shaped circle-parts which give the building its measure of frankness.

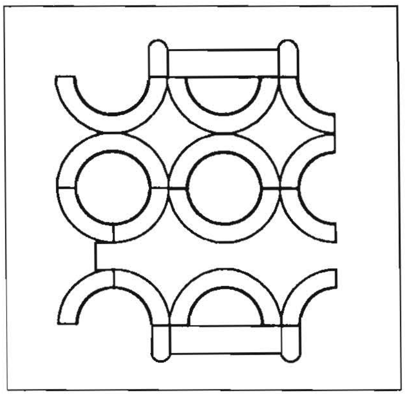


fig. 3 - The inner spaces are more enclosed by the tire-shaped forms which gives the building a more closed character than the original.

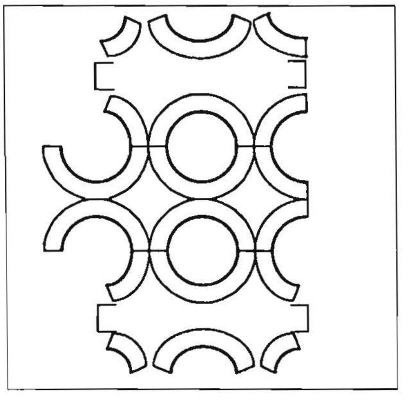
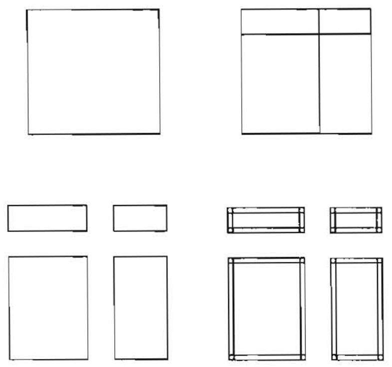


fig. 4 - The inner spaces are more open, this gives the building more frankness than the original.

Stefan Dezaire
Allard Nabben

SUBDIVISION & TRANSLATION

with the CUBE



We believed in an elementary approach, as starting modeling in a simple way may make things most clear.
So we took a very basic element: "The Cube", here 5 x 5 x 5 m.
We chose two basic modeling-tools during the workshop we started together: subdivision and translation.

By cutting the cube in pieces wich different sizes, using the proportions 1, 2 , 3 and 4, and this in x, y and z directions, we got 8 different masses. By using these numbers, every number is used, and this in all directions. Now we translated each part 1 m from the other, this to enable every part to exist on its own.
In order to get a more architectural object we cut every mass on the edge with 0,2 m.
This gave us the idea to group the elements into 6 different layers: corners, girders, floors, walls, columns and innermass. It gave the oppurtunity to treat each group separately in the next process.

We concluded that with very simple operations you can get very quikly a great number of different elements, and that the computer lets you choose the operations to build into the program: the more you do, the more there is to choose.

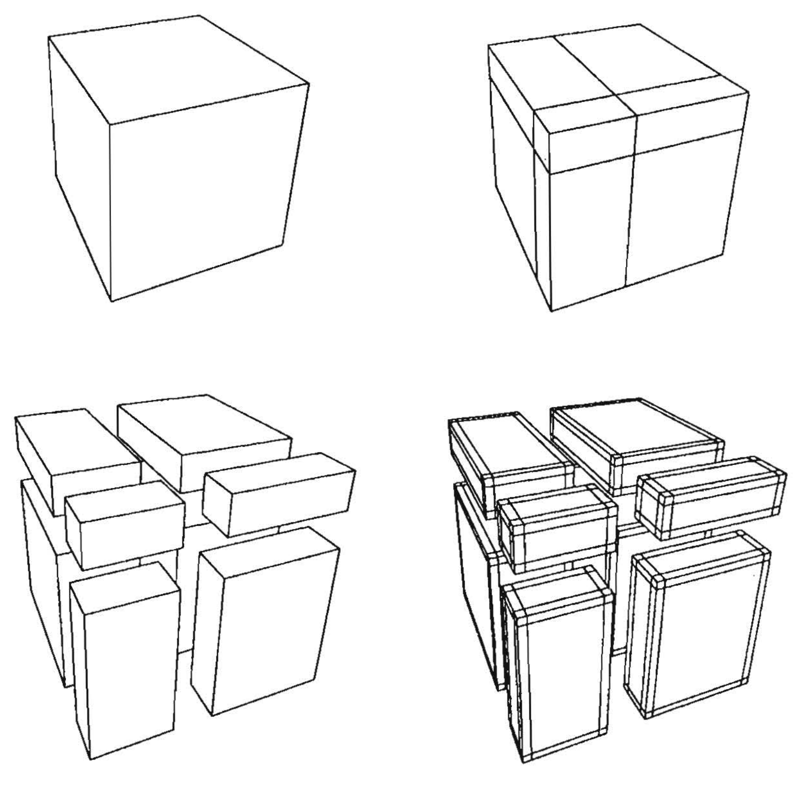
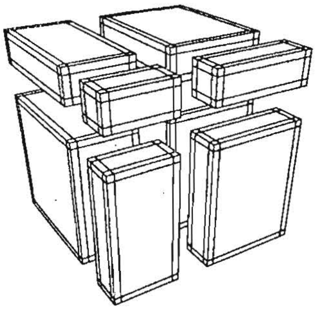


fig. 1 - Cube
fig. 2 - Subdivision in 8 masses
fig. 3 - Translation of masses
fig. 4 - Subdivision in elements

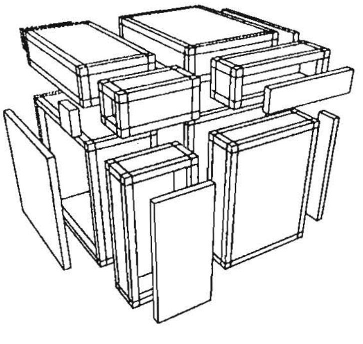
TRANSLATION & CONNECTION

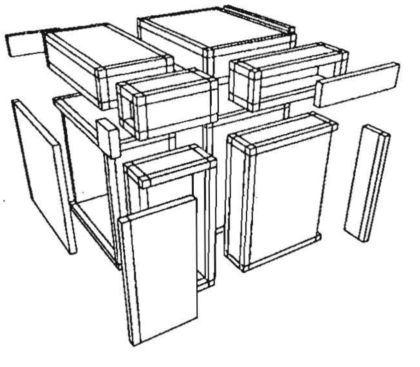
with parts of the CUBE

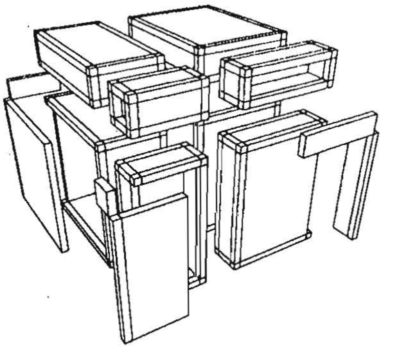
fig. 0 - Starting-point
fig. 1 - Wall translation
fig. 2 - Column connection
fig. 3 - Upper wall lowering
fig. 4 - Floor connection
fig. 5 - Girders translation
fig. 6 - Girder connection

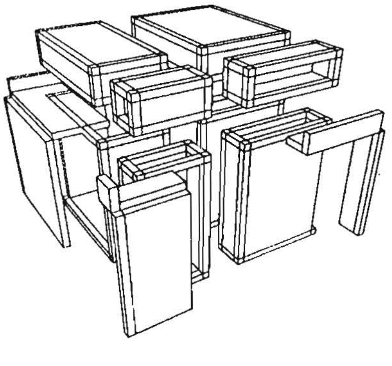


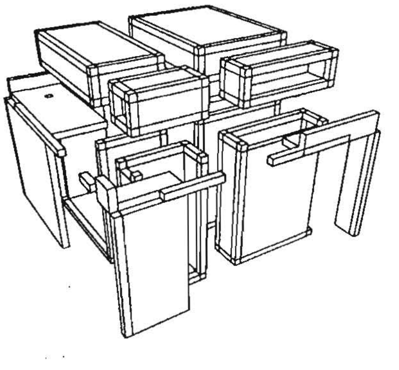
256 elements were enough for me to say: stop the cutting into pieces (= subdivision) from now on. Although I wanted to continue in this abstract way, I tried to make the object more architectural. (in the end that 's what it 's all about ?!) By moving different elements within each group (translation), remember the layersystem, and letting them touch other new elements (connection), I hoped to get another construction, but still the cube somehow visible, in a deconstructive way.
Steps:
0: Removing the innermass, this is a non-visible operation, I did this to get space inside the walls and flooors.
1: Moving the walls, alternating the upper and lower ones (to get variation)
2: Connecting the lowe rcolumns with the lower walls, which were moved.
3: Lowering the upper walls, which were moved, untill the new corners.
4: Connecting the floors with these corners.
5: Moving the girders to the sides.
6: Connecting the girders with the corner upper-walls.
Now the corners are connected with each other by these girders.
Here I stopped, this principle was clear enough, of course one can go on from here, but isn 't that true for every design-process.
It 's funny and interesting that by very simple operations and steps one can get a rather complex image in the end.

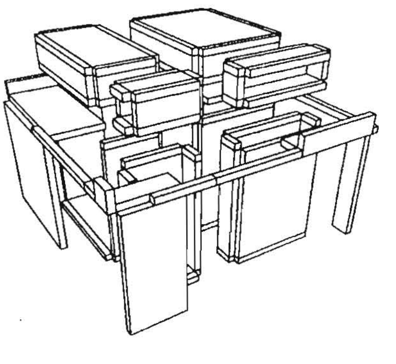






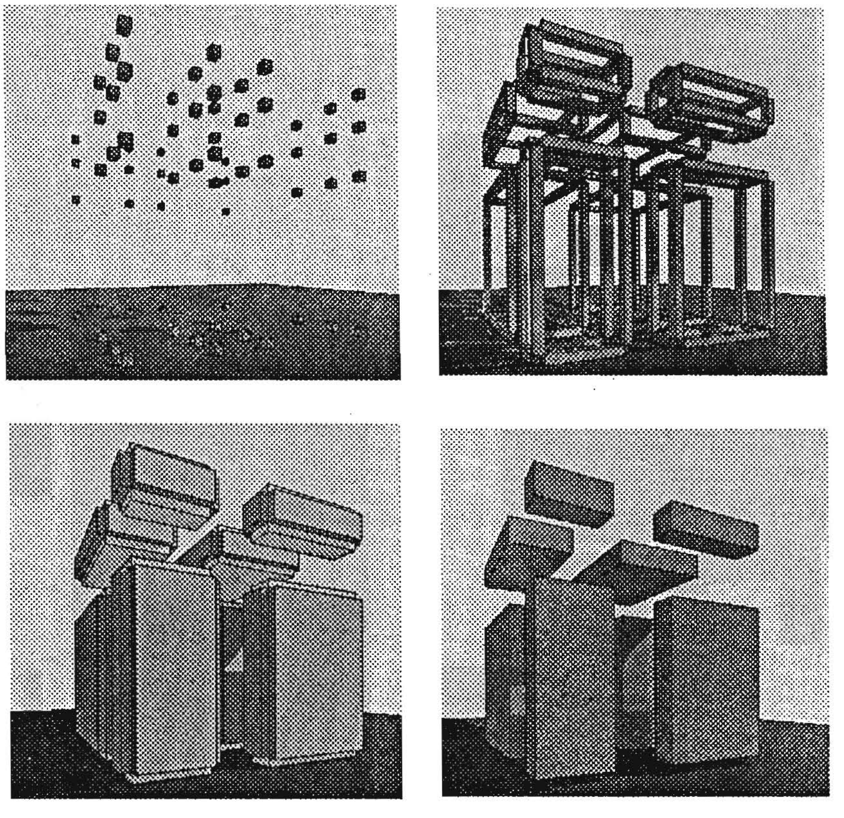






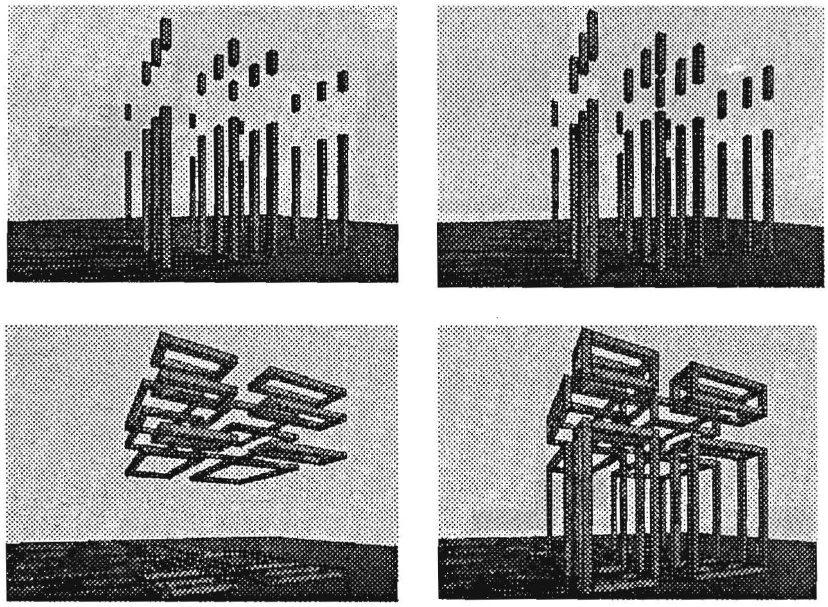
LAYERING & VIEWPOINT of the CUBE

The program "Architrion" asks for blocks. It is therefor not coincidental that Stefan Dezaire and I have come to the analysis of the block. The most primitive block is the cube because it has ribs with al the same length.
The question of form can always be turned back to a question of points, lines, surfaces and/or masses, the elementary four.
I stated and/or in the last sentence because in same cultures they don't think in those four mathematical primitives but they only see the surface as a basic element in composition (for instance the Japanese paper walls). My goal is now to analyse the created follie by putting on and off layers. For "Bauhaus" tells us: "Analysis of the parts leads to composing of forms."

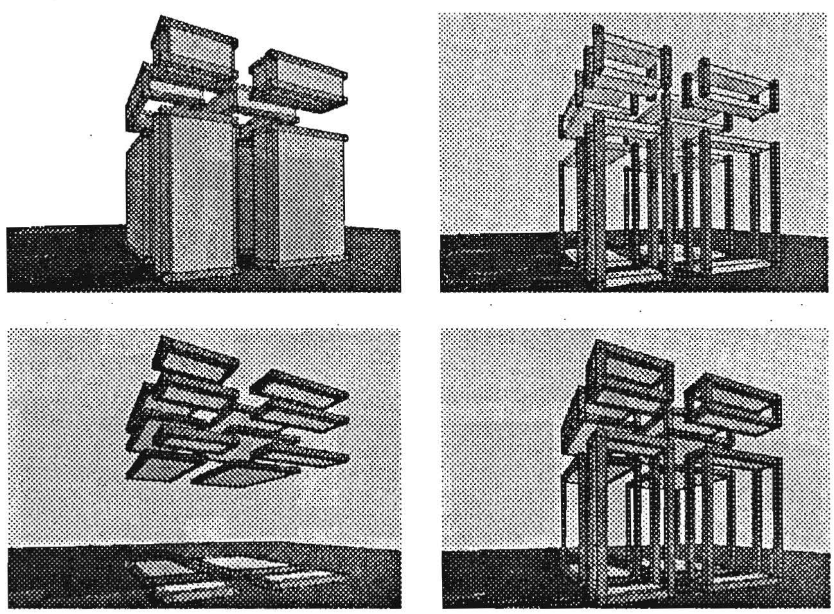


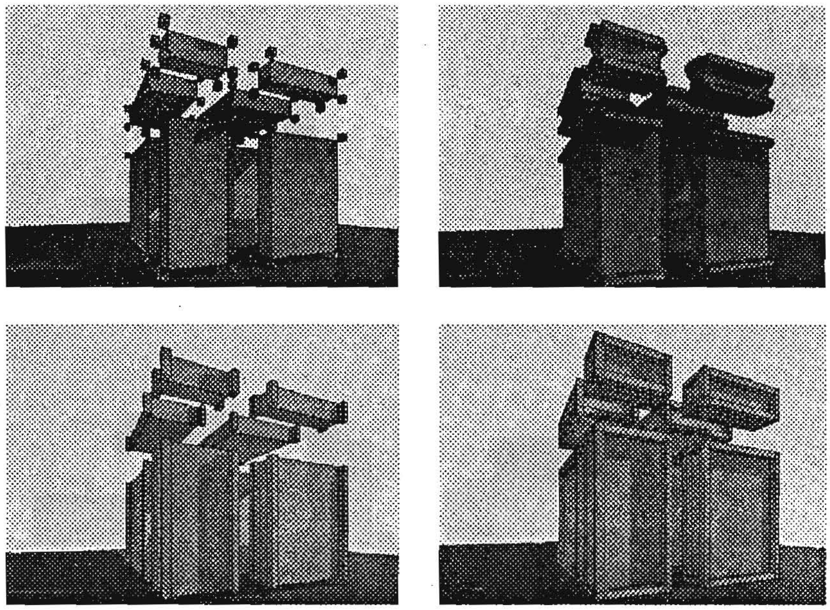
I chose the viewpoint so that a man standing or walking sees the composition as cube with ribs of 5 meters. In figure 1 you see pictures of the four elements of the cube seperatly.
I created six layers; Points, Columns, Beams, Floors, Walls and Masses. (Columns and beams are the ribs, and Floors and Walls are the Surfaces)

In the folowing pages you see a lot of examples that arise by putting on and off of layers, and so different structures and compositions are revealed.

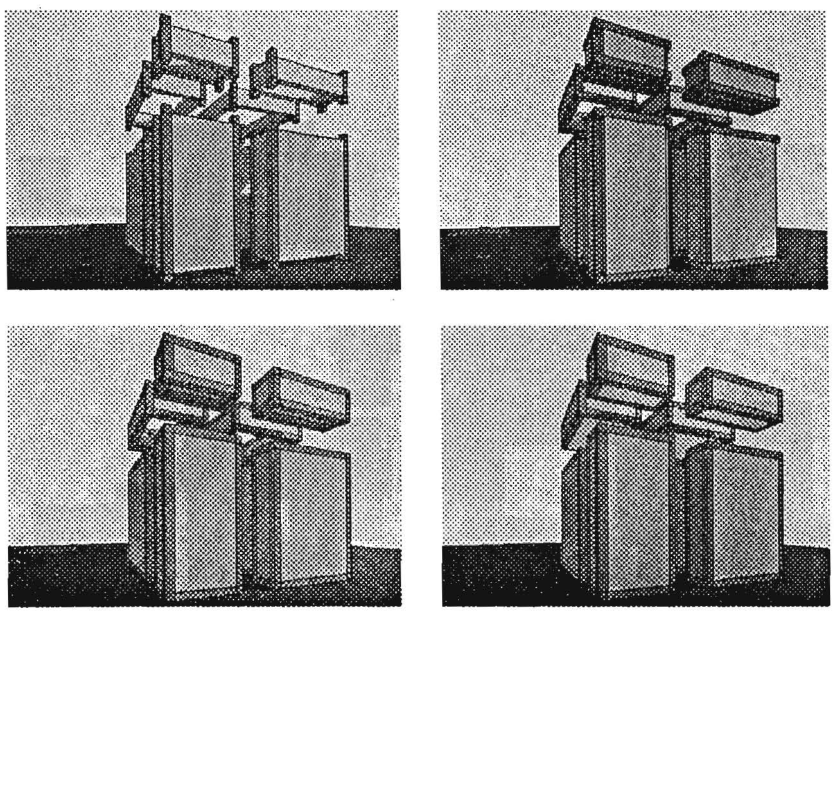


The pictures above show a play with points and ribs, while in the pictures below several surfaces are added.

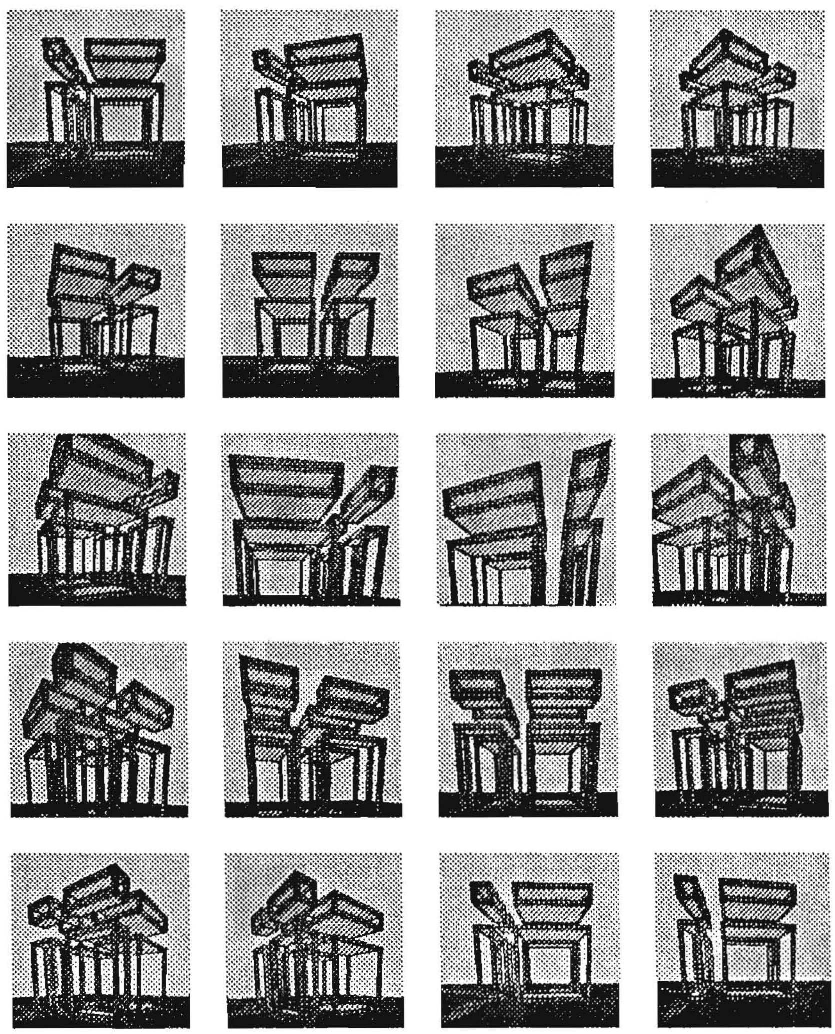




These pictures show variations that are more or less comparable with the proportions of familyhouses. In the pictures above the result is achieved by the masses, while in the pictures below the surfaces play the most clear role.



By choosing a right viewpoint you can analyse the forms in relation to man. Like Hugo Alvar Henrik Aalto says: "The ordinary room is a room for a vertical person; a patient's room is a room for a horizontal human being and colors, lighting, heating and so on must be designed with that in mind." In "The Humanizing of Architecture, 1940". And also in his plan of the Arts Museum at Reval the special layout shows a very strong connection with viewpoint analysis; the museum affords the visitor free choice as to which section he would like to see by showing a glimpse of it.
I tried to illustrate the use of viewpiont analysis by walking around the object with the layers: points, beams, columns and floors on.



THE ONION PRINCIPLE

Rings as an organizational principle in Kahn's Exeter Library

Reaction workshop Joy of Syntax novembre 16 1990

Dear Robert and Rivka,

In your workshop Joy of Syntax we worked intensely for one week, and now we have to finish the exercise as soon as possible. Although that asks a lot organization of one's study-program, it is very nice to concentrate in this way on the subject. It needs that, because it is a difficult subject: the workshop was not only meant for students but also for the teachers of our department, and a student's background in form theories, design methods and computer applications is not so big. Furthermore we had not been introduced to your ideas and work. I think it would have helped, if we read, for example, "The Language of Architectural Plans" before the start of the workshop.
Finally I want to say, that although, I fear, I have not understand half of your story, the workshop lifted a corner of the veil of the world of form. I am used to think in meaning, function, demands and constraints; the concentration on form is new. The workshop gave means to analyse designs on form and I hope that will help me generate designs better.

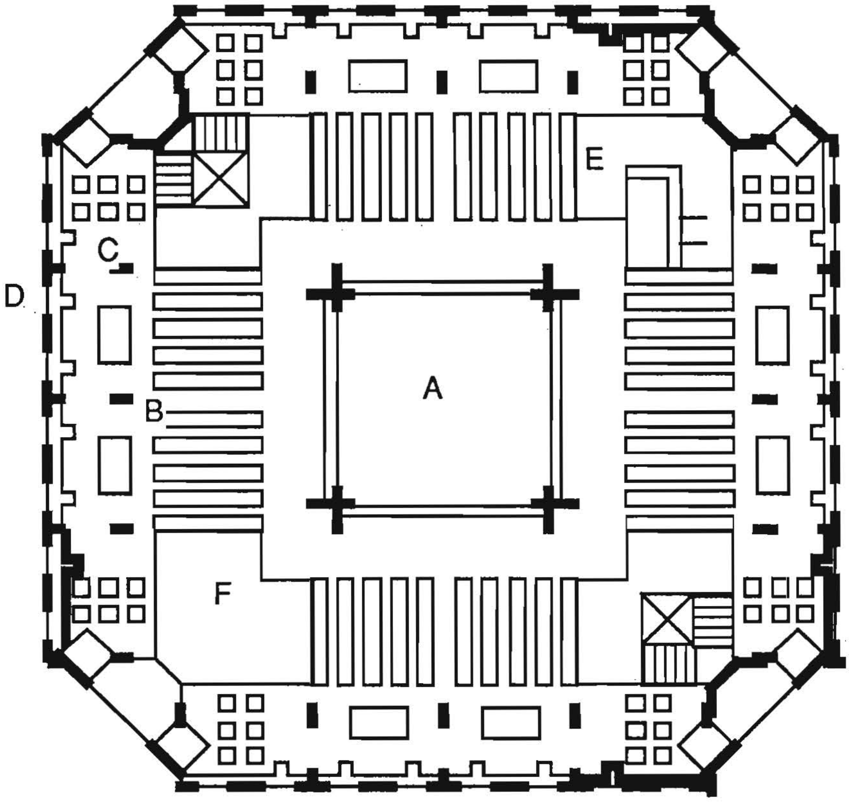
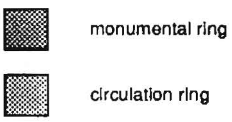


fig. 1 - third floor plan Exeter Library

A - central space
B - book stacks
C - reading area
D - carrels
E - toilets
F- special room

When I tried to analyse Kahn's Exeter Library, I took the most regular floorplan, which is the third (fig.1). I recognized a concentric layering based upon the square. This I called the onion principle. The central space is the core, round which several rings are grouped. They are named respectively: the monumental ring (a thick concrete wall with huge circular openings), the circulation ring, the knowledge ring (which contains the book stacks), the study ring and the shelter ring (the construction which keeps the plan together).

First I analysed the compositions of the several rings: what elements can populate them and what elements are essential (fig. 2 - 13). For example the reading area is essential to the study ring, but the row of carrels is not. Because it is built inside the facade, it can be an element of the shelter ring too.



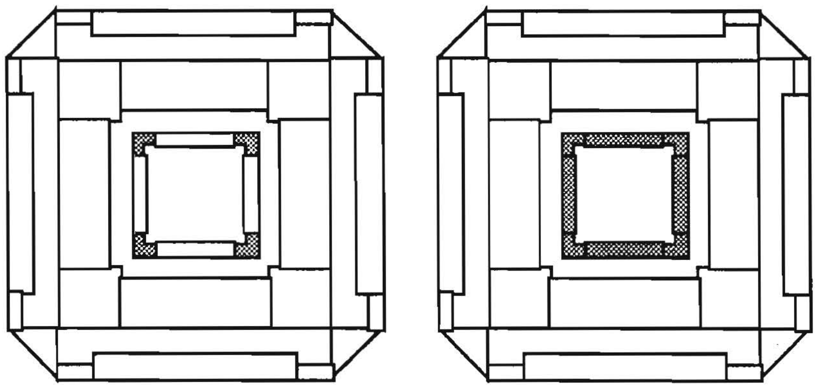


fig. 2,3

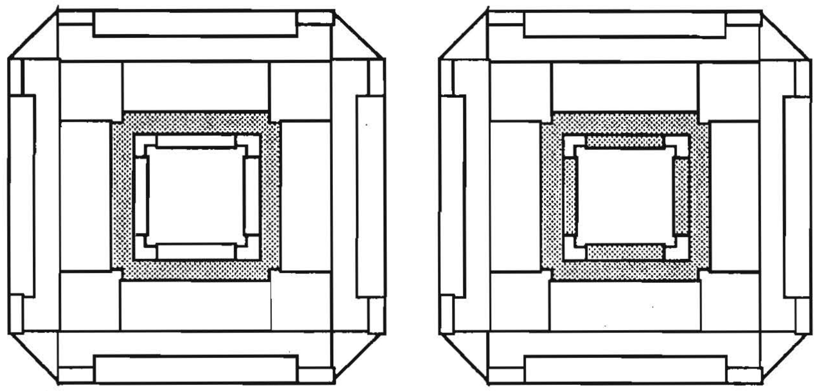


fig. 4,5

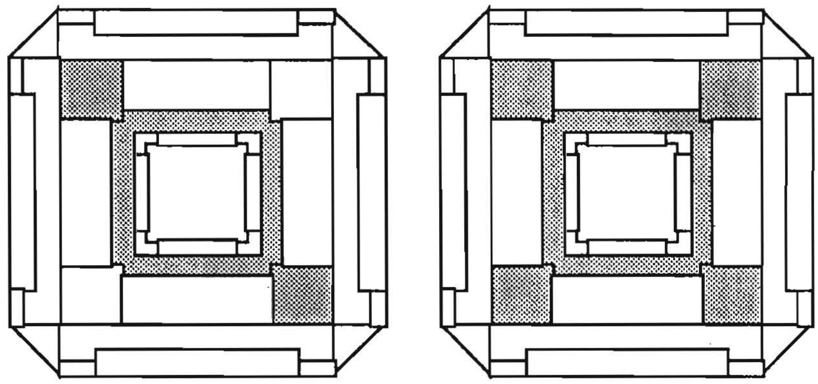
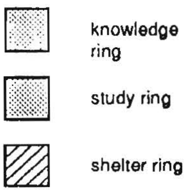


fig. 6,7



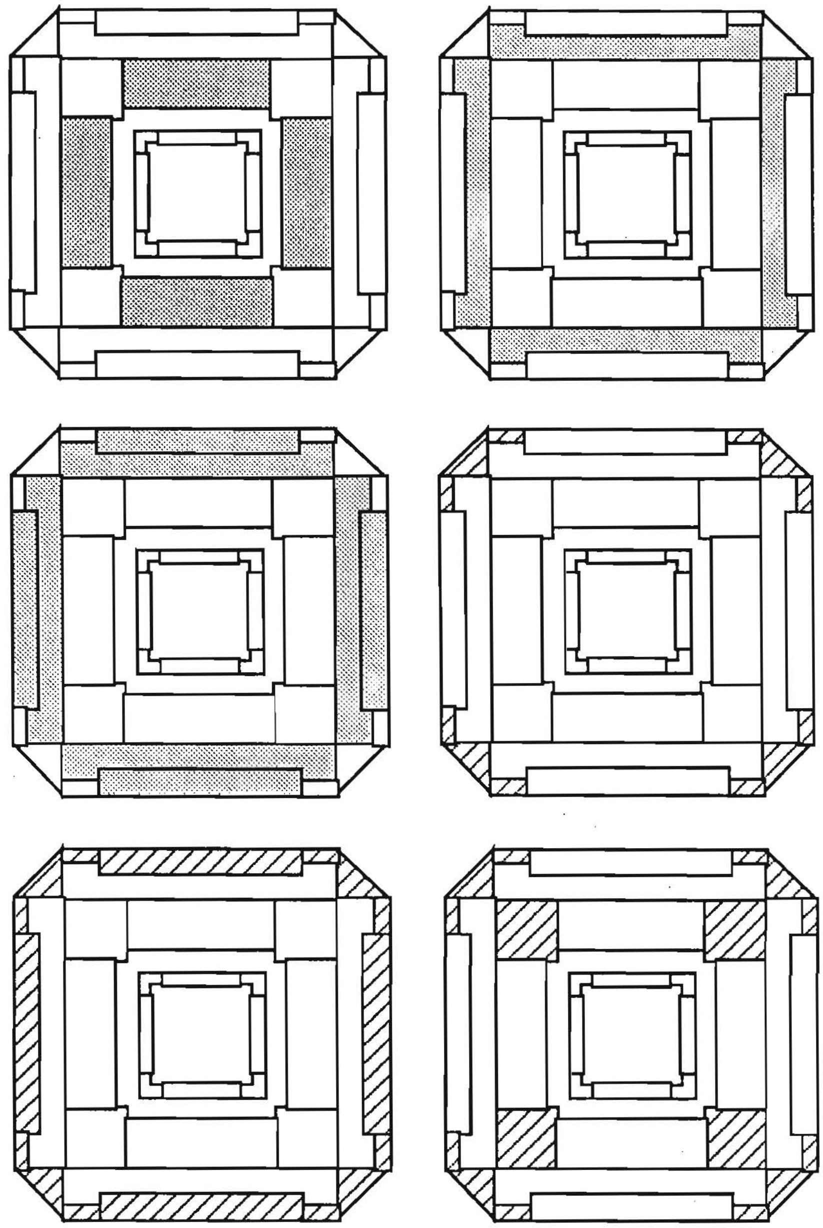
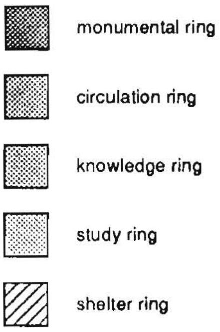


fig 8 - 13



After this analysis I combined the several conceptions of the rings to compose alternative models, which describe Kahn's floor plan (fig. 14 - 16). Each of these models has its own set of rules, which determines the model, and makes alterations possible. Alternative A sticks to the surrounding character of the ring as good as possible. Alternative B makes the rings penetrate each other as much as possible. And, actuated by the two stair and elevation elements, alternative C introduces a deviation of the rigid symmetry rule.

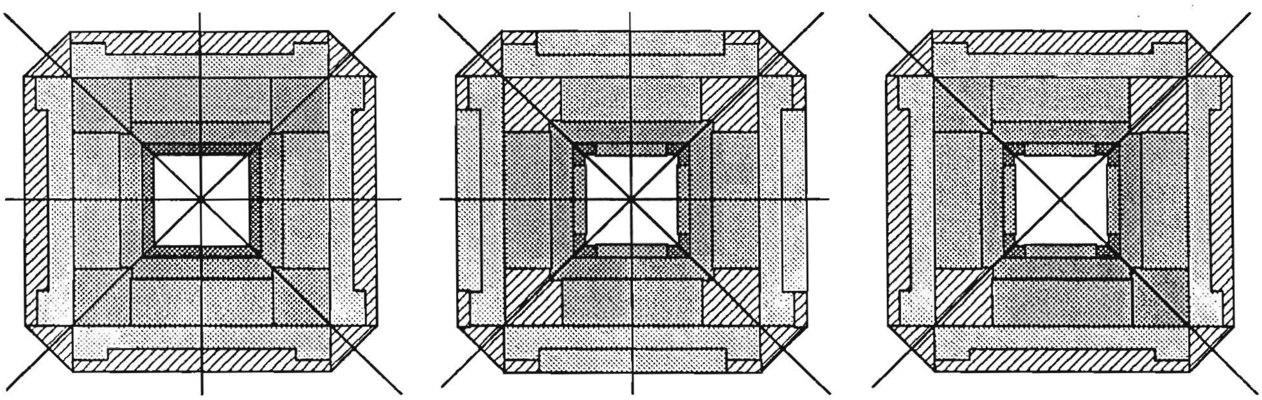
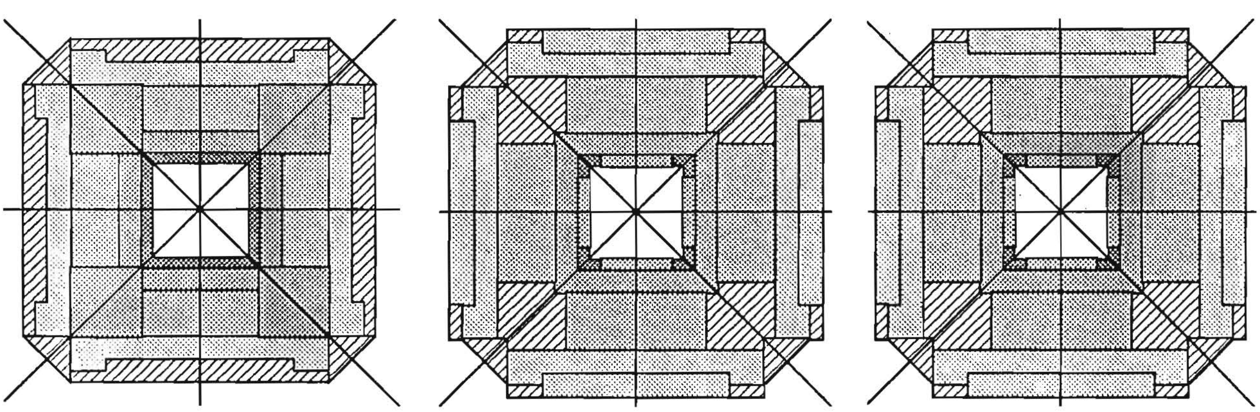
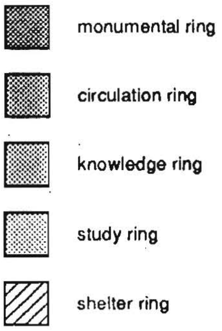


fig. 14,15,16

The alteration I chose, was the enlargement of the toilet element. According to their rules, alternative A and B had to enlarge four, alternative C only two elements in the floorplan (fig. 17 - 19). As a result alternative C had changed the square plan into a diamond one, and thus attacked the plan completely. And, because the shelter ring keeps the floor plan bound up, the fixed alternative A could not bear the alteration without losing the plan's lightness. Alternative B, I concluded, describes Kahn's plan best.

fig. 17,18,19





At that point I could reconstruct the growth of the scheme. Kahn had started with the organization principle of a square and three symmetry axes (fig. 20). The vertical axis determined the onion principle, and gave birth to the five rings (fig.21). And, because these rings were square, they were naturally partitioned into corners and intermediates (fig. 22). And here originates the possibility to make the rings penetrate each other: a ring can withdraw to its corners or its intermediates, and another ring can take over the remaining parts. In this way the model of the plan (B, fig. 15) came into being.

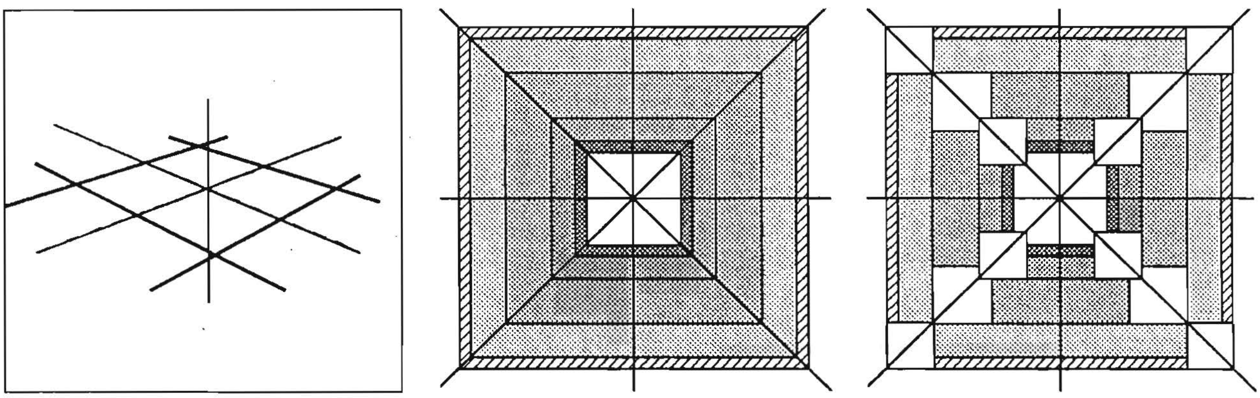


fig. 20,21,22

Conclusion

I do not know whether Kahn really worked in this rational way. And of course such a model of areas has to be filled in and refined, before it can be called architecture. But nevertheless this analysis has given me more insight in the designing process. It stimulates me to search for design-rules in other designs, and stimulates to define my own design-rules more consciously while designing.

RULING THE LAB

Language of composition in the Richard Medical Center of Kahn. What are the steps that Kahn took in the composition of this building ? What are the basic elements ?
The problem is, to find the elements vocabulary and with that vocabulary to run the language that Kahn used in this building.

The first thing you see when you analyse the design of the Richard Medical Center is, that there are two main squares and a few exeptions. The first problem is: how to come to these main squares!?

When you look to square 1 (fig. 2) you see from up to down :

1 simple square
2 the square with a square inside
3 the two squares with a grid
4 columns placed on this grid
5 materialisation of the design
6/7 the plan with additives

In square 2 (fig. 3) you see :

1 the columns (the same as used in square 1)
2 the columns with the walls
3 the plan with windows
4 the plan with additives

Now you have analysed the problem of how to make the squares you can find very easy with a few exeptions, the rule of designing of this building. It is even very easy to design your own building with these basic elements, for example: OWN DESIGN.

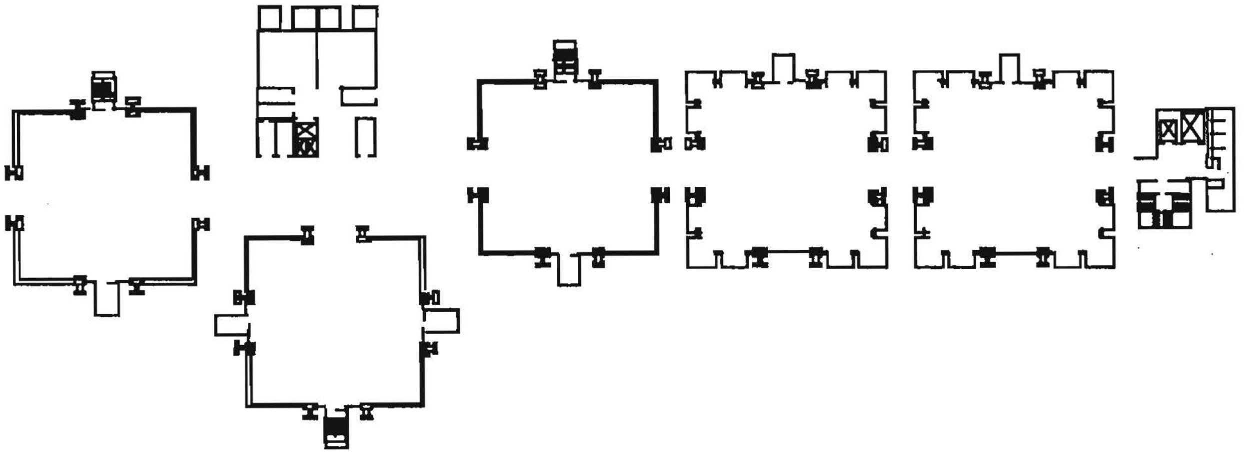


fig. 1 - Richard Medical Center

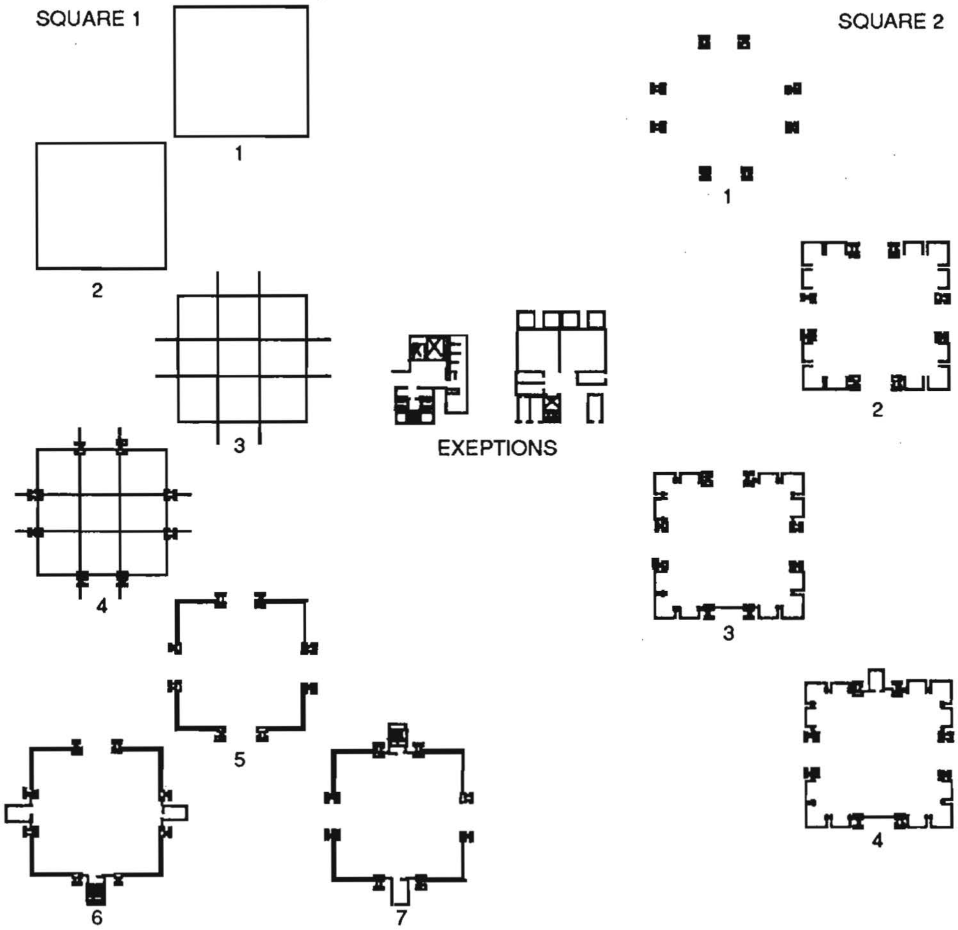


fig. 2

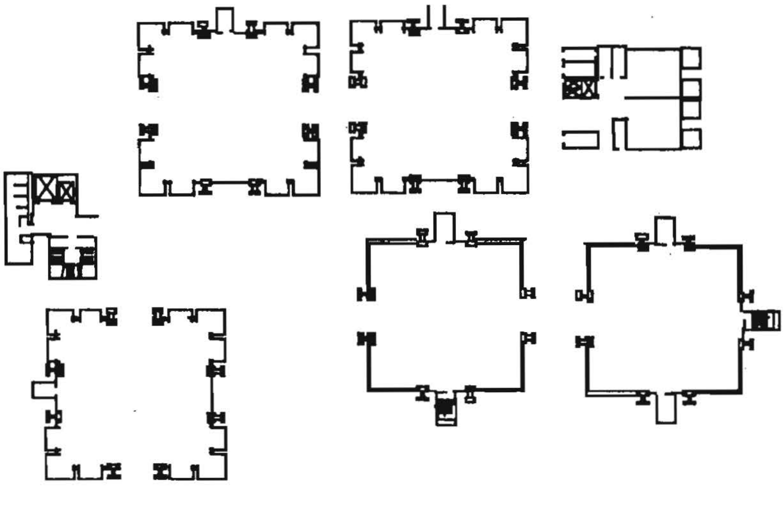


fig. 3 - Own Desgn

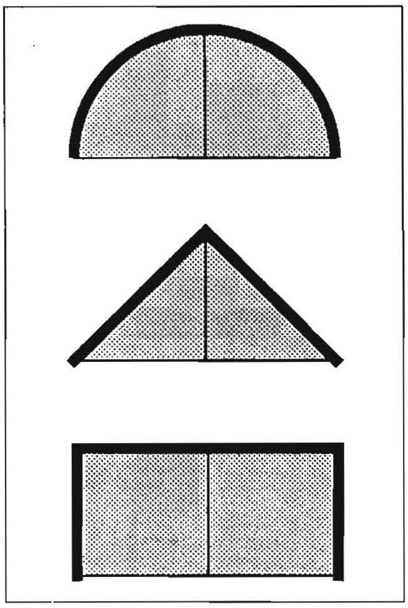
ELEMENT VOCABULARY

One half house John Hejduk 1966

FORM AND POSITION; HALF OF THE WHOLE

Procedure

The one - half house by John Hejduk is our point of departure. With the elements and the compositio n rules we are trying to manipulate and make new variation positions.
The manipulations take place by translation and rotation of the basic elements along the linear axis.
First of all we have searched in which way John Hejduk designed and how he made his basic design with the elements.
Next is that we show how we can make a complete different design with the same composition rules.

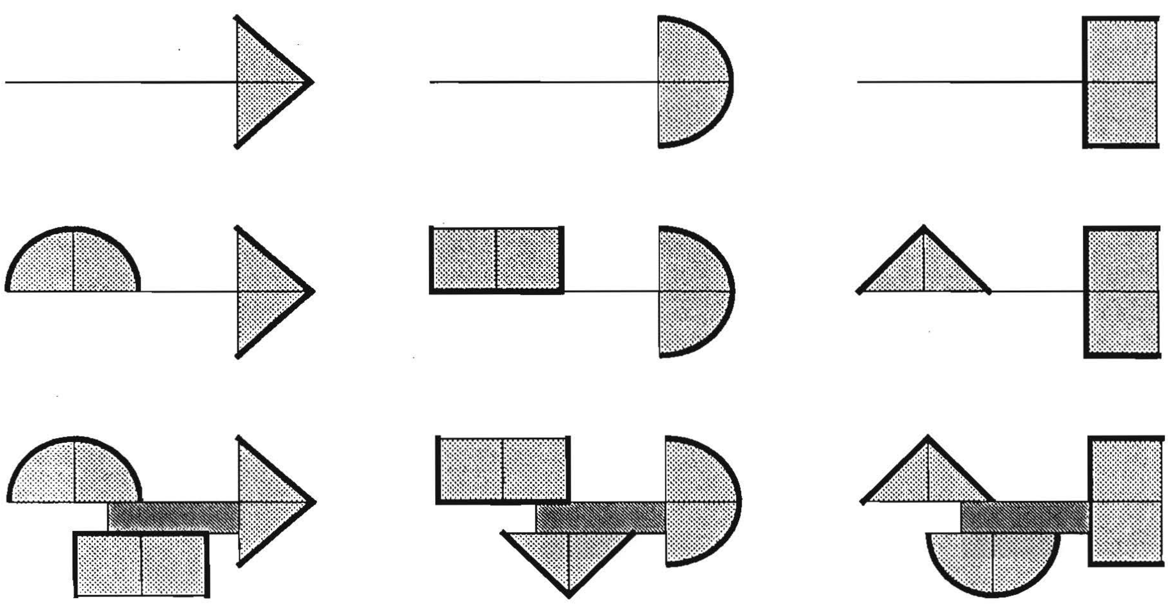


Basic elements

ONE HALF OF A ROUND
ONE HALF OF A SQUARE
ONE HALF OF A DIAMOND

Rules of relationship

LINEAR AXIS
ELEMENTS ARE MOVING ALONG THE LINEAR AXIS
ELEMENTS OPEN AT ONE SIDE AND CLOSE AT THE OTHER SIDES
LINEAR AXIS MODIFYING WITH TRANSLATION AND ROTATION

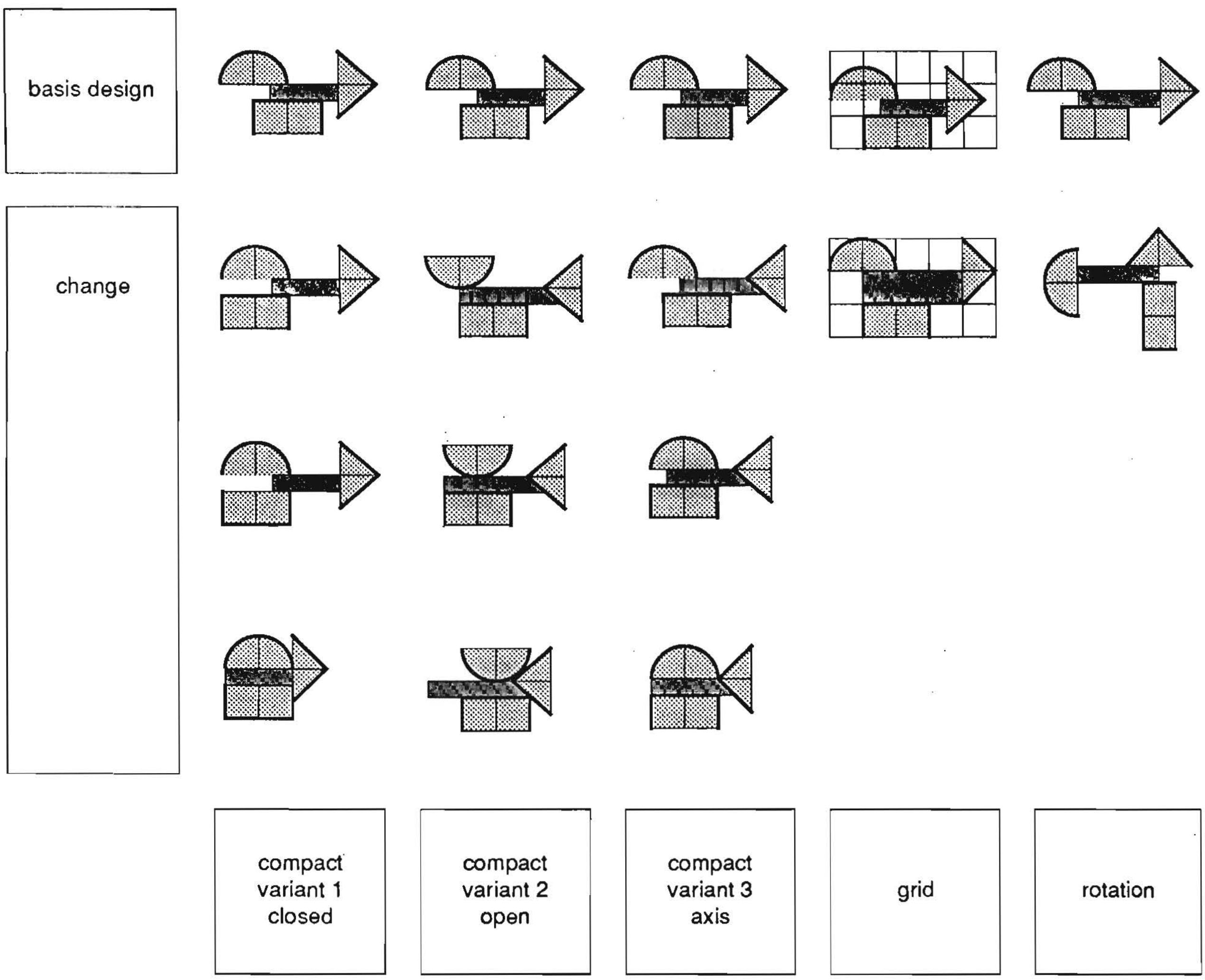


ANIMATION BASIC DESIGN ANIMATION VARIANT A ANIMATION VARIANT B

Siemen Meijer
Astrid Rasch

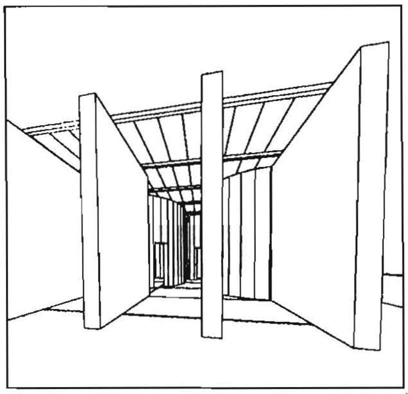
Result

If you analyse the design methods or design rules of a certain object, you can make new variation positions quite easily by taking advantage of the computer.
The results we made are just a few of all the variants which are possible. The number of variation positions is very large and our result is just a small amount of the whole.



PLACE AND STRUCTURE IN THE OPEN PLAN

Sonsbeek Pavillion, Aldo van Eyck.



Sonsbeek pavillion,
Aldo van Eyck

The purpose of this exercise is to find design-rules which define the placing of the elements in the pavillion. In order to do this, one has to have a model of the language used, rules and a set of start elements. Three kinds of models can be distinguished, and two kinds of rule-sets. The set of start elements can be the one in the pavillion, or any other set in which the number of elements and their sizes are different.

The different kinds of models are:

1. i. Grid-structure
   ii. Wall-structure - a. walls
   - b. holes - doors
   - rooms
   iii. Elements-structure - halfcircle
   - cubicle

2. i. Grid
   ii. Elements - a. straight
   - b. curved
   - c. straight and curved

3. i. Grid
   ii. Lines
   iii. Circles

The two kinds of rule-sets are:

1. Simple rule: 1. All elements have to be parallel to each other
   2. Any two elements in one line can be combined

2. Complex rules: 1. All elements have to be parallel to each other
   2. Any two elements in one line can be combined
   3. The position of the elements may not block any movement between the grid-lines, a route has to be established
   4. The postion of the elements, including the route,

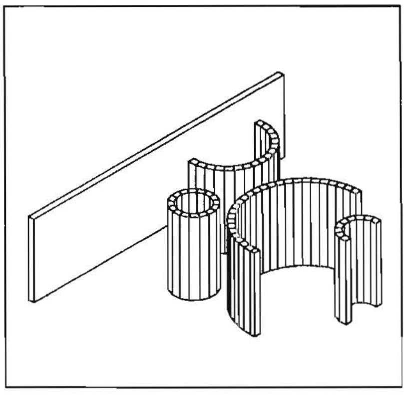
   must create a spatial sequence, that is, a series of visually separated spaces which can be moved through one after the other.

For the exercise, model 1 and the simple-rule set have been chosen. First, a 3D-model of the existing pavillion has been made. Therefore, the start elements are the ones in that pavillion.

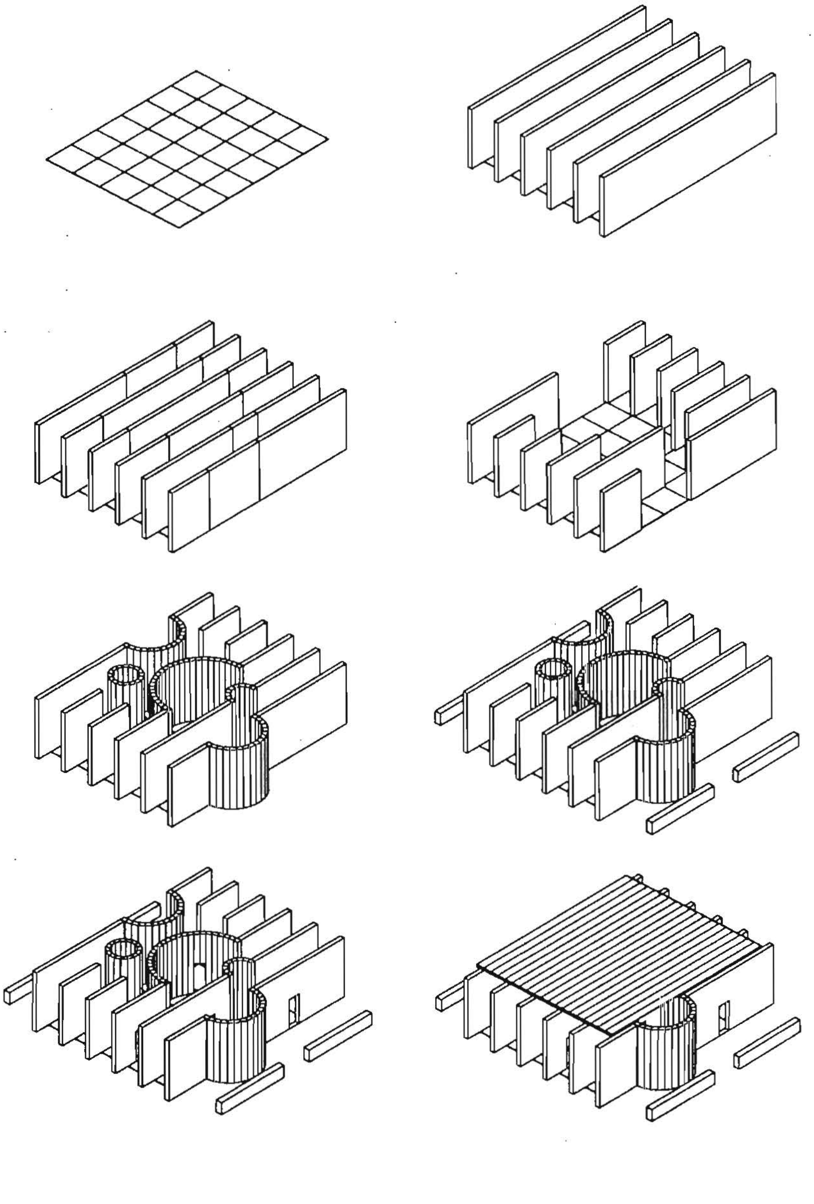
Henri Achten
Lars Stiphout

Identification of the elements and build-up of the original Sonsbeek pavillion. The build-up is numbered in the drawings:

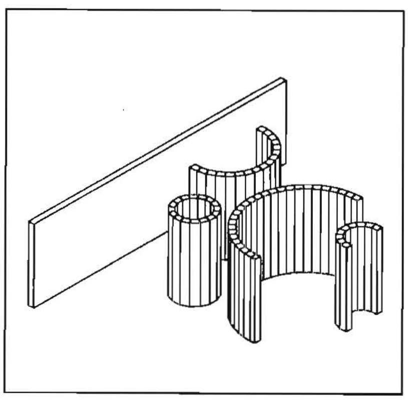
1. The grid.
2. The planes.
3. Cutting the planes.
4. Substracting planar elements.
5. Addition of cubicle and half-circles.
6. Adding the benches.
7. Substracting the holes in the walls.
8. Placing the roof.



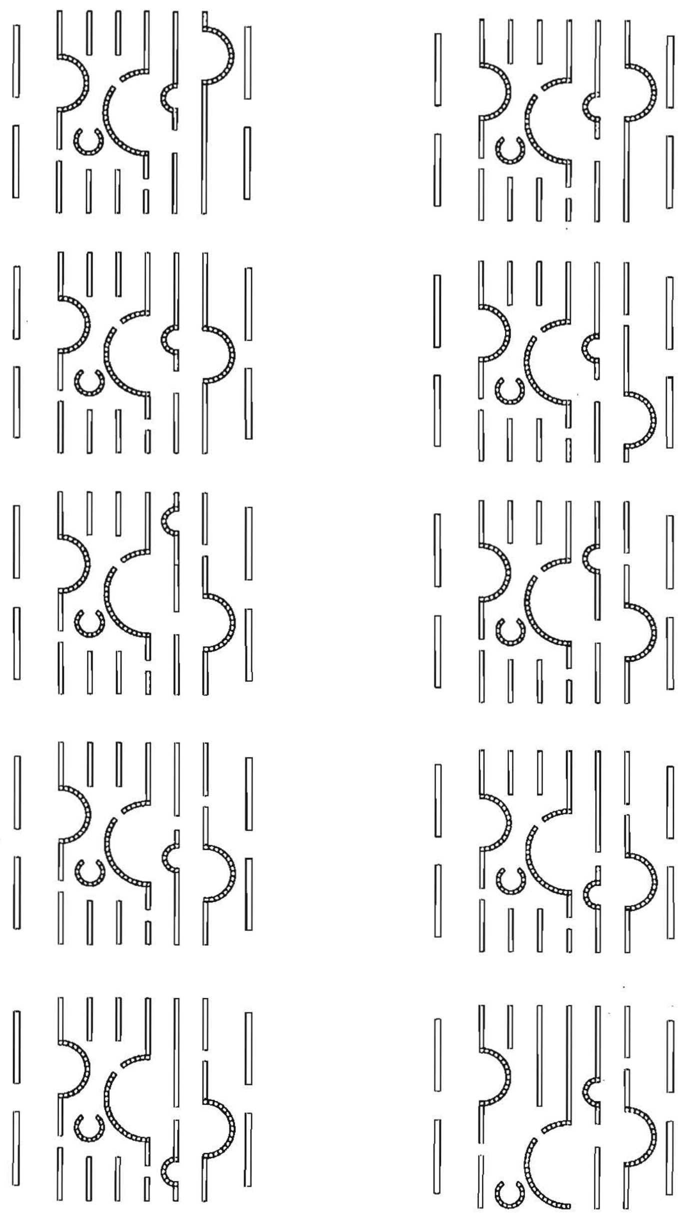
The Elements



Variations on basis of model 1 and the simple rule-set. Note that the start-set of elements consists of the elements of the original pavillion. Also note that the variations have taken place in the position of the elements in their original grid-line: no element has changed from one grid-line to the other. This is partly due to the many possible variations when all positions are allowed.



The Elements



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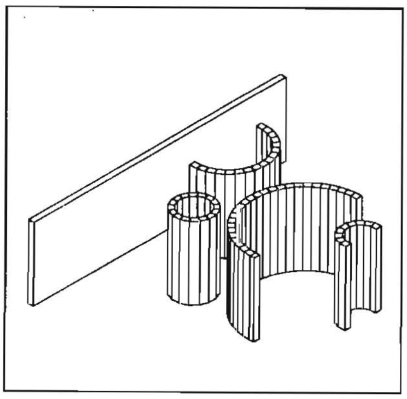
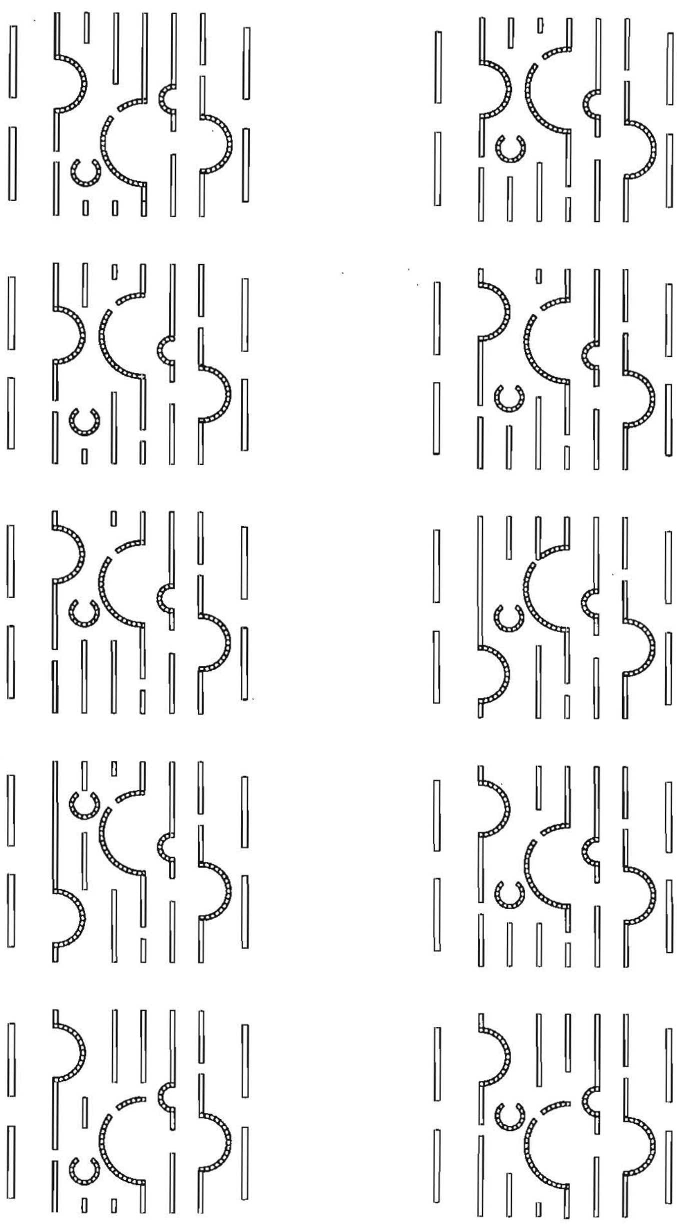
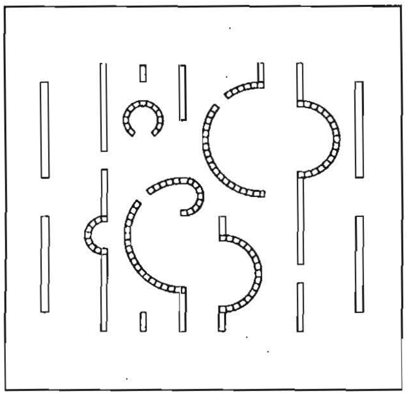


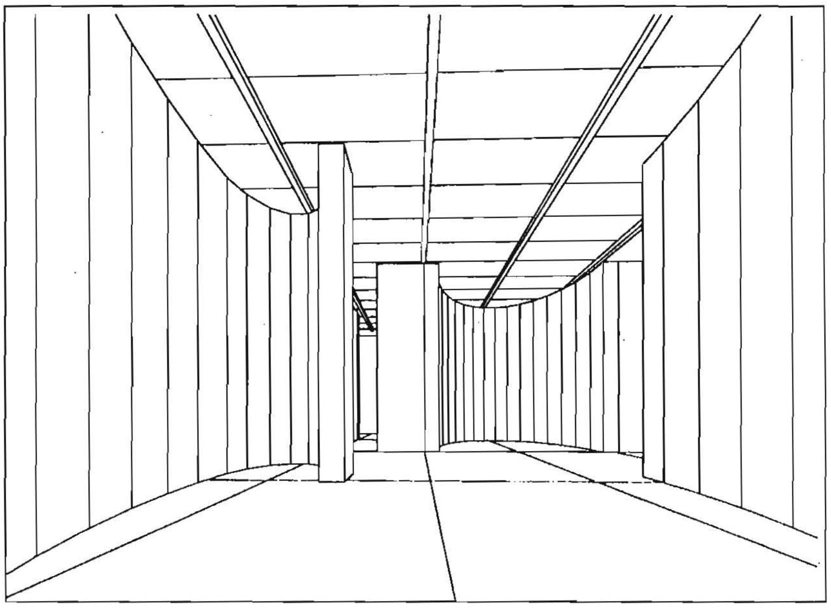
The Elements

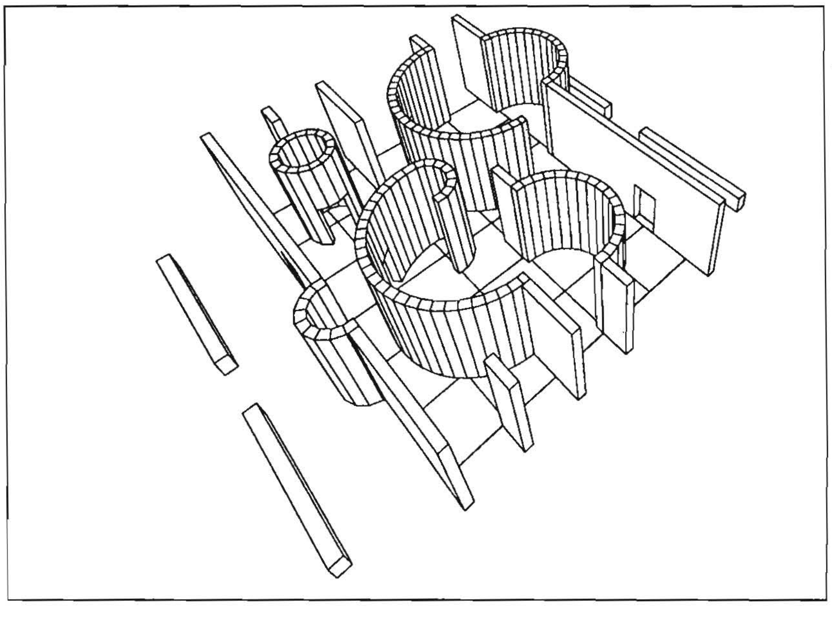


Finally, here is one alternative generated by use of the complex rule-set. The start-set of elements is different from the one used in the original. In applying the rules the effect on route and spatial sequence have to be considered. In this variation, two major spaces are created by the largest half-circles. Note the use of the combined half-circles, which is allowed by the rule-set, but probably would never have been applied in the original pavillion. Different routes and viewpoints are possible, also because of the holes in the walls.



The Plan





Perspective views

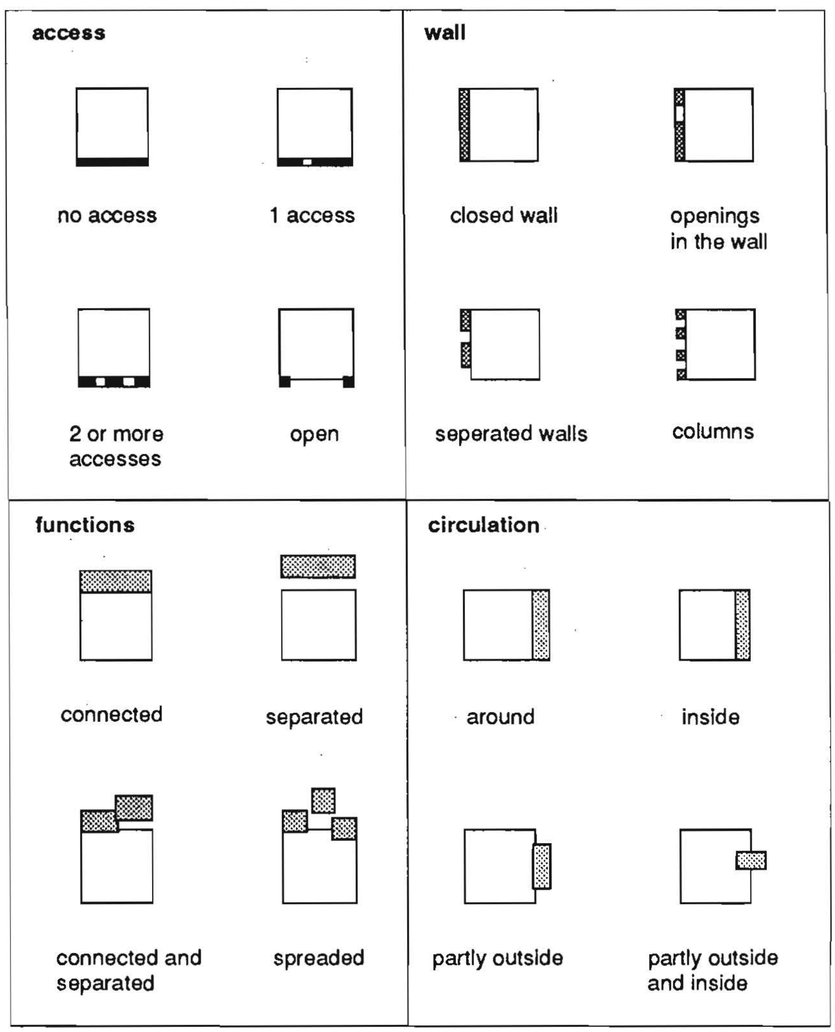
THE ATRIUM

a typological vocabulary

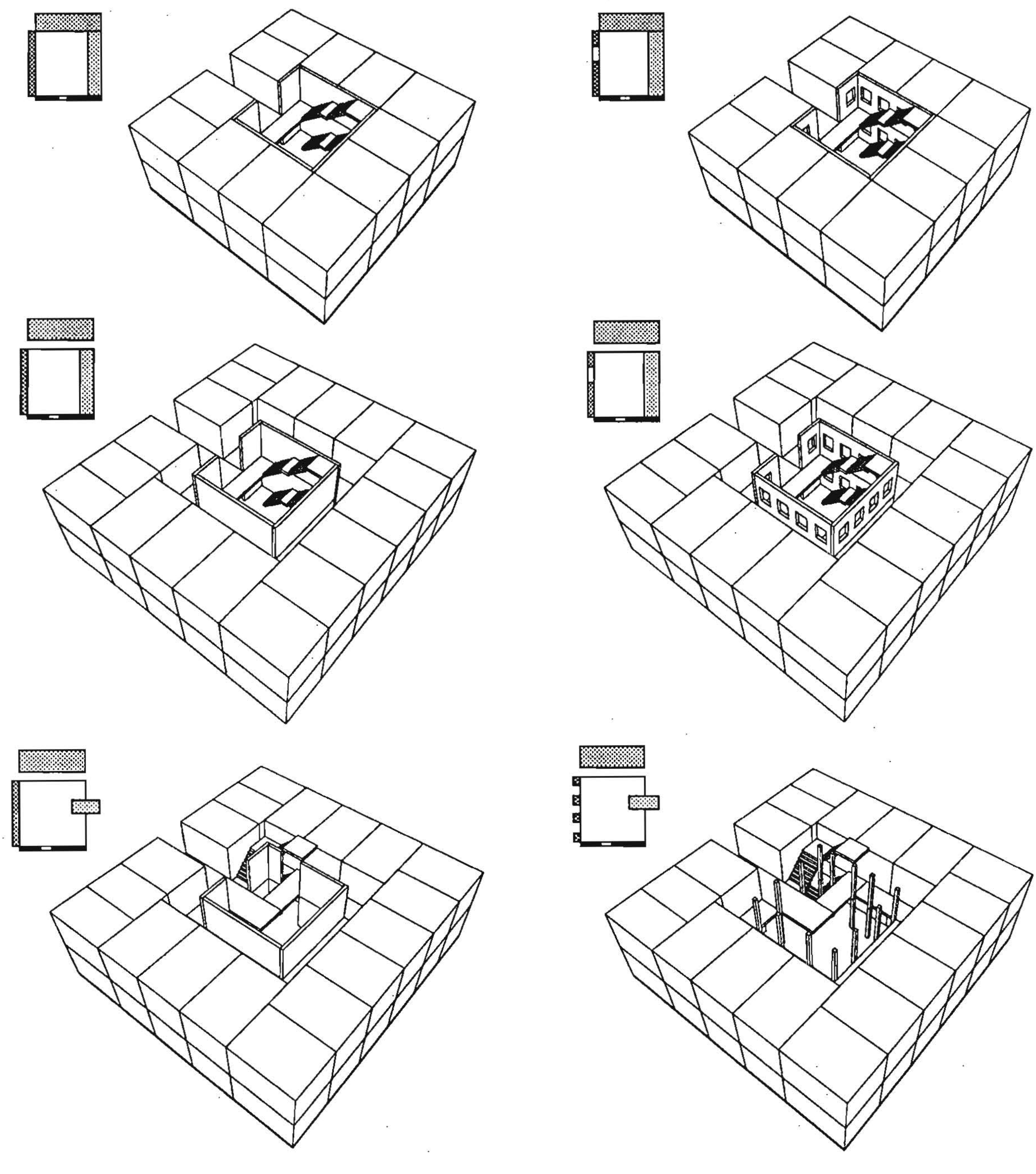
Intention
Looking for a way in which the computer can help in the design process of an atrium of any form and size. Therefore I had to find the principles, formal and functional, of the architecture of the atium.

Items
There are four items wich affect the appearance of an atrium.
1. The access
2. The walls
3. The composition of the functional elements
4. The circulation

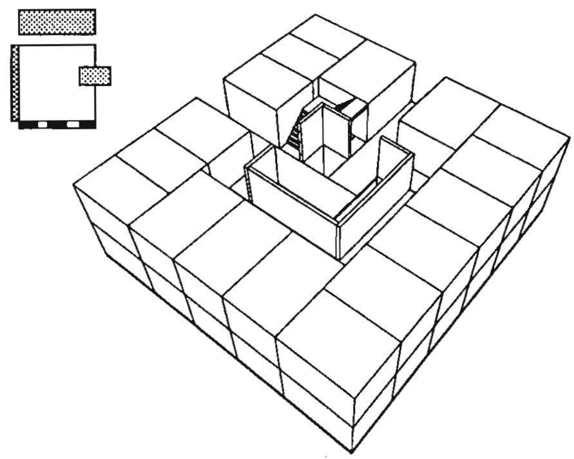
Each of these items I gave four different principles in 2-d of the functional or formal possibilities of appearance. Based on a 2-d composition of the items with there principles you can make 3-d elements with which it is possible to make a 3-d composition of an atrium of any kind and size.

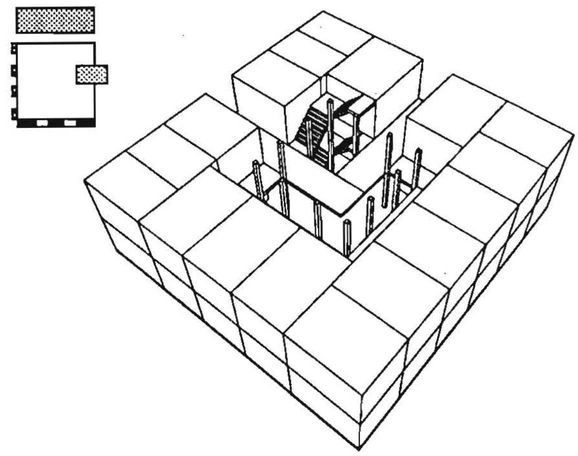


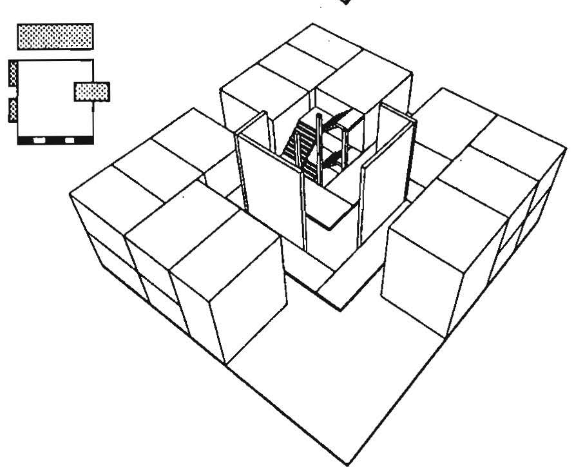
I took a square groundplan for the design process of the atrium. For every design I took a 2-d combination of the items and made 3-d elements with which I made the 3-d combinations. For each side of the atrium it is possible to make a new 2-d combination with the same elements and therefore there are a lot of designing possibilities.
I didn't take a 2-d combination for every wall, but only one underlying combination for each design which is standing next to each design.

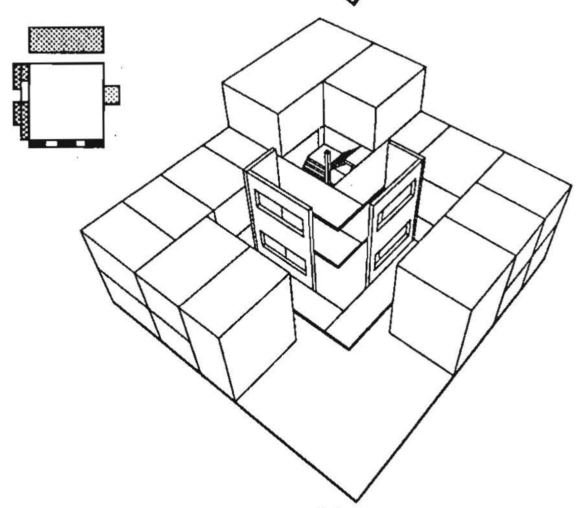


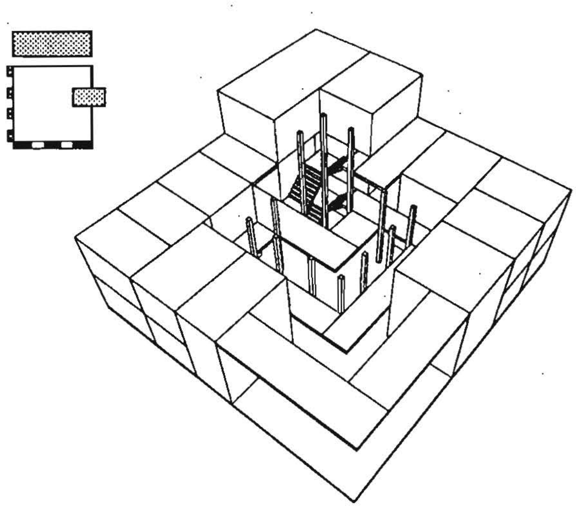
With this kind of process it is possible to make quickly different designs for the atrium. Also it is possible to make changes in every design after it is completed, so that you can adjust your design to your special wishes. The only problem is that you are bound to the created elements.

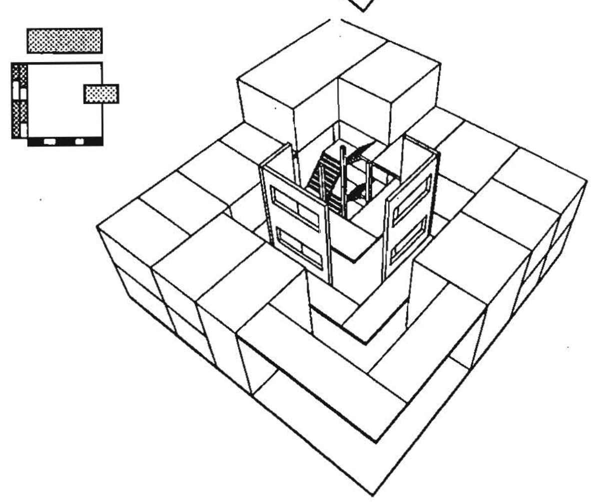












ROMANCING THE CUBE

The Envelope of the Hanselmann House, Michael Graves

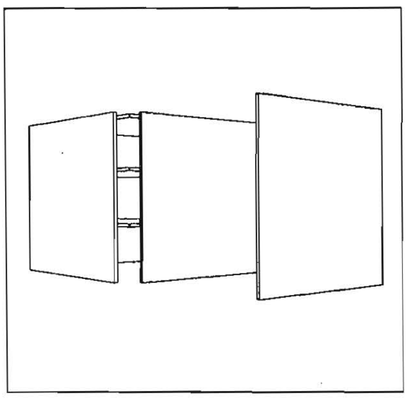
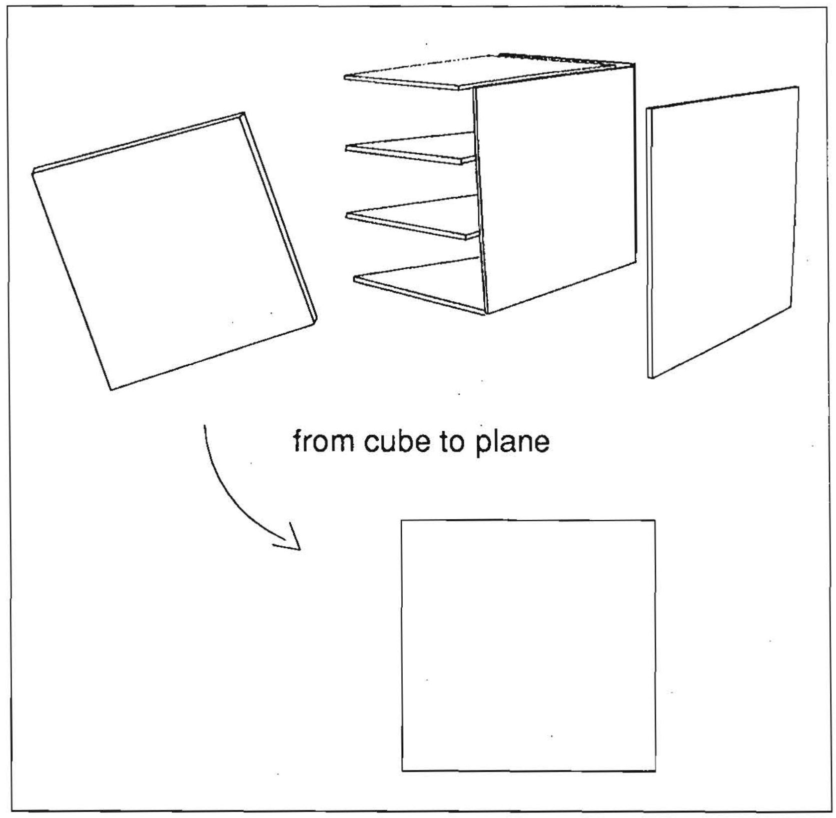


fig. 1

fig. 2



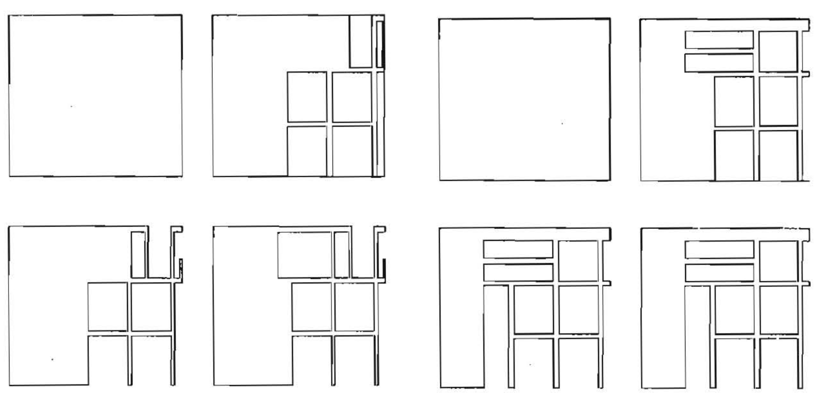


fig. 3,4

During the workshop we've learned and developed a different way of thinking about architecture. The exercise we've done was to dismantle a building or series of buildings of one architect, and try to find out which rules the architect has used to create his building. I have chosen 'The Hanselmann House' of Michael Graves for this exercise. After we've learned about syntax, it was obvious to me that this house primary was a cube. (fig. 1) That's why I called the exercise 'Romancing the Cube'. But this cube was not a solid, but it was made of different planes, as you can see in the second picture. These planes can be horizontal and vertical - such as floors and elevations. For instance the elevations are in the beginning just planes, but it is allowed to make rectangular holes in it. This can eventually lead to a system of collums and beams, in case of minimum material and maximum 'structure'. (fig. 3) This idea you can find in the inside 'elevations', which are nearly just collums and beams. With these rules you can easely make new elevations just like in fig. 4.
The floors are not made by substraction, but here Michael Graves has added new horizontal planes to the existing plane. An example of this is the way the balcony is attached to the floors. You can see this principle in fig. 5.
With these rules you can make many new compositions, because these are very simple and basic rules. Michael Graves seemes to use these rules very freely, but it is possible that there are 'hidden' lines on the elevations, but a overall rule I couldn't find. All these rules led to a better syntactical understanding of the Hanselmann House, so I can space-interpretate the house in a different way. That why I think they've called the workshop 'The Joy of Syntax'.

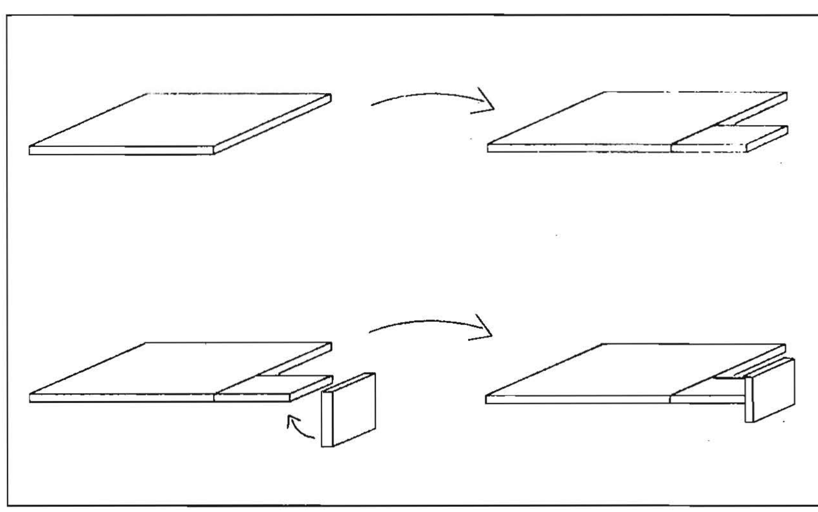
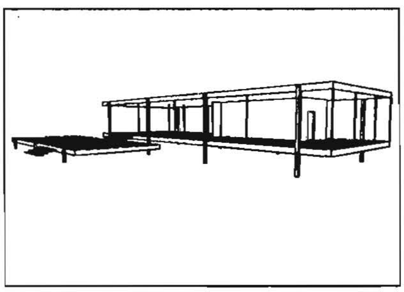


fig. 5

BETWEEN TWO PLANES

RULES

Farnsworth House, Mies van der Rohe



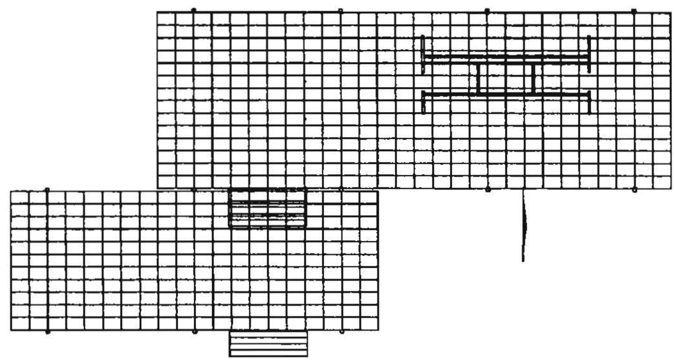
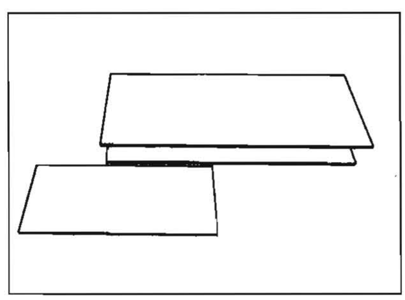


fig. 1 - view of the building

fig. 2 - all elements are rectangular



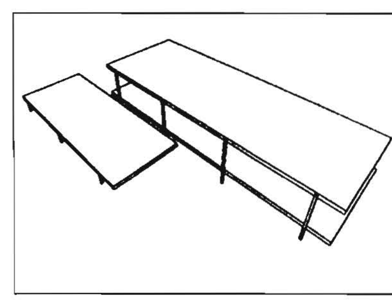


fig. 3 - horizontal planes are facing each other: rel 1:1
fig. 4 - connection of horizontal and vertical elements

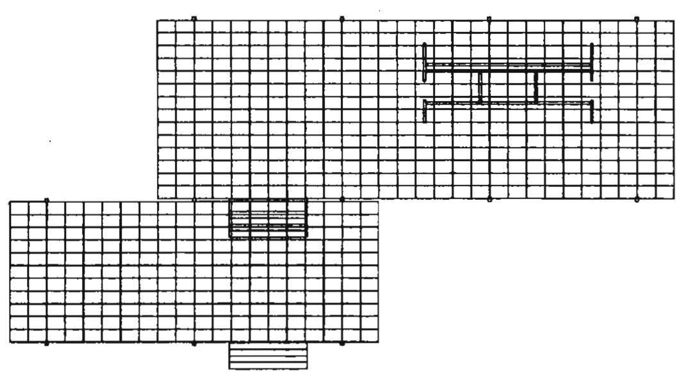
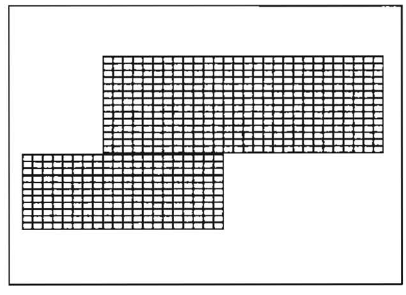


fig. 5 - plan view: you see clearly the axis and grid



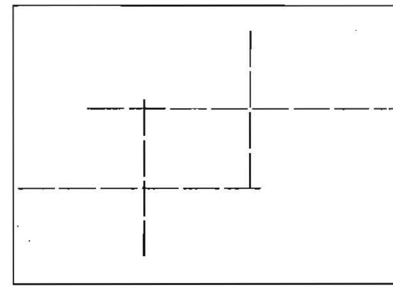


fig. 6 - the grid
fig. 7 - axes of symmetry

CHANGING OF RULES

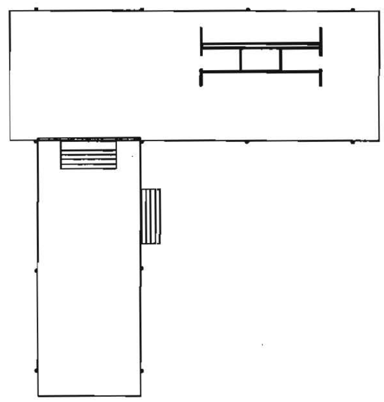


fig. 8 - Rotation of platform and stairs orthogonaly

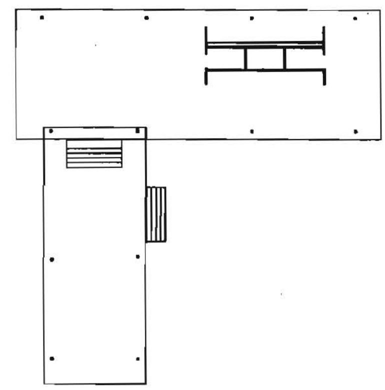


fig. 9 - Changing of position of placing columns

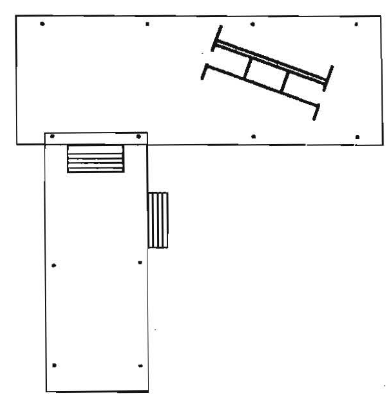


fig. 10 - turning of interior

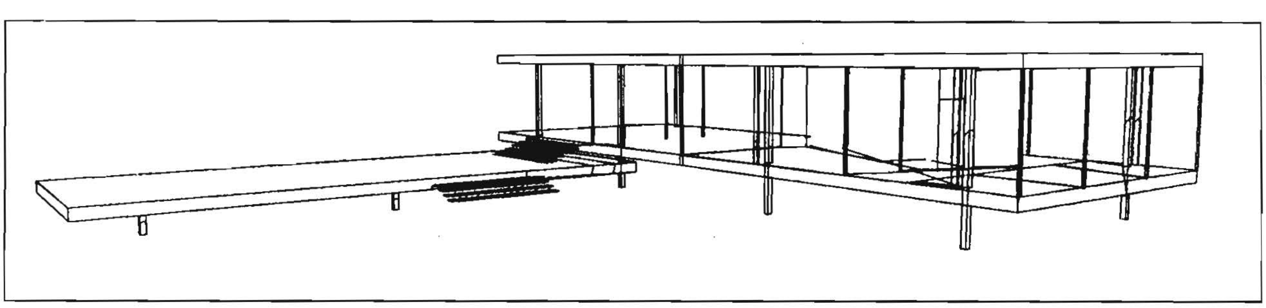


fig. 11 - Result in 3D

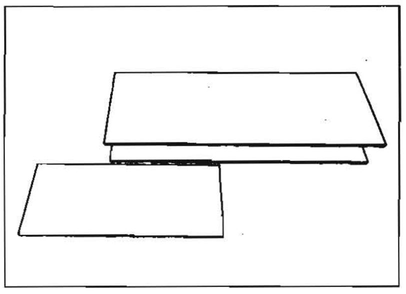


fig. 12 - Initial placing of the horizontal planes

CHANGING OF RULES

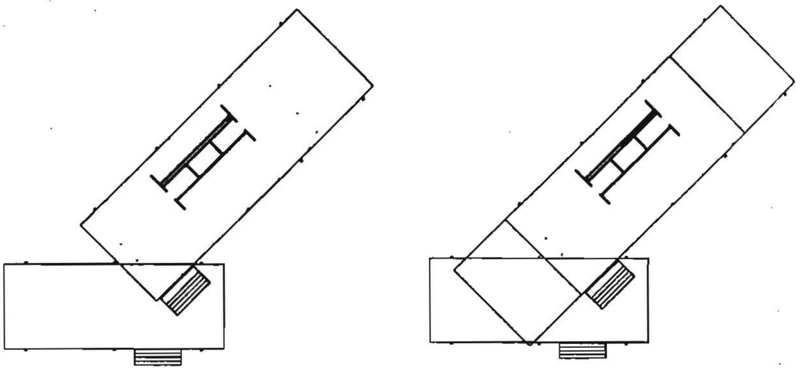


fig. 13 - Rotation of main block of 45°
fig. 14 - Moving upper planes

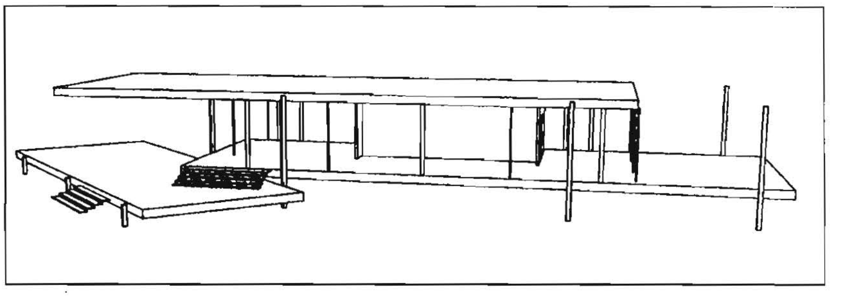


fig. 15 - Result in 3D

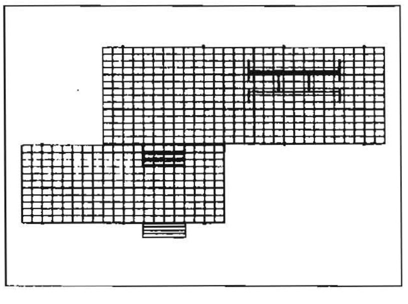


fig. 16 - Initial placement of elements

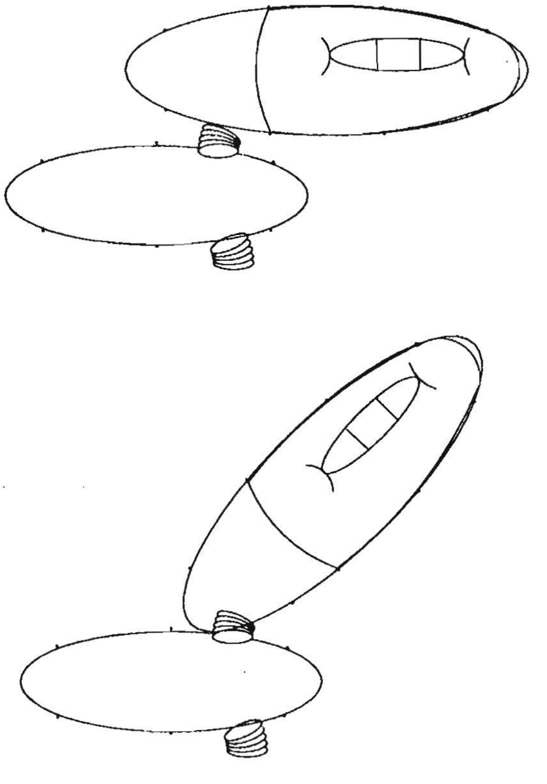


fig. 17 - Replacing rectangulars by ovals and circles
fig. 18 - Replacing and moving

A TYPOLOGY OF COMPOSITION

Items:
types, constraints & situations, heuristics

In this project we are dealing with the problem of the translation of proximity diagrams into 3-D representations.

The starting point for this exercise is a classification of spaces. Three types of spaces can be distinguished, circulation spaces, general (multi purpose) spaces and specific (single purpose) spaces (figure 1). These spaces can be organized according the classification of Francis Ching (Architecture: form, space & order). He distinguishes lineir, centralised, radial, clustered and grid organizations (figure 2).

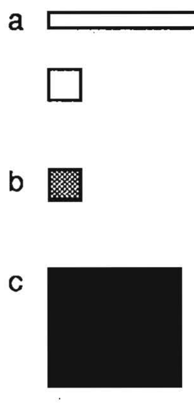


Figure 1
Space types:
a ciculation spaces,
b specific (single purpose) spaces,
c general (multi purpose) spaces.

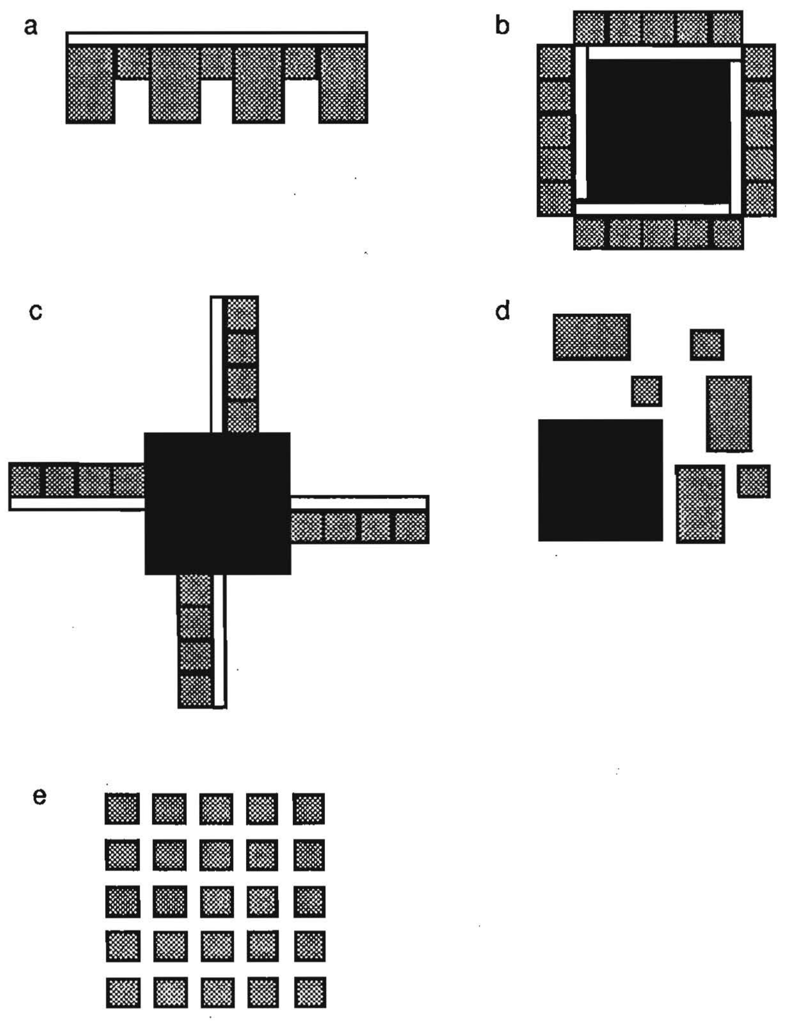


Figure 2
Organization types:
a linear,
b centralised,
c radial,
d clustered,
e grid.

Compositions are combinations of these space and organization types. The relations between them can be expressed in rules. Rules that can be regarded as adaptation rules. In these rules the special conditions of the design are expressed.

In this example a general space is combined with a linear organization of specific spaces. Between them exist a strong relation on basis of proximity and they should be situated very close to each other. The linear element is positioned along one side of the general space. A problem rises when the linear element is longer then the lenght of the side of the general space. Now there has to be formulated an adaptation rule, the bending rule (figure 3). In order to keep the linear element as close to the general space the linear organization is being bent around the general space.

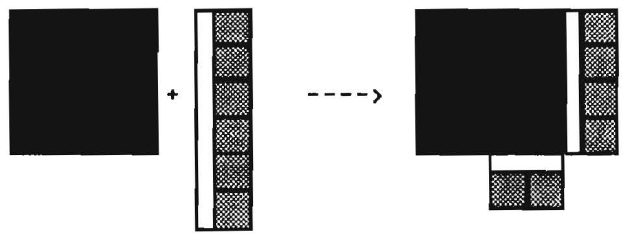
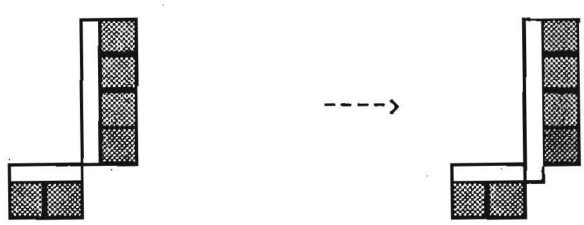


Figure 3
Bending rule
When a general space and a linear organization of specific spaces are combined and the linear element is longer then the side of the general space then the linear element is bent around the general space.

Doing this another problem rises. At the corner the linear element is broken and the corner becomes an open space. Will the corner be filled? When and how? There are several solutions possible and they also have to be formalized in rules (figure 4). These rules can be regarded as refinement rules.

a



b

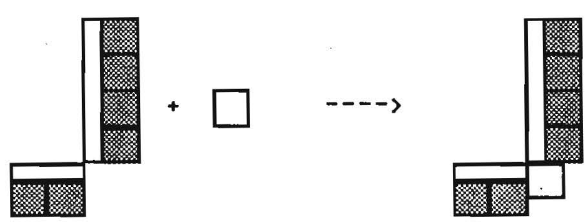
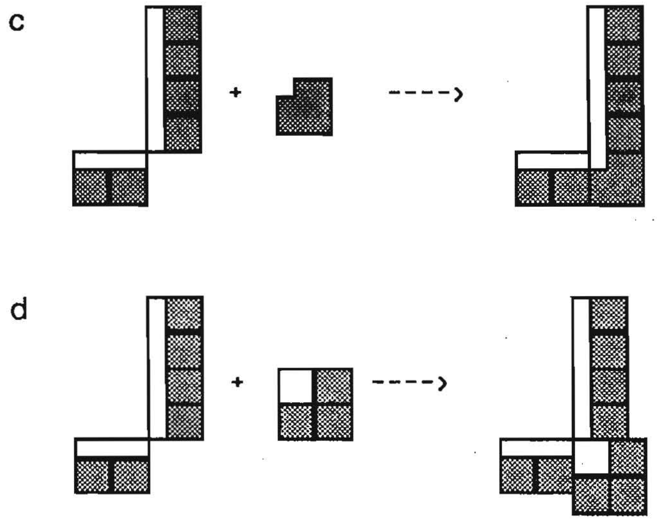


Figure 4
Corner rules
a continued circulation spaces,
b special circulation spaces,
c continued circulation spaces and special specific spaces,
d special circulation spaces and three specific spaces.



and the general space is automatically leading to a subproblem that can be solved by introducing a subrule. When the general space is completely enclosed by the linear organization and there is still left a chain of specific spaces that has to be bent the question rises how to do this. The bending can be continued on the same level in a spiral way or what is more obvious continuing on top of the first ring. This last possibility is chosen here (figure 5).

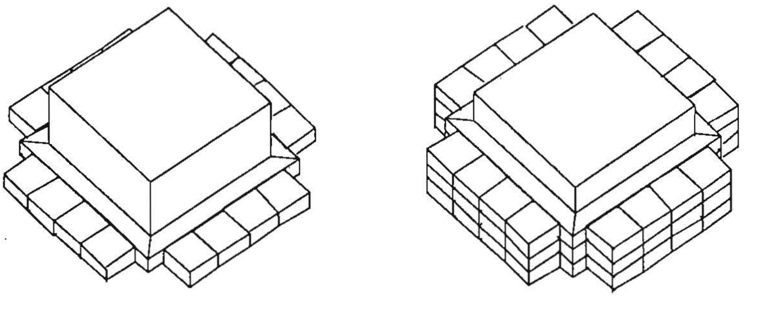


Figure 5
Bending subrule
When the enclosure at one level is complete the bending continous on top of the first level.

The application of the bending rule is in particular defined by the program of requirements. The application of the refinement rules is mostly defined by the situation although this is not always the case (e.g. architecture styles, detailing) (figure 7). The refinement rules can then be regarded as adaptation rules. When the rules are not so dominantly defined by the situation they give the architect the opportunity to demonstrate different characters to buildings (figure 6.1 - 6.6).

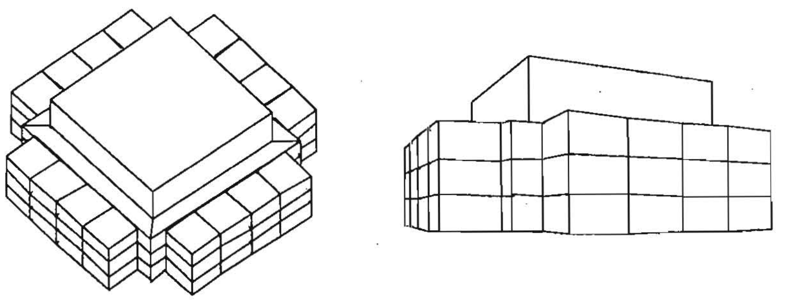


Figure 6.1
Application of bending rule, bending subrule and corner rule a (continued circulation space).

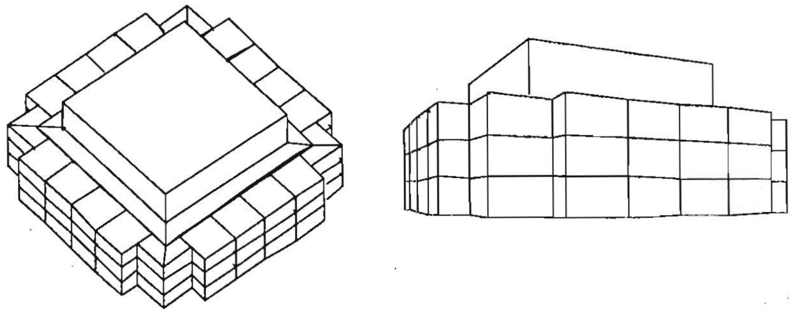
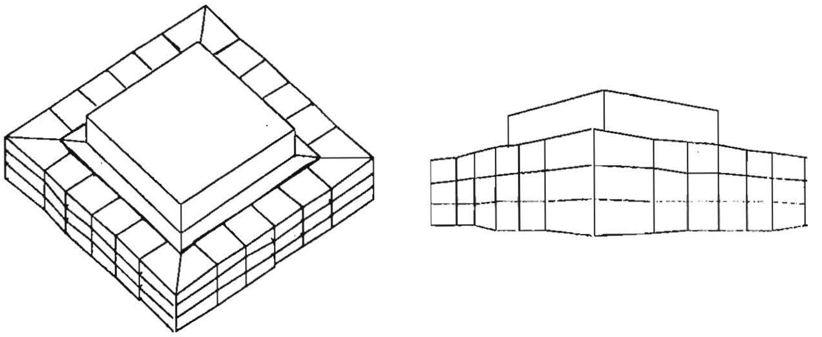


Figure 6.2
Application of bending rule, bending subrule and corner rule b (special circulation space).



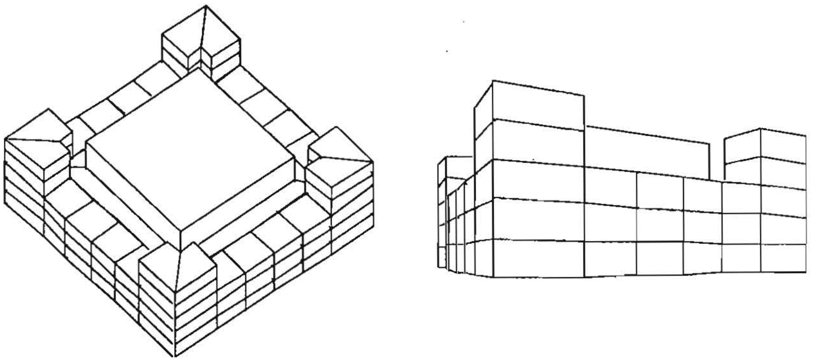
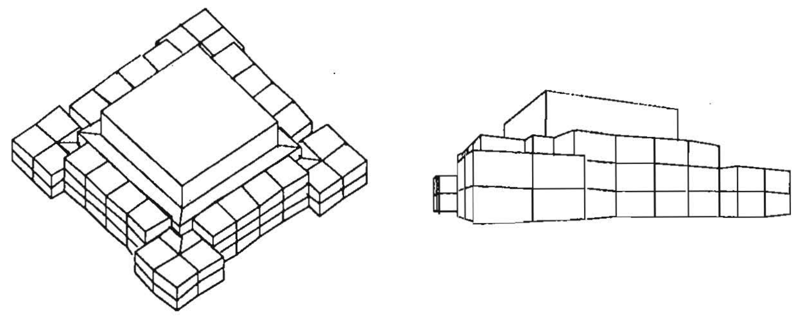


Figure 6.3
Application of bending rule, bending subrule and corner rule c (continued circulation space and special specific space).



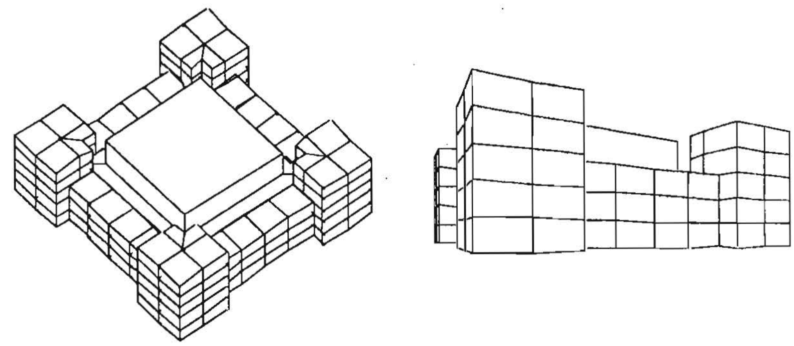


Figure 6.4
Application of bending rule, bending subrule and corner rule d (special circulation space and three specific spaces).

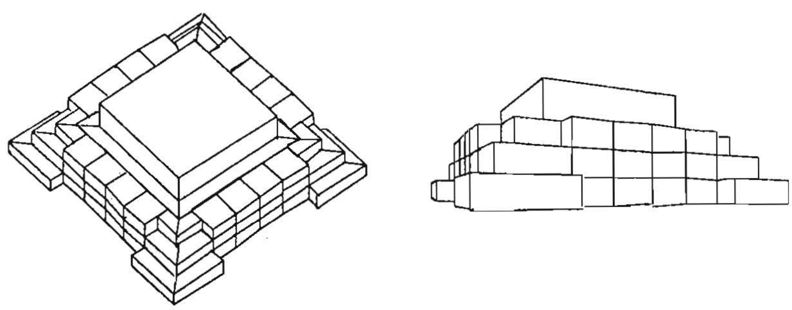


Figure 6.5
Application of bending rule, bending subrule and corner rules d, c and b. The combination of corner rules produces a pyramidal form.

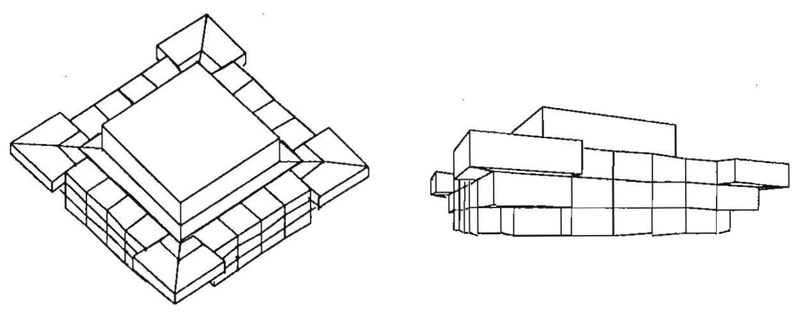
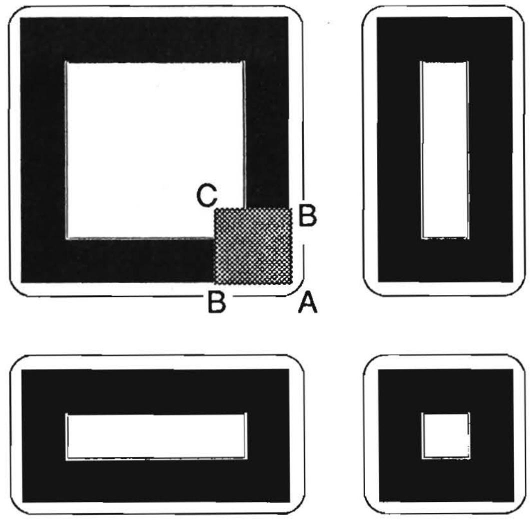
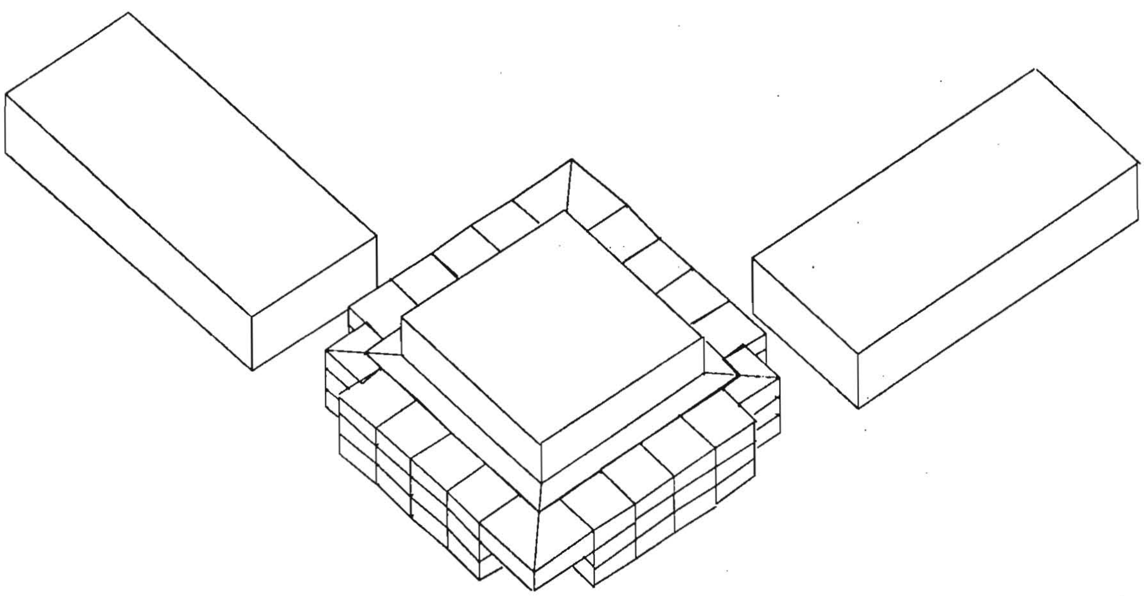
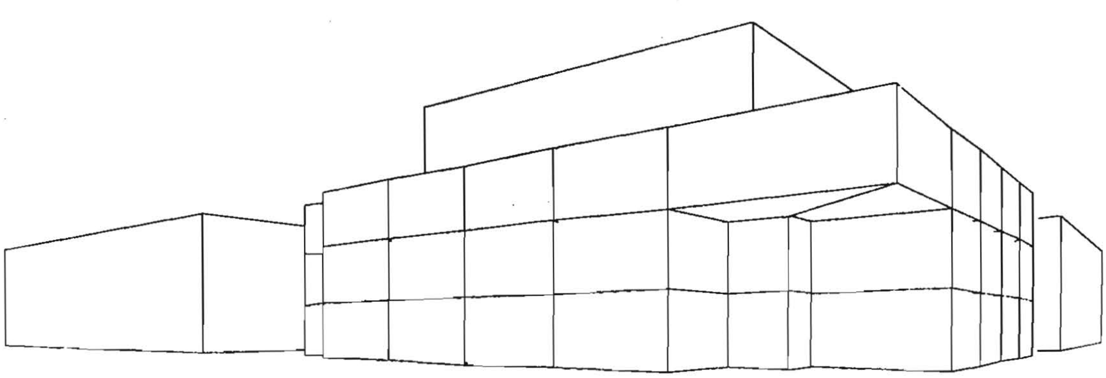


Figure 6.6
Application of bending rule, bending subrule and corner rules b, c and d. The combination of caorner rules produces a reversed pyramidal form.

Figure 7
Is the situation defining the refinement rules then they can be regarded as adaptation rules. For each part of the situation other combinations of corner rules are applied:
A: Entrance: corner rules a, a and c (from bottom to top),
B: Surrounding buildings: corner rules b, b and b,
C: Courtyard: corner rules c, c and c.



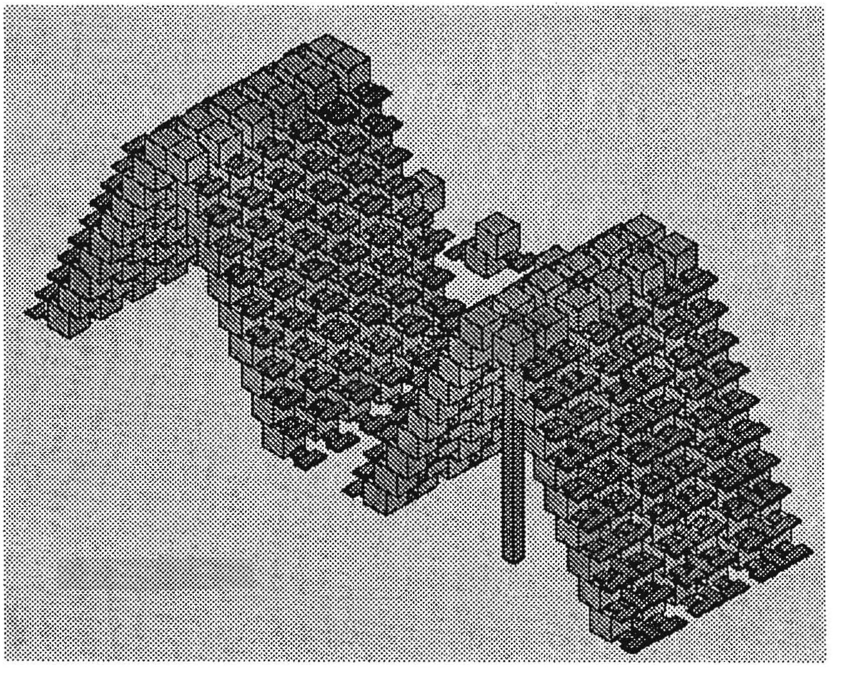


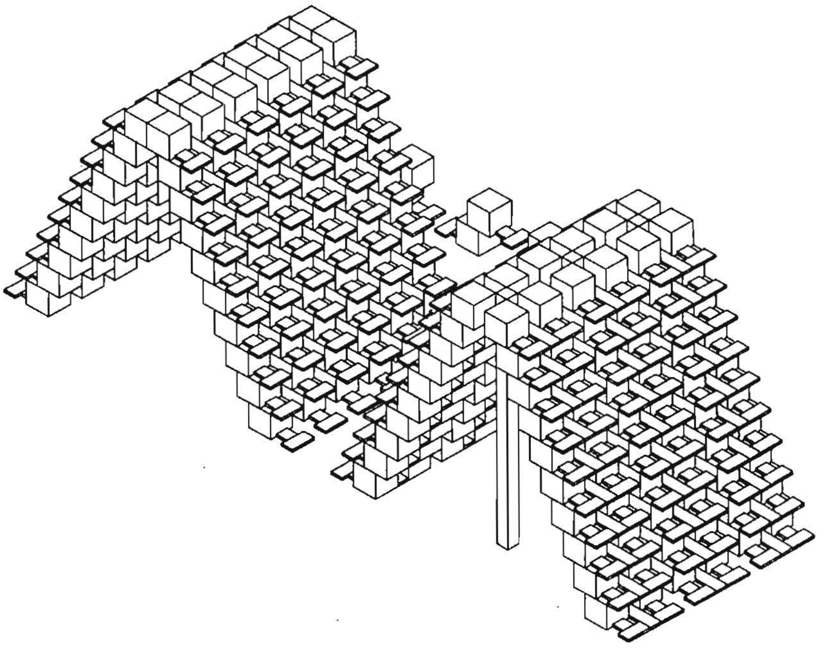


Roeli Procopiou
Aad Jongbloets

THE GRAMMAR OF HABITAT

A 3D shape-grammar for housing





Karina Zarzar
Maha Choukry

The compositional principles of the Tugendhat House, by mies van der Rohe

Context: Introduction to concepts of architectural formal knowledge.
Aspect: The organizational and composition concept.

The analysis

The approach towards understanding the plan language of Mies van der Rohe started by redrawing the plan of the "Tugendhat House" (2.1). Next we tried to follow a possible procedure that might lead to his plan and an attempt was made to deduce a number of his design elements and the way he cobined them (2.2). The occurence of those design elements in other designs is performed by Mies van der Rohe was checked (2.3)

The procedure is summarized as follows:

1. Schematic representation of the plan of the Tugendhat House.
2. Path that might have lead to existing plan
   - 2.1 Initiation
   - 2.2 Envelope hypothesis
   - 2.3 Envelope refinement
   - 2.4 Grid hypothesis
   - 2.5 Grid refinement
   - 2.6 Rectangular grid hypothesis
   - 2.7 Rectangular grid refinement
   - 2.8 Vocabulary of elements
   - 2.9 Combination of elements
3. Occurence of elements in other projects designed by Mies van der Rohe.

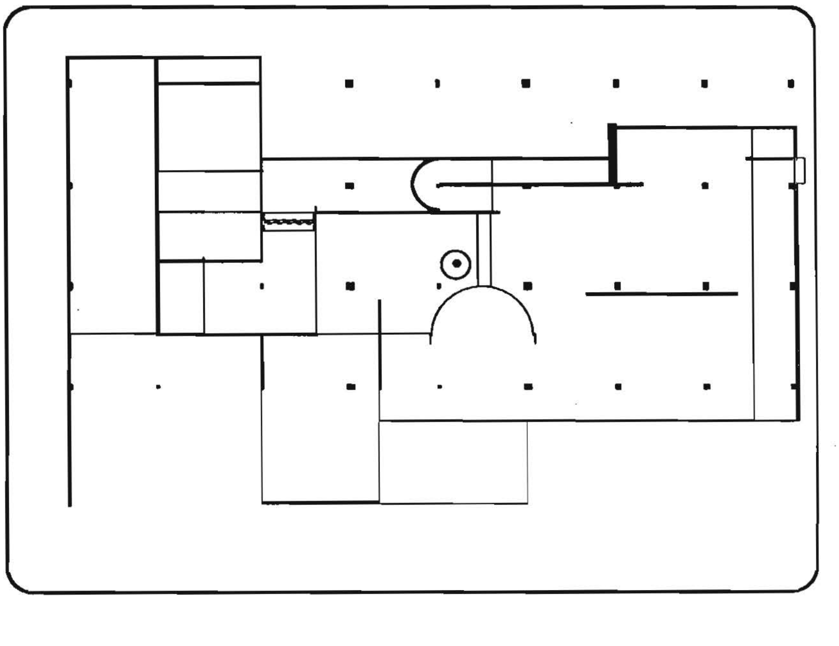


Figure 1
Schematic plan
A schematic representation of Tugendhat House plan.

Figure 2.1
Initiation
At this phase the idea of plan is maybe initiated as a result of the designers architectural knowledge in relation to the circumstances of the particular project.

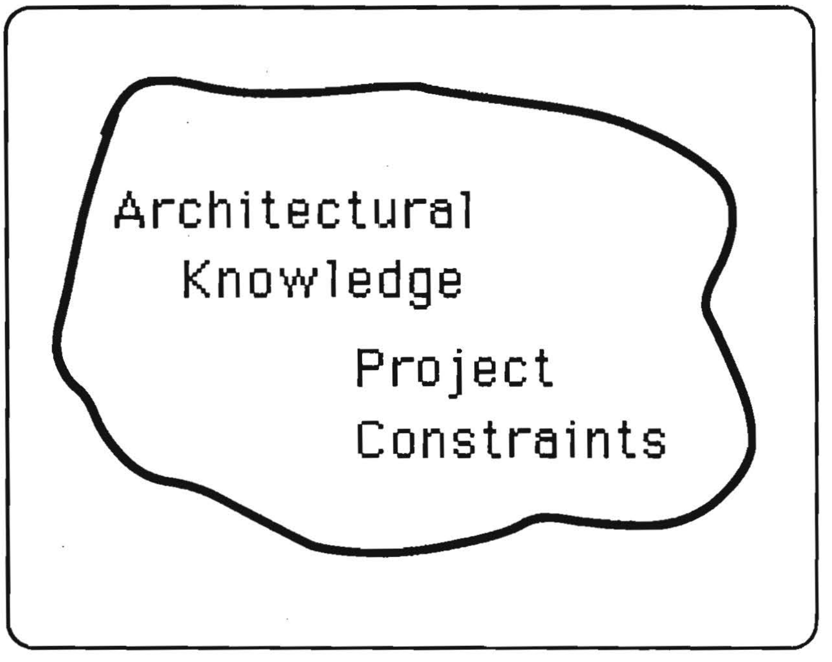
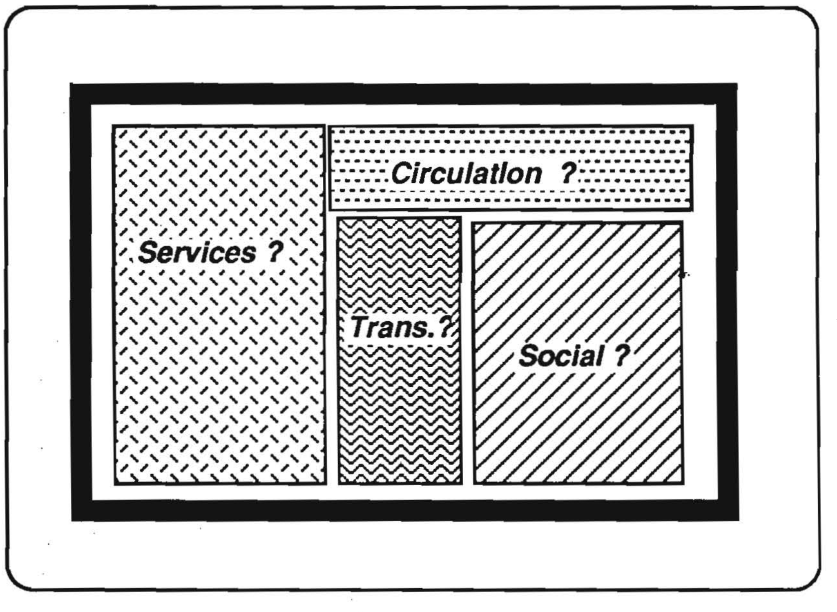


Figure 2.2
Envelope hypothesis
At this phase an envelope is maybe proposed with respect to functional areas.



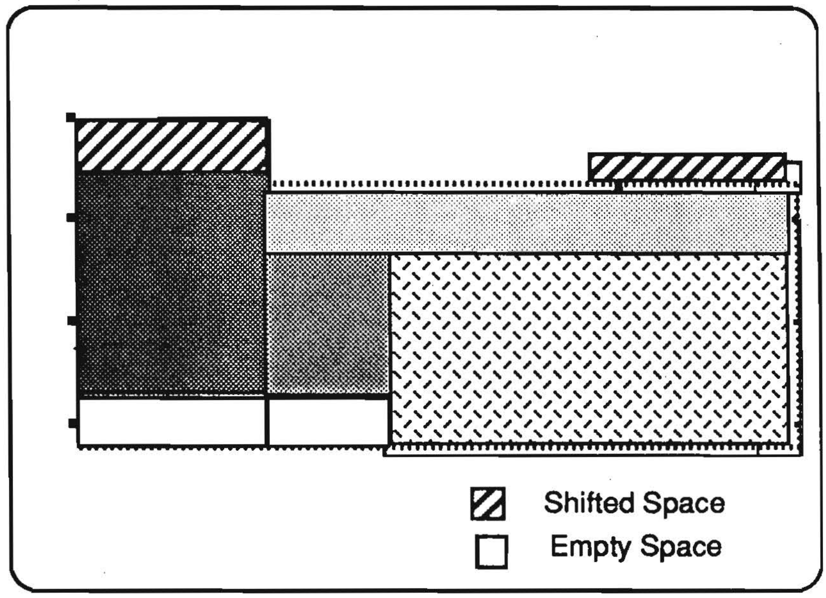


Figure 2.3
Envelope refinement
At this phase refinement of the envelope might have occured by shifting spaces.

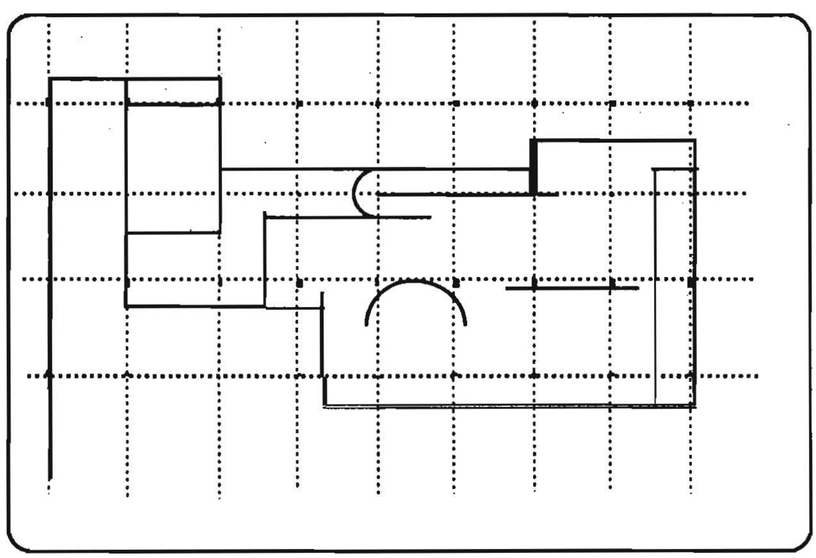


Figure 2.4
Grid hypothesis
At this phase an attempt is made to analyse the grid spacings (3m x 3m).

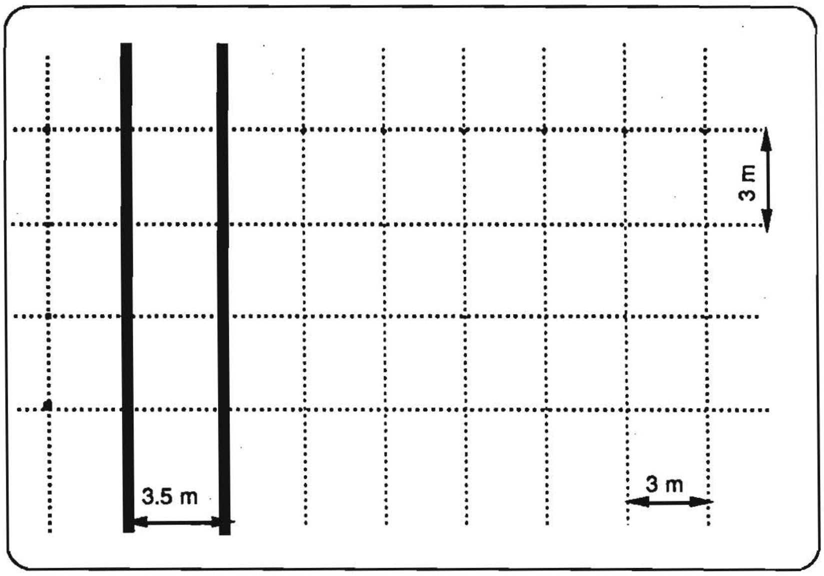


Figure 2.5
Grid refinement
Because of the need of extra space the grid was probably refined by changing one of the grid spacings from 3m to 3.5m.

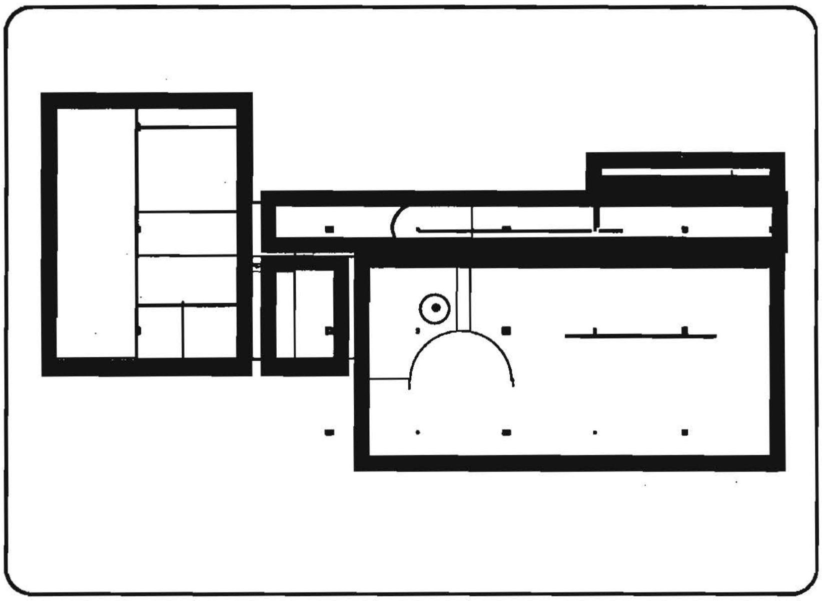


Figure 2.6
Grid/rectangular hypothesis
At this stage an attempt is maybe made to set the spatial division.

Figure 2.7
Grid/rectangular refinement
A possible attempt to refine space rectangles in relation to the grid refinement.

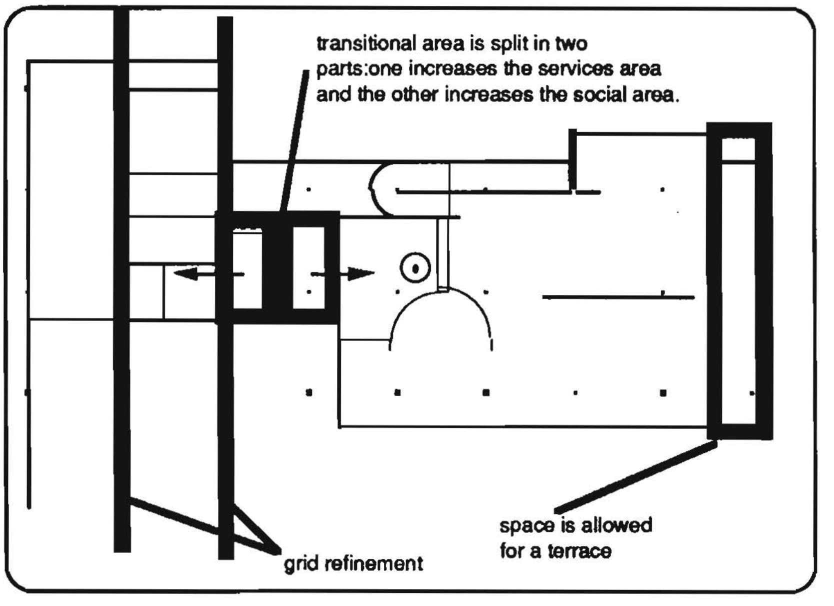


Figure 2.8
Vocabulary of elements
The designer may have used a number of elements to express his language:
1. the horizontal line,
2. the vertical line,
3. the arc.

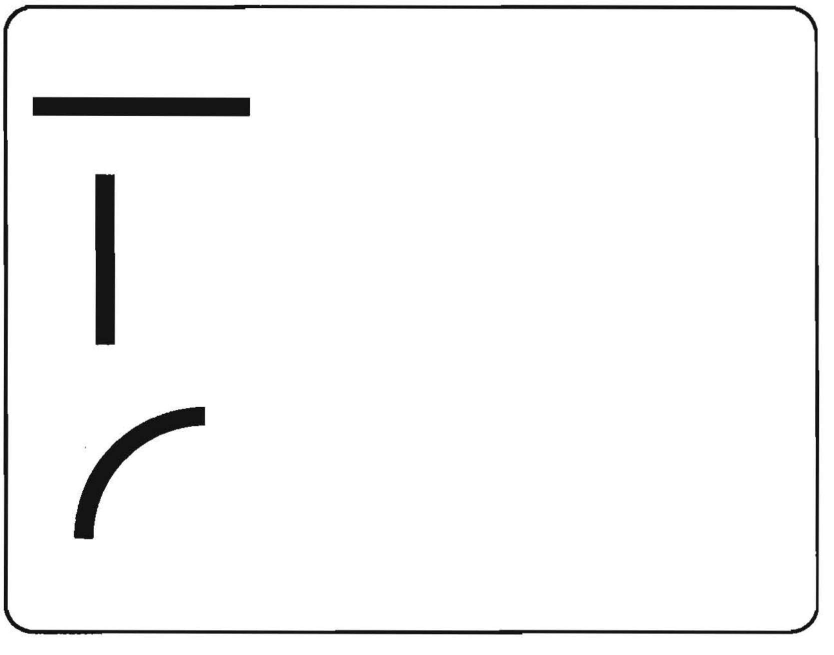


Figure 2.9
Composition of elements
Three examples A, B and C of the composition of elements in the final plan are shown. A composition methodology may be distinguished.

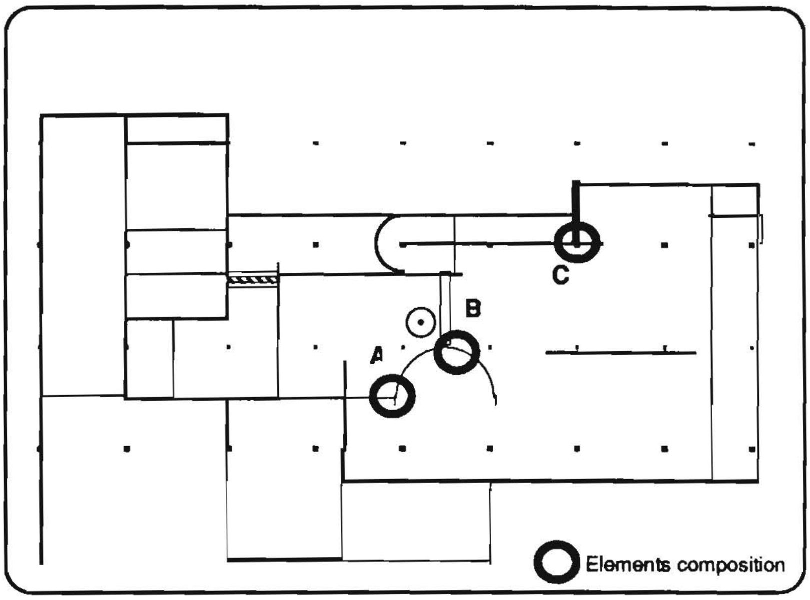


Figure 3
Occurence of of elements in other designs

Cruciform Column:
The combination of element 1 (the horixontal line) with element 2 (the vertical line) and element 3 (the arc) is noticable in Mies van der Rohe's design of the Cruciform Column of the Barcelona Pavillion.

Barcelona chair:
A refined composition of element 3 (the arc) with element 1 (the horizontal line) may be seen in the Barcelona chair.