Tectonic Visions in Architecture

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Tectonic Visions

in Architecture

What gives our dreams their darings is that they can be realized [1]

Le Corbusier

Architecture serves practical ends, it is subjected to use; but it is also shaped by ideas and fantasies, and these it can classify, crystallize, and make visible.
Very occasionally indeed the architectural crystallization of an idea may even precede the literary one […] [2]

Colin Rowe

Contents

Summary

Technology and its course of development are often claimed to be controlled by rational and economic powers. Although in architecture, there seems to exists an intrinsic relationship between building technology, practices of construction, and architectural form. Any sort of change in the thinking or practice of either field immediately affects the meaning or physicality of the other. As such, there is another driving force different from the pure rational one that shapes the architectural discourse.

This study explores this shaping power in architecture identifying it as, tectonic visions, which define: Visionary investigations into new materials, technologies, structures, and practices of construction, as means to construct (new) meaning in architecture. In this study, visions are regarded as an imaginary force and tectonics as a means for transforming architectural ideas into building. Identified as both processes and built results, they can be claimed to have carried transcending ideas that have affected the traditional development of building technology and changed existing perceptions and practices of construction. The study investigates the ontology of these phenomena – visions and tectonics – paying special attention to theories and practices that relate to building construction. The study equally analyses architectural design processes and follows how ideas transform into building. As such, it concerns not only the different realms of visions and construction, but in particular the range between the two.

Three visionary themes have been selected for further investigation. These themes can be claimed to have dominated the realm of architectural construction during this century; however, they also reflect fundamental discussions about the relationship between architecture and technology - discussions that have existed throughout architectural history.

The first theme, Process and Technology, concerns how architects approach new materials and implementation of industrial construction methods, exemplified by works of Mies van der Rohe and Le Corbusier, the second theme, Component and Composition, inquires into architectural component design and rational standards of prefabrication, illustrated by designs of Charles and Ray Eames, and Jørn Utzon. Finally, the third theme, Separation and Integration examines various building morphologies defined as different physical entities, through the work of Louis I. Kahn, and Alison and Peter Smithson.

The selected projects are perfect examples, showing how the dialogue between visionary intention and the extension of reality provides the basis for the making of architecture. In this context, the architectural design process can be regarded as a way to identify the immeasurable, or as a method to pursue something that is even greater than the ethereal dream, in order to supply architecture with a poetic dimension.

Therefore, tectonic visions in architecture depend on these processes and the architect's subjective reading of reality, as well as his/hers understanding of ideal visions. This way, the individual definition of the architectural ideal or utopia seems to form part of the theoretical basis for the design process. As such, each of the selected case studies must be perceived as products of various circumstances of their time, as well as an individual will to form, which explains why some of the architects seem to have fulfilled their architectural intentions, whereas others appear to have failed. This sort of paradoxical circumstance is analyzed by Robert Maxwell in his essay The Dialectics of Positions, in which he explains that even though utopia is regarded as a means to criticize the status quo, it may hold aspects that both are innovative and others that are reactionary. However, the objective of this study is not to decide which architects were right or wrong, or if they succeeded as technological innovators or architectural geniuses, but rather to show how different approaches to visions in architecture also affect the conceptual basis for the understanding of technology and vice versa. This way, the different case studies are perceived as parallel readings of their immediate reality, each of them providing critical answers to how one defines questions of construction within the reality of modern, industrialized building practices.

This study of tectonic visions in architecture aims to identify the intentions that architects bring into the design process and the meaning they translate into physical form with their projects. The architectural projects selected for this study can be regarded as architectural answers responding to critical problems existing within the individual building programs or prevailing at the time. Therefore, the building projects contain an ethical dimension that is important to recognize not only as a historical issue, but in particular when studying the potentials of future construction.

If not for the interest, support, and qualified criticism from a number of people, this work would never have reached fruition. Among these, I want to thank:

Associate Professor Peter Sørensen, for sharing with me his extensive knowledge about building practices - being a poet of construction himself.

My advisor, Associate Professor Torben Dahl, who has kept me focused and patiently waited for the dissertation to take shape.

My fellow Ph.D. students at The Royal Danish Academy of Fine Arts, School of Architecture, Copenhagen. Especially, Ola Wedebrunn for his consistent encouragement and Hilary Adler Fenchel, who has proofread the dissertation with great care.

From the University of Pennsylvania, I particularly want to thank:

Professor Marco Frascari, who invited me to study in the Ph.D. Program of Architecture, Graduate School of Fine Arts. Prof. Frascari's theoretical discourse is of great inspiration to me, and his sincere involvement in my work has played an important role.

Professor Joseph Rykwert, for pouring out so generously of his tremendous knowledge and for opening my eyes and senses to the classical treatises of Leon Battista Alberti and Vitruvius.

My friend and colleague, Franca Trubiano fellow student in the Ph.D. Program 95/96, from whom I have learned to pursue the essence in things.

The library and administrative staff at GSFA/Penn

- and the spirit of Louis I. Kahn.

Various people have provided me with helpful information and constructive criticism. Among these are:

Artist Morten Skriver and the late Professor of Architectural Theory, Jørgen Sestoft, who both have been critics in the early phases of the thesis in progress.

Dip. Arch, RIBA, James Strike, Bournemouth University, who encouraged me to study abroad, and whose own research within the field of architecture and construction has acted as a great source for inspiration.

Architect Peter Smithson, who has kindly provided me with important information about the Alexandria Library Competition scheme.

As part of the study, it has been necessary to travel and study abroad. Thus, I want to thank Margot & Thorvald Dreyers Fond and Statens Kunstfond for financial support.

Finally, I want to thank my patient family for the finest support and encouragement possible.

The original impetus to delve in-depth into the notion of tectonic visions in architecture stems from my participation in two research projects. The projects were carried out at the Institute of Building Science, Royal Danish Academy of Fine Arts, School of Architecture, in Copenhagen in the period from1991-1995.[3] Through to this research, I found that in contemporary architectural practice, there seems to be an inherent paradox in the relation between design processes and the actual practice of construction. Therefore, it seemed intriguing to examine the ideas that condition the development of architectural construction and design. Furthermore, practical experience, gained through my participation in designing and building an experimental housing project in the period 1992-1995, has supported my doctoral research. The project was entitled: Homogenous Masonry Construction. The design team included Torben Dahl and Peter Sørensen. The commission was to design a 24-unit experimental housing block, for the city of Slagelse. The client was, Fællesorganisationernes Boligselskab, supervised by KAB (The Housing Association of Copenhagen). The project was awarded in 1995 by DAL (The Federation of Danish Architects).[4] Having to deal with practical aspects of construction while working on this thesis has been a vital learning experience for me as practicing architect, and has proved to be essential to my research on the process of construction. Last, but not least, a year spent as a visiting scholar in the Ph.D. Program at the University of Pennsylvania helped me to collect and crystallize a series of ideas on the role of visions and tectonics in architecture.[5] Thus, it was during my studies at University of Pennsylvania that the contents and structure of my thesis evolved into its present form.

[1] Le Corbusier, The City of Tomorrow and its Planning, Dover Publications, Inc., New York, NY, 1987, p. 139

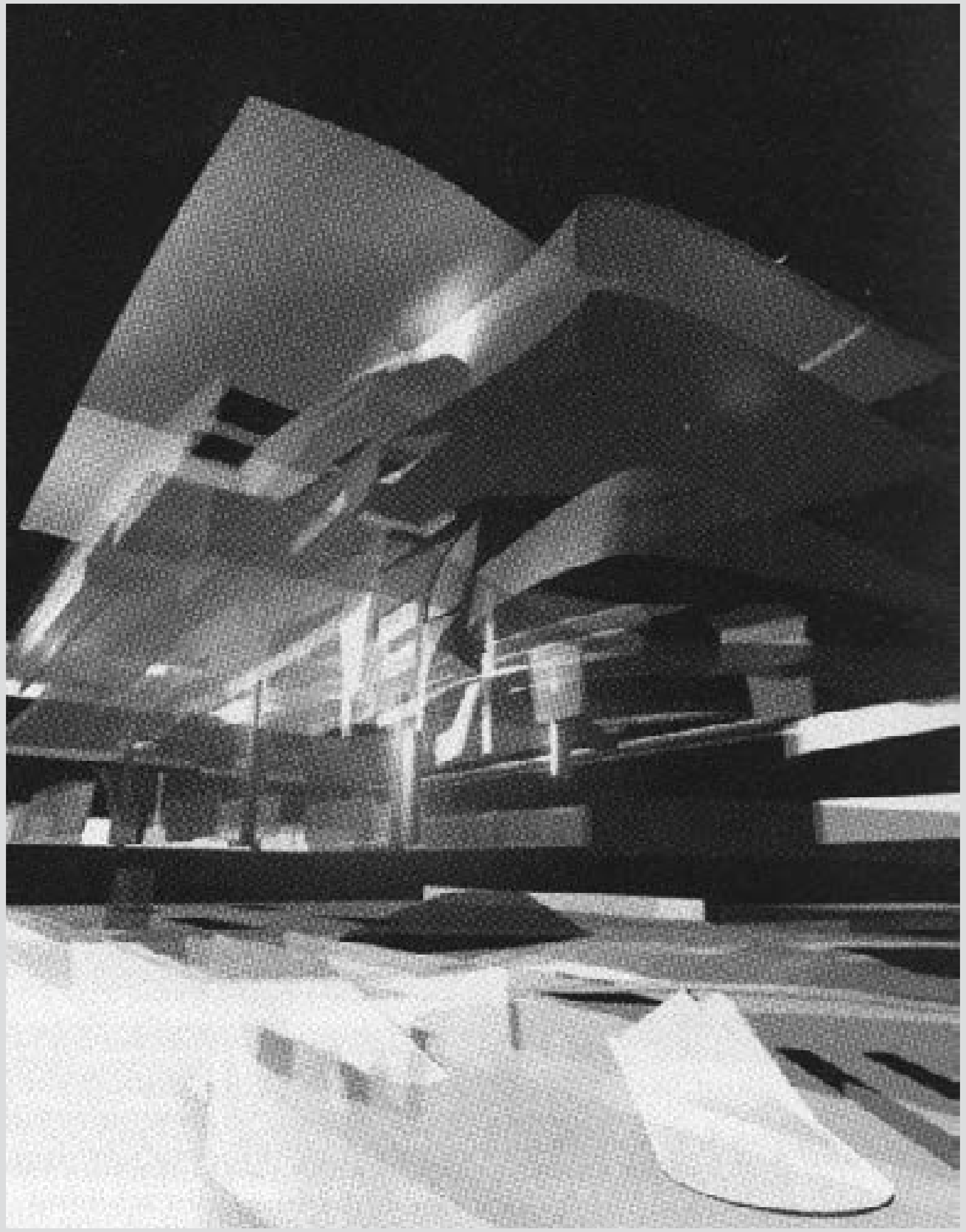
[2] Rowe, Colin, "The Architecture of Utopia", The Mathematics of the Ideal Villa, MIT Press, Cambridge, Massachusetts, ninth ed. 1993, p. 206

[3] These projects were: The Cavity Wall: Walls of Brick, New Products, New Perspectives, Torben Dahl and Peter Sørensen, Den Hule Mur – Et udviklingsprojekt, Forlaget Tegl/Kunstakademiets Arkitektskole, København, 1992, and Technique and Architecture: A Better Building Practice – Year 2000, Arkitekten, (Special Issue), No. 17, 1995, Arkitektens Forlag, København, 1995. These projects are summarized in the booklet, Building Science, Institute of Building Science, The Royal Academy of Fine Arts, Ministry of Cultural Affairs, Copenhagen, 1998, p.10/26

[4] Beim, Dahl & Sørensen Arkitekter MAA, Homogen Mur: et udviklingsbyggeri – Mølletorvet i Slagelse, Eget forlag, København, 1997

[5] During the visit, I wrote the papers: The Cosmology of Glass: Bruno Taut and the Glas Haus, The Notion of Technology in the Vocabulary of Mies van der Rohe, and The Notion of Space in the Schröder/Schräder Huis. The Glass paper was rewritten into the essay: Bruno Taut and the Glass House - The Infinite Dream of Translucency, and presented at the 1996 ACSA European Conference: Constructions of Tectonics for the Postindustrial World, in Copenhagen.

Concepts and Themes



Introduction

The Aim of the Thesis

The aim of the thesis is:

- to unfold the concept of tectonic visions in architecture;
- to investigate building technology and practices of construction as carriers of meaning, apart from the instrumental and economical point of view;
- to discuss construction technology at an abstract level through visions and ideas, as well as in specific terms through materials, their processing and use;
- to provide a more profound understanding of the ideas and processes that delineate the development of building construction and architectural design;
- and to contribute to the forging of a critical attitude towards construction as an ethical dimension in architectural design.

Reflections on Contemporary Construction Practice

This century is representing the shortest time span in which the largest range of human activities has undergone the most radical changes. Industrialization - that is, mechanization of manufacturing, prefabrication, mass production, and transportation - has reached maturation. Moreover, refined technologies and computer science have influenced and changed most professional fields, from the laboratories of natural sciences to general production industries.

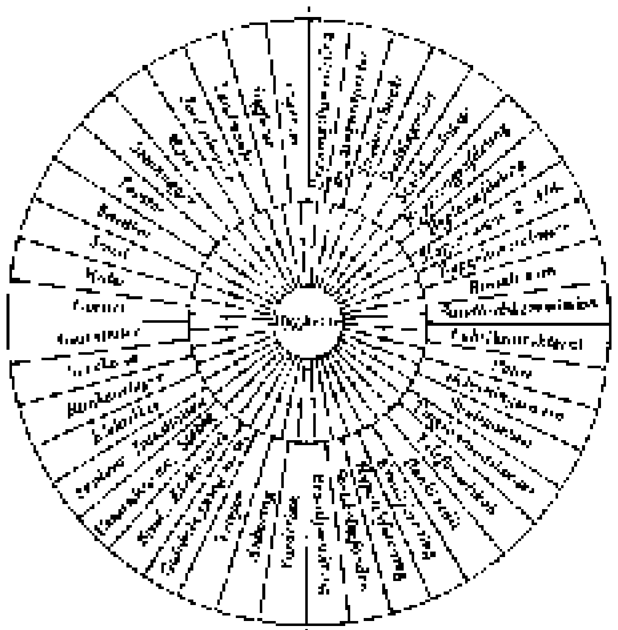
Now, at the turn of the century, modern man and society are facing a new era shaped by the critical consequences of industrialization and modern technology. Technological progress and an increasing implementation of computer technology into everyday life will eventually lead to a society based on information and communication technology that will create the backdrop for The Cyber Age.

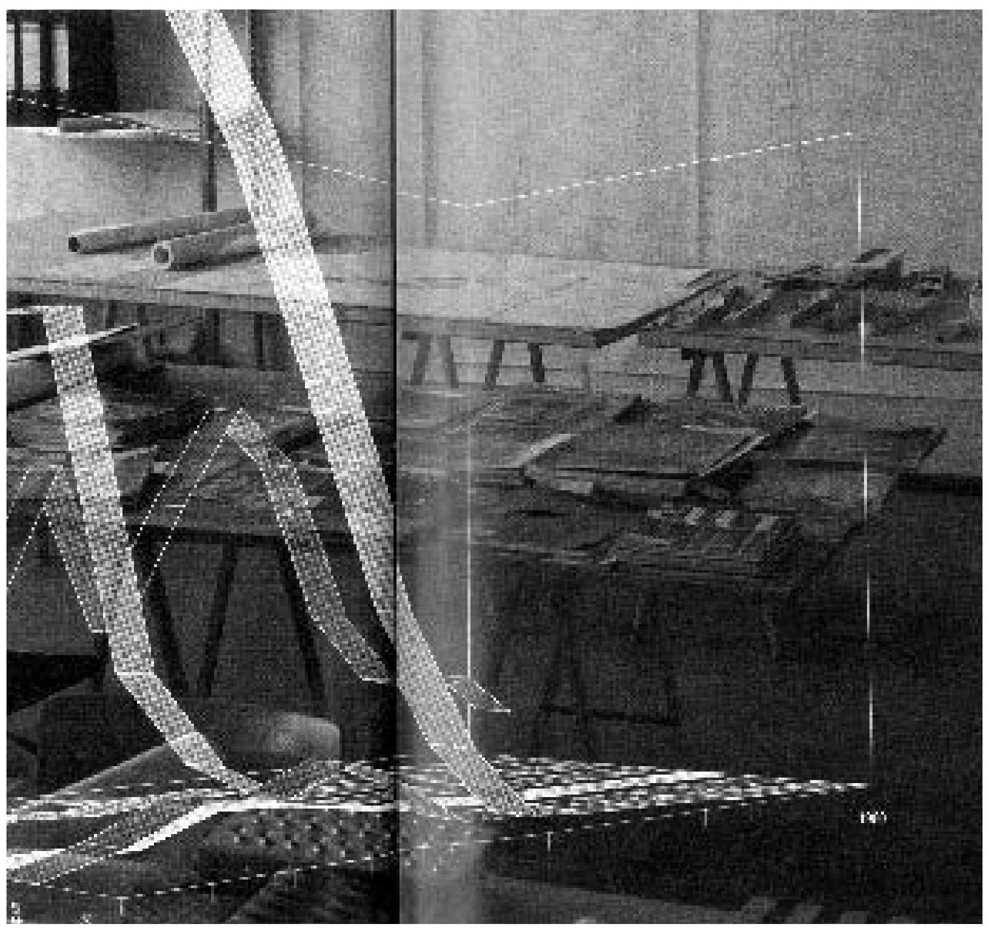
Considering these circumstances, (the concept of) technology as we know of today will assume new dimensions, and thus it is relevant to question modern construction practice as it has developed during this century in order to approach its future potentials.

The process of building construction has always been a complex affair, involving a large number of decision-makers: clients, technical consultants, building contractors, and public authorities. Today, this is truer than ever, since contemporary construction business has grown increasingly bureaucratic and specialized. Some of the circumstances giving rise to this situation are formal; others concern the changing roles of the actors involved in the building process. Building legislation has become more and more restrictive through the years, and the number of building codes and standards have increased, creating a jungle of regulations that must be met.[1]

1
Computer simulation
of structural elements
Project for the Central Station
in Arnhem, Holland by
UN-Studio / van Berkel & Bos
1996

In most building projects with the possible exception of single-family housing, the ultimate decision-maker - the client - is no longer just one person with a clear





2
Diagram published in the first issue of Arkitekten Weekly, 1927 showing all the actors that are involved in the phase of construction. They range from various contractors to building authorities. The client is situated in the center.

3
The office-site of the O.M.A.-office, 1995.
Rem Koolhaas and Bruce Man.

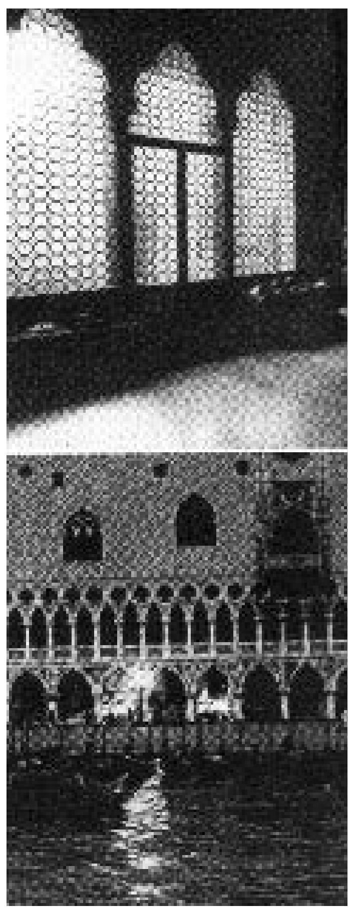
view of needs that are to be fulfilled in the final project. The single client has been replaced by a committee, increasing the number of potential decision-makers. Therefore, the interaction between the various decision-makers, the consultants, the architect, and the contractors has become even more complex. Moreover, today's architect is no longer considered as the leading, all-embracing figure of the building process, but is often relegated to the role of 'yet another consultant', who mainly deals with issues of aesthetic appearance.

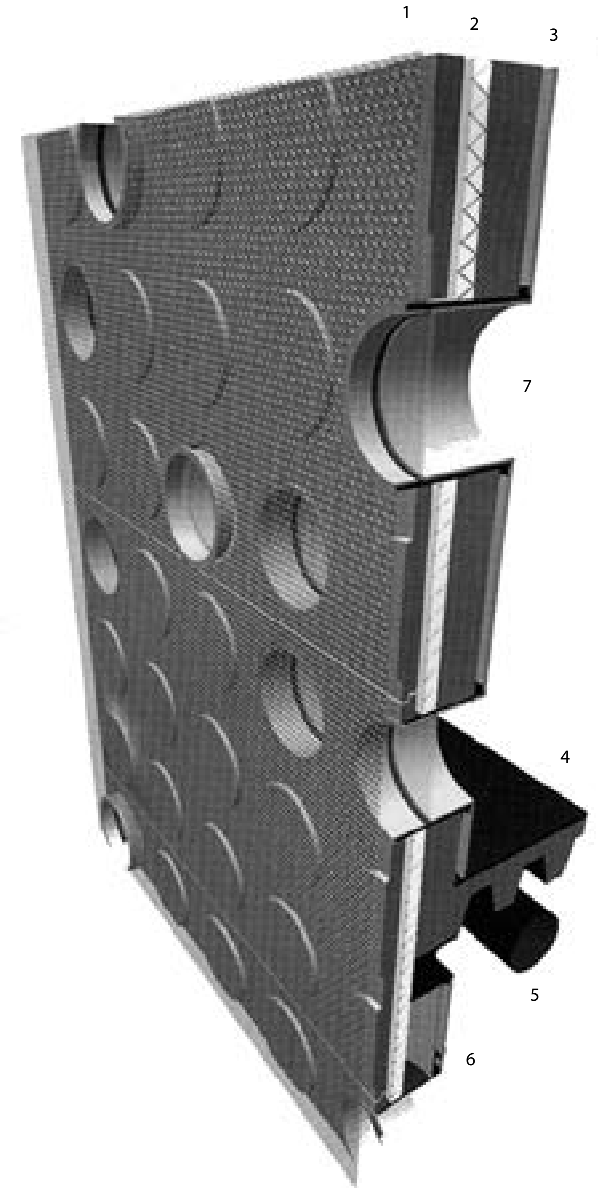
Why the role of the architect has changed may be due to changes in how architecture is practiced. This change entails, among other things, an increased emphasis on matters of administration (office site), hereby distancing the design process from the realities of execution (construction site). Increasing specialization of the professions that deal with construction may also be considered as an aspect effecting such changes. Construction management, planning and control are often in the hands of 'experts' in supervising (engineers), in isolation from the designing architect. Thus, there are more links in the chain of communication, and questions of construction are further removed from the design process and the designer's intentions. The result we too often observe is an architecture lacking of coherence.

Another change we see on the current scene concerns how both architects themselves - and others in the field of building and design - identify their own professional role. Few architects and architectural offices are professionally involved in the development of new technologies that will benefit both design and construction practices.[2] But, who better to design e.g. the details of an extruded aluminum frame for windows, or define the aesthetic, functional and technical qualities of a composite wall made of seven different layers of materials?

Sensitivity to cultural setting, a knowledge of regional building traditions and craftsmanship, and attention to the site and environmental context do no longer seem to be essential design parameters for the modern architect. Several of the world's most prominent architectural offices have turned into large, international firms, which offer solutions to any architectural problem for any kind of client, anywhere in the world. The omnipresent Sir Norman Foster is a perfect example.

Contemporary architecture seem to pursue a form of architectural homogeneity and general standard in order to satisfy an unidentifiable clientele. In much the same vein, the increasing industrialization of building construction has apparently resulted in a deterioration of the cultures of traditional craftsmanship. Whiping away crafts which have slowly developed over thousands of years.
This circumstance may be due to industrial construction practices aim at mechanical procedures that are totally different in nature, compared to traditional building practices that are grown out of an empirical approach based on the





4
Venetian references. UN-Studio / van Berkel & Bos.

5
Mesh-like facade system. With round glass bricks for daylight. Designed for the project for the faculty of Architecture, the University of Venice. UN-Studio / van Berkel & Bos. 1998.
Facade Panel:
1. Metalmesh screen
2. Prefabricated concrete panel
3. Interior finish, painted wooden panels
4. Floor og metal or wood
5. Additional element
6. Ceiling of metalmesh screen
7. Porthole of metal with fixed glass bricks

work of the hand. This consideration can be applied to architectural design as well. The aesthetic quality of industrial design depends on careful detailing and often lengthy speculation, hereby defeating the aim of rationality and time saving procedures that are the essence of industrialization.

It is often claimed that modern building construction evolves very slowly, compared to other branches relying on industrial production technology, e.g. shipbuilding or automobile design. Nevertheless, there is no doubt that the acceleration of industrialized processing and the technical development during this century have revolutionized traditional construction practices. This has lead to construction details of high complexity and a great number of new building materials. However, building industries, contractors, and architects have adopted these new practices of construction and materials without any thorough evaluation of the aesthetic consequences of such processes and products.

Contemporary construction practices bear witness to a strange cocktail. Often, low-tech procedures based on manpower and traditional craftsmanship are mixed with mechanized high-tech processes. Therefore, in light of the amount of know-how that is accumulated within the construction industry, the great number of technological innovations, and progressive ideas that distinguish architecture of this century, one should expect a synergistic relationship. But is there?

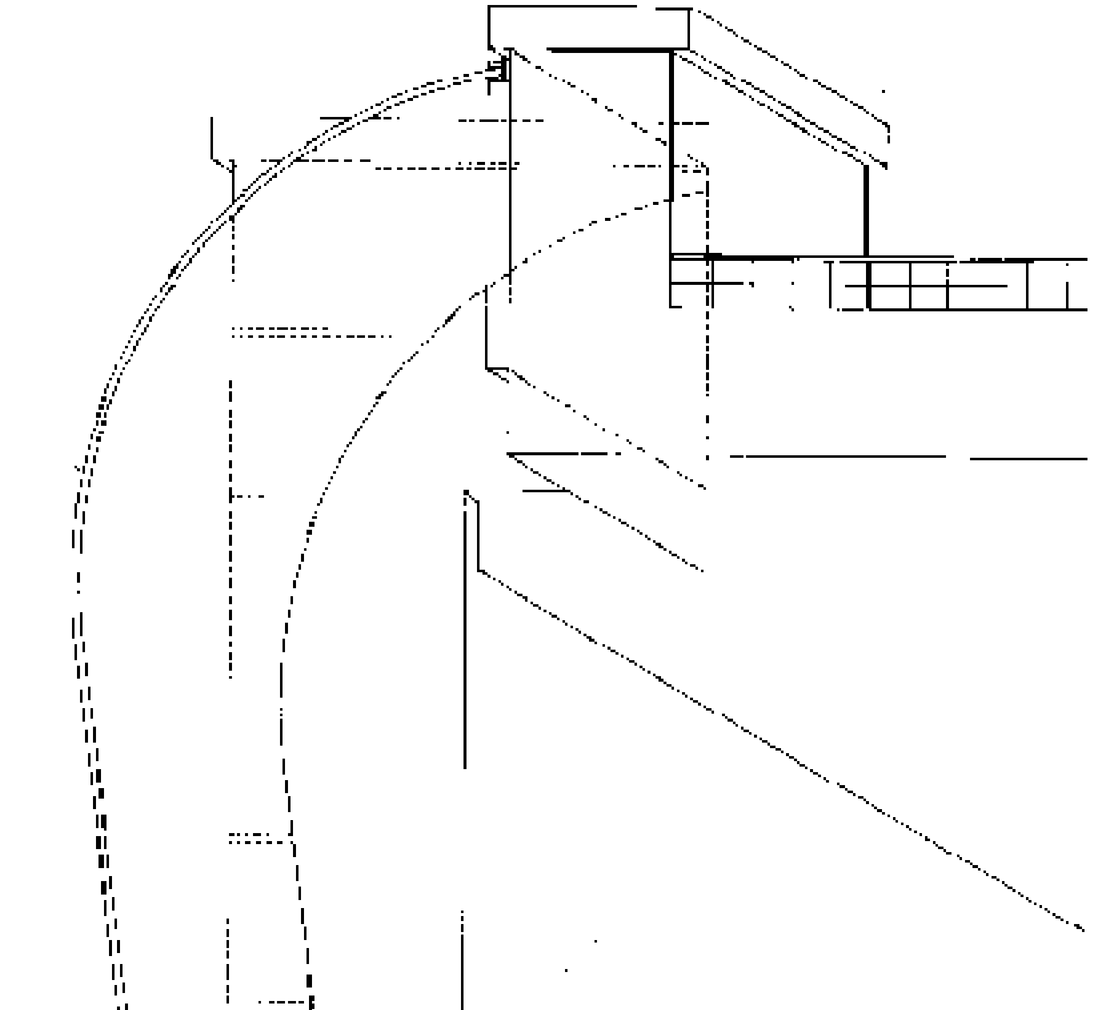
The paradoxes that characterize contemporary construction practice seem endless in number. Thus, one is tempted to ask:

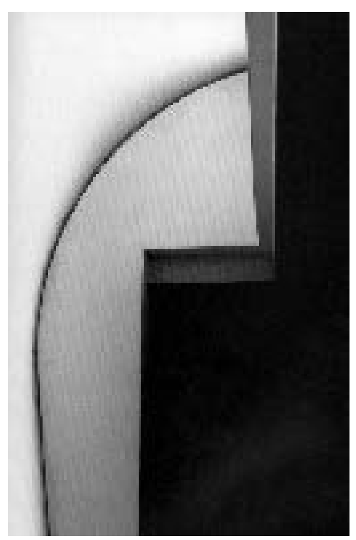
- What sort of ideas and elements determine practices of construction?
- Why have certain ideas changed practices of construction, while others remained but a flash of thought?
- Why do most visions in architecture end up with a physical result at variance with the original thoughts and motives?
- Why have contemporary architects not yet elevated construction technology to a higher level of sophistication, in light of their fascination with plane and car industry for the past century?

This series of reflections about contemporary practices of construction, the identity of the modern architect, and the architectural consequences of increasing industrialization describes the background upon which my professional experiences were mirrored and upon which the theme for my dissertation found a voice.

The Scope of the Study

This study explores the notion of tectonic visions and how they are reflected in architecture. In this context, visions are regarded as an imaginary force and tectonics as a means for transforming architectural ideas into building. As such, tectonic visions can be defined as: Visionary investigations into new materials,





6 - 7
Window detail of the Stretto House, Texas - 1989-92 by Steven Holl.
"The texture of a Silk drape, the sharp corners of cut steel, the mottled shade and shadow of rough sprayed plaster or the sound of a spoon striking a concave wooden bowl, reveal an authentic essence which stimulates the senses."

technologies, structures, and practices of construction, as means to construct (new) meaning in architecture.

Identified as both processes and built results, tectonic visions can be claimed to have carried transcending ideas that have affected the traditional development of building technology and changed existing perceptions and practices of construction. The study sets out to investigate the phenomenology of visions and tectonics - paying special attention to theories and practices that relate to building construction.

The study equally analyses architectural design processes and follows how ideas transform into building. As such, it concerns not only the different realms of visions and construction, but in particular the range between the two. Three visionary themes have been selected for further investigation. These themes can be claimed to have dominated the realm of architectural construction during this century; however, they also reflect fundamental discussions about the relationship between architecture and technology - discussions that have existed throughout architectural history.[3] The themes concern three fundamental aspects of construction: structural materials and analysis of their properties; construction elements and their composition; and building organization in relation to the use of building services. As such, the study examines tectonic visions as generators of new perceptions of architecture.

Theoretical Point of Departure

Technological development is often claimed to be controlled by rational powers of a socio-ecomic nature. However, in architecture there seems to exist an intrinsic relationship between construction and architectural form that refers to a different value system. Any sort of change in the thinking or practice of either field immediately affects the appearance and meaning of the other. As such, building technology and practices of construction can be regarded as sources and agencies of meaning in architecture. In contemporary architectural theory and history this definition of construction is related to the notion of tectonics. As a theoretical approach to construction it has developed into yet another architectural discourse over the past decades.

The American scholar, Kate Nesbitt, who recently edited the anthology; Theorizing a New Agenda for Architecture, describes this discourse as:

…a phenomenological approach and interest in the 'thingness' of architecture, which can be recognized as a criticism of both 'formulaic corporate modernism' and 'superficial postmodern historicism'.[4]

Today, there are several schools of thought that provide each their definition of construction and how it manifests itself as a poetic (tectonic) or instrumental (technological) force in architecture.[5]

Especially, the pivotal work by Kenneth Frampton, Studies in Tectonic Culture: The Poetics of Construction in the Nineteenth and Twentieth Century Architecture has provided significant material for this renewed discussion on architecture as a constructional craft. Together with Kenneth Frampton's Studies in Tectonic Culture, the most influential source material for this study has been definitions and theories offered by professor Marco Frascari, especially those presented in the essay, The Tell- The-Tale Detail. In this essay, Frascari unfolds the notion of signification in the construction details of Carlo Scarpa, relating architectural design processes with those of construction. Analogous to Vitruvius's axiom of the signifying and the signified, Frascari applies the terms, construing and construction.[6]

These concepts relate to the theoretical discussion about the distinction between 'techné of logos' – which refers to the reflective and mental components (rhetoric), and 'logos of techné' – that refers to the operative and manual components (technology). According to Frascari, the notion of (building) technology is double faced, containing both poetic and physical qualities that provide meaning in architecture. Regarded as such, this ambiguity furnishes architectural constructions with a dynamic dimension that allows for various interpretations and continual exploration. Frascari claims further that:

…the use of these binomials returns architecture to its original nature as a discipline with a system of knowledge that can be transferred into the instrumental knowledge necessary to practice of construction.[7]

This critical field between construction and construing identified by Frascari forms the theoretical framework of this study and seems to hold potentials of new ways to approach questions of technology in architecture.

Structure of the Thesis

The thesis consist of three parts: Part I: Concepts and Themes frames the study as a whole, defining terms, ideas, and theories that are essential to the discussions of the following chapters. It is divided into three chapters:
Introduction, which renders the scope of the study; Ideal Visions: Architectural Utopias, which describes the concept of visions in architecture; and Tectonics: Constructing Form that unfolds the meaning of technology and construction in architecture. Part II: Case Studies consists of inquiries into construction, examining architectural building projects generated by tectonic visions. It is divided into three primary chapters that refer to three tectonic themes:

- Process and Technology: The Dream of Industrialized Building
- Component and Composition: In Quest for the Ideal Building System
- Integration and Separation: The Building as Organism or Machine

The first theme, Process and Technology: The Dream of Industrialized Building, concerns the potentials of new structural materials and their processes of construction. The second theme, Component and Composition: In Quest for the Ideal Building System, deals with the prefabricated building component as a parameter of design. Whereas, the third theme, Integration and Separation: The Building as Organism or Machine, concerns principles of building organization in relation to environmental control. Each theme is studied through two case studies that represent different approaches to the same vision about new building technology and practices of construction. Finally, Part III: Conclusion, forms a discussion about the ethical dimension of the ideas and construction methods presented in the case studies.

Ideality - Reality

In one sense, the selected building projects can be characterized as utopian statements because they suggest ideal solutions to common architectural problems and, in the course of time, their visionary ideas have become models for other architectural projects. Various ideas have turned into common features in modern architecture, e.g. the fenêtre en longeur (strip window) of Le Corbusier or the flexible open-plan solution, as in the medical research laboratories of Louis I. Kahn.

However, the selected projects are embedded in reality, since they are built or were meant to be built.[8] Therefore, the ideas that drove the designing architect have been confronted with the limits of contemporary construction industry, the will of the client, and the general spirit of the professional environment. This presence of both ideality and reality in the building projects raises the question: can architecture fulfil the ideal, when it must be modified to the shortcomings of reality?

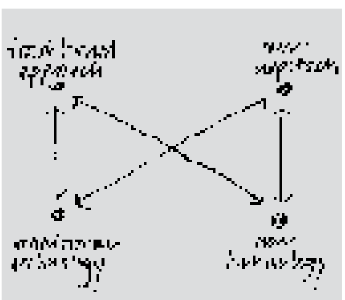
The British architect and architectural historian, James Strike, who has dealt with this architectural paradox, claims that;
The architectural design process raises building construction above the singularly physical solution to a higher mental level, which brings together the intellectual forces and aesthetic considerations with the physical requirements.[9]

Strike's argument automatically raises the question: does architectural design (aesthetics) determine building construction (technology) or does building construction (technology) determine architectural design (aesthetics)? Or rather, how do architectural design and construction technology interact and evolve, and what sort of basis do these elements provide for one another in order to reach an architectural ideal or to bring forth paradigmatic shifts?

At first glance, these questions suggest two ways by which architectural design as well as construction evolve. The first way is defined by the designers/ architects, who envision new sorts of architectural spaces and morphologies that consequently bring about new structures, new types of construction technologies, exploration into new materials - or a renewed approach to existing materials and methods of construction.

The second way is formed by traditional (scientific) progress within the production industries. This is usually characterized by development of new technologies, the improvement of fabrication procedures and solutions to problems in contemporary products and processes. By this, different materials and new technologies gradually become integrated into the building industry and provide the architect with an extended range of design options.[10]

Questions of Approach



This circumscription may clarify how architectural design and construction may change and develop. Roughly characterized - the architect may assume different approaches to issues of construction, which can be illustrated as follows:

The architect pursues either a traditional approach, based on prevailing ideas or a visionary approach, based on new/transcending ideas. These two sets of approaches relate to either traditional technologies, or new technologies.

However, opposite movements may also happen, where different sorts of technologies inspire different approaches and equally form a new setting for their original standpoint. See illustration.

This attempt to explain the dynamics of technology and architecture simplifies the overall complexity of these issues, since most changes embody several elements at once. However, the illustration may help to identify architectural approaches to these issues at a general basis and to explain the particular course of this thesis.

Process as Method

Architecture wrote the history of the epochs and gave them their names. Architecture depends on its time. It is the crystallization of its inner structure, the slow unfolding of its form.[11]

Mies van der Rohe's theorem suggests that architecture embodies a two-way movement, it forms its time as well as it is formed by time. Together, these forming movements describe the dynamics of architectural history, which reflects immediate reality, as well as embodies elements of the past and prophecies for the future. Acknowledging these dynamic movements as essentials of architectural production, it therefore seemed obvious to strive for the same nature of processing ideas for this thesis. This meant to introduce several ideas and layers of thought that could be read simultaneously in order to provide a new understanding of the history on visions and construction in architecture. Instead of the common linear perception of cultural events and technological innovations that seem to have led from one thing to another, the thesis was to be structured as a matrix of thoughts describing various approaches to a number of tectonic themes.

However, several attempts were made to define the essential questions of the thesis in order to reach these conclusions.The first draft for the study concerned Ideal projects reflected in architecture and construction. Ideal visions were exemplified through architectural projects from 1750 - 1995. These were broadly identified as 'visionary' - ranging from pure paper-fantasies to built projects. Therefore the scope of study slowly grew into a vast historical survey of technological development and culture in general.

See the folded chart in the back.

In order to specify the criteria for selection and test the appropriateness of the various projects, the Einstein Tower was tried as a model. The project was analyzed according to my initial ideas of how visionary architecture evolves and slowly transforms into typical architectural constructions. See the diagram page 22.

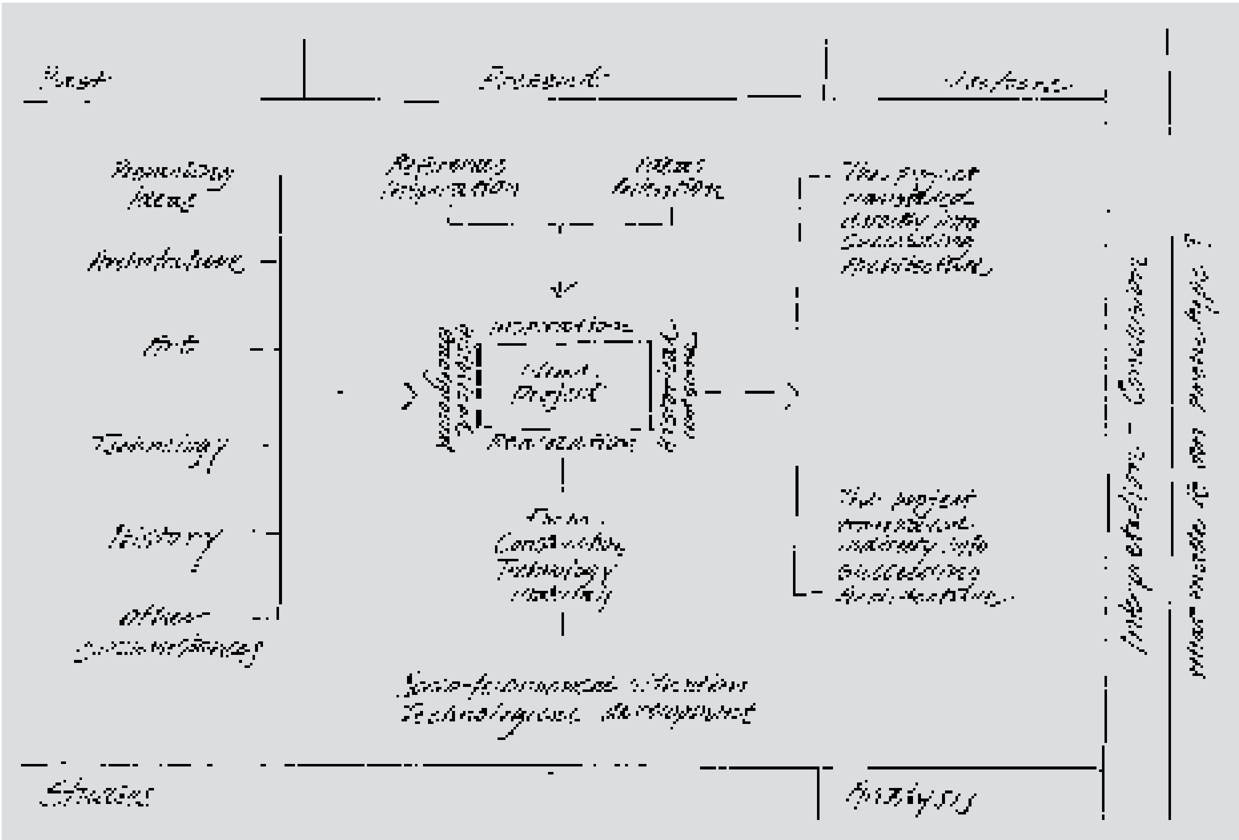
The Einstein Turm (1919) by the German architect Erich Mendelsohn represented an illustrative example of how building projects can emerge from an ideal vision. Mendelsohn believed that Einstein's Theory of Relativity could be translated into a structural composition that fulfilled the functional requirements of an astronomical observatory, as well as providing the theory with some sort of architectural terminology.[12]

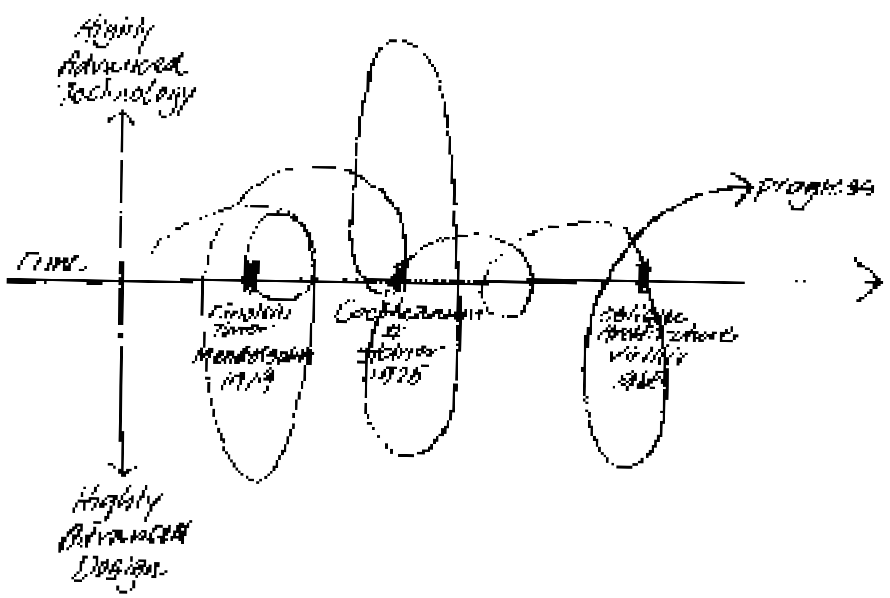
Even though the Einstein Tower is considered an architectural monument, it has hardly inspired to similar experimentation. The difficulties in constructing the organically molded structure may explain this in part. In addition, the specific scientific purpose of the tower and Mendelsohn's individual architectural style might have made it too controversial and unique an object to become an architectural model. The studies showed that the Einstein Tower primarily reflected formal intentions rather than pursuing questions of construction and therefore it did not represent a pertinent type for the study.[13]

Furthermore, the schematic approach to the subject seemed too rigid, since investigations into new technologies and methods of constructions showed different aspects of how they slowly get implemented into architecture.

In order to examine this further, another theory was tried, illustrated by the butterfly-model, which combined two barely comparable concepts, aesthetic

8
Diagram showing principles of how to approach technology.





9
Diagram showing the first assumption of how visionary architects evolves.

10
Butterfly-model, illustrating the development of in-situ concrete construction related to different architectural visions.

intention and technological innovation. However, this model still sustained a sort of Cartesian approach, relying on logical inference between cause and effect. See illustration

Acknowledging symbolic and poetic aspects as important parameters for the making of buildings and reading of construction, it thus seemed appropriate to bring these elements into the field of investigation. This process of thought led to a thematic matrix combining the two different angles of approach the descriptive (concerning tangible matters) and the symbolic (concerning intangible matters).

Altogether these initial studies helped to identify which architectural examples to include, to define the central themes and to clarify a method of approach. Incidently, Giedion has provided a very precise description, that fits the essential nature of this study very well:

The architect is little interested in when or by whom a certain building was erected. His questions are rather: what did the builder want to achieve and how did he solve his problems? In other words, the architect is concerned with searching through previous architectonic knowledge, so that he can immediately confront contemporary architectural aims with those of a former period.[14]

Similar to the architectural pursuit described by Giedion, this dissertation does not follow any historical, chronological format, but rather examines seminal ideas and architectural projects that identify themes of tectonic visions from this century. Regarded as such, the study is a selected focus on 'the history of tectonic visions in architecture', where each of the case studies is looked upon strictly in accordance to the subject of its theme. This way, much of the designing architect's biographical informations have been left out as well as their general architectural production is only scarcely touched upon. Nevertheless, this is all intentional since the aim of the study was to discuss construction details as well as tectonic ideas. However, this modus operandi cannot be taken into full account of the complex and interweaving events, which shape architectural history altogether and therefore each of the themes as well as the selected case studies must be perceived within a wider context of ideas, historical/cultural events, and architectural works that are excluded from the scope of the study.

[1] The energy crisis in 1973 had a worldwide affect on the requirements for insulation; moreover a couple of serious hotel fires in the early 70's in Denmark generated more restrictive fire regulations. Furthermore the national and international standardization programs (DS, Danish Standard and ISO, the International Standardization Organization) have added yet another set of rules regulating the process of designing construction.

[2] Prominent High Tech architects such as Nicolas Grimshaw, Sir Richard Rogers, Renzo Piano, and Sir Norman Foster represent this field of construction design.

[3] Through the ages, different kinds of theoretical systems have been developed and applied in order to categorize various aspects of architecture. Both practicing and theorizing architects have been contributors to these systems of definition. Vitruvius, Roman architect and engineer (first century BC), authored the oldest and most influential work on Western European architecture, De re Architectura. Vitruvius formulated the classical theories applied to architecture and identified the architectural triad, Firmitas, Utilitas and Venustas. Firmitas refers to the field of structure, construction and materials, Utilitas refers to use of the building and how to secure a 'successful functioning', and Venustas refers to aesthetic questions, such as composition and proportion.

Another much later example, which was published along the Gothic debate in France between the Ecole de Beaux Arts and Ecole de Polytechnique, is the treatise of Leoncé Reynaud (1803-80). Reynaud published his lectures at Ecole de Polytechnique under the title Traite d'architecture (1850-58). According to Vitruvian tradition, he divides his treatise into three parts: commodité, solidité and beauté. The first part deals with structural materials and with the scientific analysis of their properties. The second part deals with the elements of architecture (that is, columns, beams, apertures, vaults, and so on, considered as much from the point of view of construction as from the aesthetics); the final part deals with composition, that is to say with various building types, and the way in which different programs of requirements had been fulfilled at the time he wrote.

Kruft, Hanno-Walter, <u>A History of Architectural Theory: from Vitruvius to the Present</u>, Zwemmer, London, 1994, pp. 280-281 and Collins, Peter, <u>Changing Ideals in Modern Architecture 1750-1950,</u> Faber & Faber, London, 1965, pp. 192-193

The thematic structure of this study reflects a similar classical format, dealing with structures/constructions, composition, and organization. This disposition was not intentional, but came about automatically while working on the thesis.

[4] Kate Nesbitt is Ass. Professor at the University of Virginia. Nesbitt, Kate, <u>Theorizing a new Agenda for Architecture: An Anthology of Architectural Theory 19965-1995</u>, Princeton Architectural Press, New York, 1996, p. 494

[5] Works with a conceptual approach: Frampton, Kenneth, <u>Studies in Tectonic Culture: The Poetics of Construction in the Nineteenth and Twentieth Century Architecture</u>, MIT Press, Cambridge Massachusetts, 1995; Hartoonian, Gevork, <u>Ontology of Construction: On Nihilism of Technology in Theories of Modern Architecture</u>, Cambridge University Press, New York, NY, 1994; Alberto Peréz-Goméz, Steven Holl & Juhani Pallasmaa, <u>Questions of Perception: Phenomenology of Architecture</u>, A+U, July, Special Issue, 1994 ;

Marco Frascari, "The Tell-The-Tale Detail", <u>VIA 7</u>, The Building of Architecture, 1984, pp. 23-37

Works with a historical approach: Edward R. Ford, <u>Details in Modern Architecture I-II,</u> MIT Press, Cambridge Massachusetts, 1994/1996

Cecil D. Elliott, <u>Techniques and Architecture</u>, MIT Press, Cambridge, Massachusetts, 1994; Tom Peters, <u>Constructing the Nineteenth Century,</u> MIT Press, Cambridge Massachusetts, 1997; James Strike, <u>Construction into Design: The Influence of New Methods of Construction on Architectural Design 1690-1990</u>, Butterworth Architecture Oxford, 1991

[6] Frascari's reading of Vitruvius's axiom reflects a semiotic discourse in architecture. According to Frascari, these concepts come together in a dialectic relationship in the architectural detail or joint, as a unit of architectural production and signification. Furthermore, he identifies the detail/joint as a generator of construction and meaning, as the site of innovation and invention. Marco Frascari, <u>Monsters of Architecture: Anthropomorphism in Architectural Theory</u>, Rowman & Littlefield Publishers, Inc., Savage, ML, 1996, p.117

[7] Ibid.

[8] The L'Esprit Noveau Pavilion and the Alexandria Library scheme.

[9] Despite the fact that James Strike recognizes these circumstances, he argues that construction is not perceived this way today and calls for architects who will pursue a different conduct. Strike, <u>Construction into Design</u>, p.1

[10] This categorization partly reflects the structure of the supporting argument of the hypothesis in Strike's <u>Thesis for a M. Phil. In Architecture,</u> submitted to The Institute of Advanced Architectural Studies, University of York, in 1988. The thesis has subsequently been edited into the book: <u>Construction into Design</u>. Strike focuses on, "the aesthetics that are inherent within construction, and generated by construction, rather than aesthetics which are forced into construction" (p.7) This thesis explores both issues.

[11] Architecture and Technology, was a speech presented at the IIT in Chicago, 1950.
Ludwig Mies van der Rohe, "Architecture and Technology", <u>Architectural Review</u>, vol. 67, no. 10, 1950, p. 30

[12] Erich Mendelsohn was a close friend of the German astrophysicist Erwin Finley Freundlich, who assisted Albert Einstein at the University of Prague in the period around1910-15. In 1913, Freundlich introduced Mendelsohn to the general theory before Einstein had completed his formulation of it, and before it was generally known among the small community of scientist. After WWII, Freundlich wished to prove relativity through astronomical observations and searched for proper facilities where he could mount the attempt. He tried to get access to the equipment at Babelsberg in Berlin, but the director refused. Freundlich decided to build his own observatory and began to plan a project together with Mendelsohn in the period from 1914-18. Mendelsohn envisioned the tower to be constructed in reinforced concrete and designed the observatory tower to be a total organic form. At the time, concrete was regarded as an extremely flexible construction material, with its fluid, moldable and castable properties, and to Mendelsohn, this new material represented similar dynamic potentials as the Theory of Relativity. The articulate curving cladding construction of the tower was too advanced for contemporary construction industry and thus it was built as a masonry construction covered with plaster to resemble the original intention. The Einstein Tower was way ahead of its time and a much more feasible construction today, when computer aided design tools and highly evolved concrete casting methodology can be applied. Kathleen James, "Expressionism, Relativity and the Einstein Tower", <u>JSAH</u>, 53:4, December, 1994, pp. 395-397

[13] "It is absolutely vital to building and structural form for the artist to realize his artistic intention accordingly", Mendelsohn, Eric, <u>Eric Mendelsohn: Letters of an architect</u>, ed. Oskar Beyer, Letter, Munich, March 14th, 1914, p. 30

[14] Giedion, Sigfried, <u>Space, Time and Architecture: The Growth of a New Tradition</u>, "Jørn Utzon and the Third Generation", Harvard University Press, Cambridge Massachusetts, 5. Edition, 1982, p. 670

11
Video Gallery in Groningen, Holland. 1990.
Bernard Tschumi.

Architecture reflects, materializes and eternalizes ideas and images of ideal life.[1]
Juhani Pallasmaa

This chapter deals with the notion of vision in relation to architecture.

As constructions of thought, visions are associated with concepts such as ideals and utopias. Similar to visions, ideals and utopias reflect the desire to either improve or change present conditions; thus, it is essential to describe their conceptual nuances and ontological differences.

The object of this chapter is to construct a conceptual framework for the visionary themes discussed in the succeeding chapter, Case Studies. This is important, not only because each of the case studies reflect various visionary intentions, but also because they represent different architectural approaches to the same question how to envision new architecture.

Designing – Imagining - Envisioning

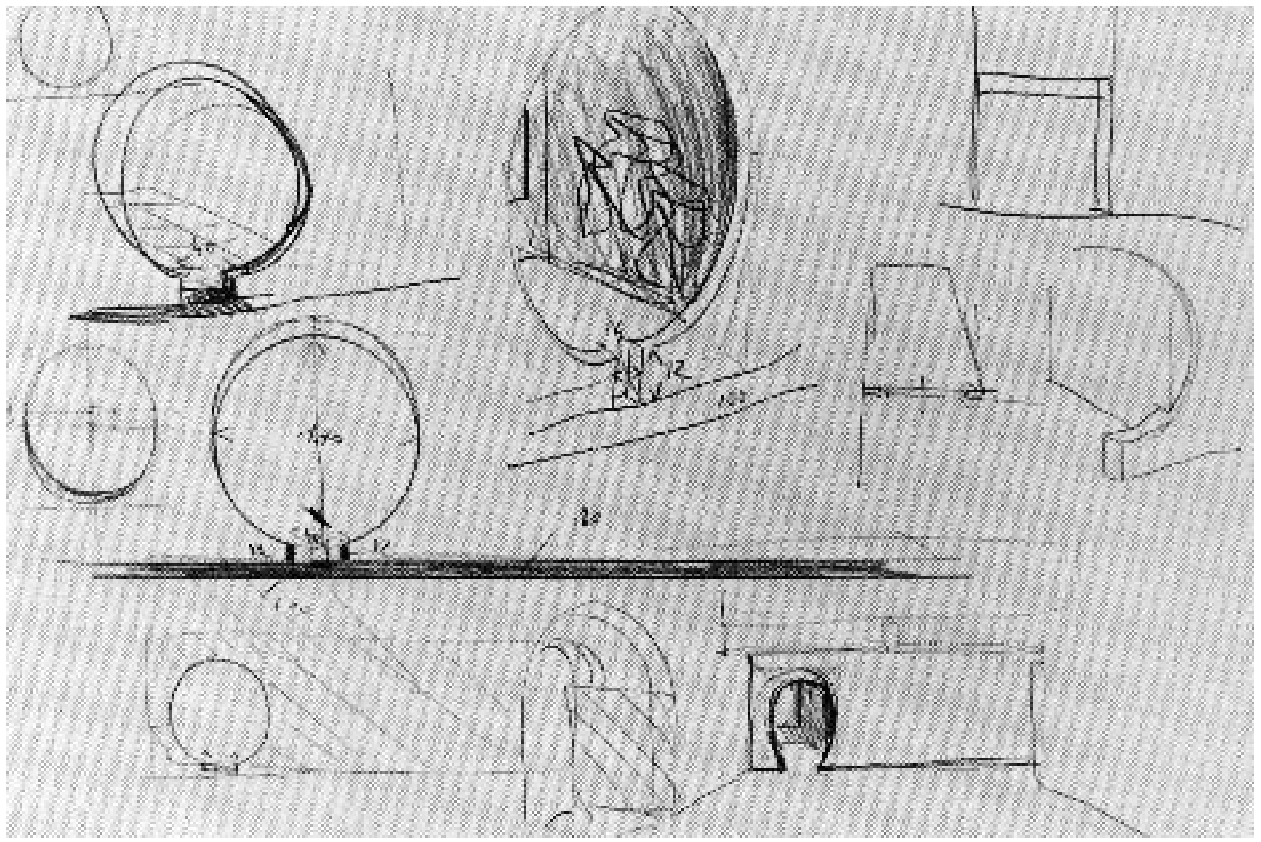
In common literature of architectural history, the concept of architectural visions is primarily dealt with as levels of thought applying to socio-political realms or pure abstraction. However, architectural vision as a process of thought associated with the actual creation of architectural design seems to have been ignored. The following notes pursue this aspect of visionary action in relation to architecture.

Dreaming, fantasizing and imagining have always been a fundamental part of human activity and nature. As constructions of thought, they depict 'another world', and thus represent a mental refuge or ideal solutions to present reality. These sorts of actions form a significant part of the basis of how built spaces come into existence in architecture.

The architect employs his imagination in order to design architectural spaces. As for imagining, the French philosopher, Gaston Bachelard, (1884-1963) writes:

> […] images are certainly units of reverie [dreams] But these units of reverie are so numerous that they are ephemeral. A more stable unit appears when a dreamer dreams of matter, when in his dreams (songes) he goes to "the bottom of things". Everything becomes great and stable at the same time when the reverie unifies cosmos and substance. In the course of interminable research on the imagination of the "four elements", on the substances which, since time immemorial, man has always imagined to sustain the unity if the world, we have very often dreamed upon the action of traditionally cosmic images.

These images, taken at first very close to man, expand by themselves to the level of the universe. One dreams in front of the fire, and the imagination discovers that the fire is the motive force of the world. One dreams in front of a spring and the imagination discovers that the water is blood of the earth, that the earth has living depths. He has a soft, fragrant dough beneath his fingers and proceeds to knead the substance of the world.[2]



12
Castelvecchio museum, Verona, 1956. Studies for aperture of niche towards the Adige in the entrance hall.
Carlo Scarpa.

Bachelard describes a dream process analogous to how the design process of the architect evolves. Roughly described, the design process is the art of joining intangible and tangible matters, the delineation of the relation between ideal and real worlds. Through the design process the architect kneads the substance of this world into building.

Designing architecture seems to require the ability to envision space and to perceive its function, structure and meaning. The architect constructs space by imagination. Architectural envisioning then becomes a matter of sensing non-existing spaces, their essence, and qualities as a whole. Marco Frascari, describes of how this 'inference process' of imagination, 'conversation' by drawing, and the correlation to reality forms a working method of Carlo Scarpa:

…Scarpa's drawings show the real nature or architectural drawings, that is, the fact that they are representations that are the results of constructions. They are construing of perceptual judgments interfaced with real process of physical construction of an architectural object.
… A design is developed by the same technique in which the drawing is made. The continuous inference process on which the design process is based is transformed in a sequence of marks on paper that are an analogy for the process of construction and construing. The piece of paper selected for supporting the slow process of the construction of a design presents concurrently vertical and horizontal sections, as well as elevations of the designed piece. These drawings are surrounded by unframed vignettes that analyze tri-dimensionally any joint of the object, as in a prediction of the role of each detail in generating the whole text and in the perception of them in the "indirect vision". Scarpa's drawings do not define future architectural pieces as simple sum of lines, surfaces, and volumes. Rather they represent the process of transformation of the details from one system of representation to another, from drawing to building.[3]

According to Frascari, the architectural design process is not only a matter of visualizing architectural objects, it equally involves the ability to perceive and incorporate the process of building construction, and finally, to relate these two levels of knowledge to one another. Understanding the amorphous flow of reality and consequently transforming it into architectural spaces therefore

seems to require a certain amount of sensitivity and poetic talent for the delicate process of translation.

The Finnish architect, Juhani Pallasmaa identifies this as, 'questions of perception that relate to the bodily senses. In the essay, The Eyes of the Skin: Architecture and the Senses, he notes:

All experience implies the acts of recollecting, remembering and comparing. An embodied memory has an essential role as the basis of remembering a space or place. We transport all the cities and towns that we have visited, all the places that we have recognised, into the incarnate memory of our body.
[…] We identify ourselves with this space, this place, this moment, and these dimensions become ingredients of our very existence. Architecture is the art of reconciliation between the world, and ourselves and this mediation takes place through the senses.[4]

Pallasmaa points out the crucial link between the intellectual and physical dimension in experiencing architecture, exemplified by the sensation of 'embodied memory', and describes how the steady flow of architectural information, becomes stored in our in minds and bodies. Taking Pallasmaa's chain of thought a little further, one could argue that the act of designing – of visualizing and bringing forth architectural space – also draws on a particular sort of 'corporeal attention'.

Regarded as questions of perceptions, architectural visions are based on numerous sets of ideas; therefore, the notion of vision can be identified at various levels and in different form in architecture. As such, a very broad definition of visionary architecture seems necessary. Prior to examining various types of visionary activities in architecture, the very essence of vision must be examined.

Visions, Ideals and Utopias

Visions, ideals and utopias represent different aspects of the human activity, to dream, to imagine, to fantasize and to envision. Besides being products of subconscious energies, these activities seem to spring from a well of desire and longing. As a whole, these emotions reflect aspirations for a different mode of thought, in essence, a desire for another, or better way of being or living. This may concern political or ideological change, new/improved living conditions, personal progress, or material wealth.

In many ways, this striving to transcend reality is so widespread, and yet so varied in form and content, that there seems to exist a utopian propensity in human beings, either expressed as part of a collective unconscious or as an aspect of human nature.[5]

In order to approach the nature of vision, it might be helpful to study the etymology of the various terms, vision, ideal and utopia.

Etymologically, the term vision is connected to the notion of sight.[6]

It defines the sensation or the event of seeing - virtually or as images in one's mind, usually described as a kind of phantasm. Parallel to Pallasmaa's line of thought, one could suggest that the concept of vision, as a type of sensorial experience relating to our perception of sight, stems as much from the realm of our senses as from our mind.

Ideals belong to a quite different realm, which refers to pure intellectual activities.[7] Regarded as a genuine construction of the mind, the ideal also relates to such aspects as perfection, universality and truth, and thus it often raises the question of moral values.

One can also talk about, ideal visions, which characterize visionary endeavor aiming at ideal solutions. This conceptual construction joins the pragmatism of visions with the abstract sphere of ideals. Ultimately, one could argue that whenever the concept of the ideal is involved, the vision becomes discursive, as in the case of Le Corbusier's architectural theories of L'Esprit Nouveau.

Utopia defines the overall concept of the 'other', an imagined place or world, a 'nowhere'.[8] Thomas More (1478-1535) is claimed to have invented the concept of utopia in a modern sense, using the term for his description of, The Best State of a Commonwealth and the New Island of Utopia.[9] Supposedly, his choice of the term was a pun upon, eutopos (Gk.), meaning the good place.

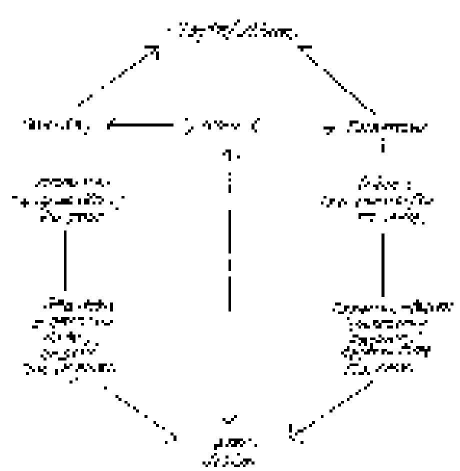
The British author Ruth Levitas characterizes utopia along More's positive definition. In the introduction of her book, The Concept of Utopia, she writes:

Utopia is about how we would live and what kind of world we would live in if we could do just that. The construction of imaginary worlds, free from the difficulties that beset us in reality, takes place in one form or another in many cultures. Such images are embedded in origin and destination myths, where the good life is not available to us in this world but is confined to a lost golden age or a world beyond death.[10]

As Levitas points out, utopia relates to reality through myths, which are usually based on traditional or legendary tales, describing beings or events, with or without determinable basis of fact or natural explanation. Although, speaking of 'the good life', which is latent in the concept of utopia, one ought to mention the notion of dystopia that describes the opposite condition, a society marked by human misery, squalor, oppression, diseases, or overcrowding.[11]

Finally, Utopia can be defined a dynamic and productive force as sustained by the German historian, Karl Mannheim, who defines utopia not only as an end,

13
Church of Sainte-Bernadette du Bantay, 1965.
Claude Parent and Paul Virillio.



14
Woodcut image of Thomas More's Utopia from the March 1518 edition.

15
The concept of Utopia.

but also a means – representing a will to change the world.[12] As such, utopia always reflects reality, as well as the past and prospects for the future. This sort of dynamic mirroring effect is roughly illustrated to the left.[13]
Studying the illustration of utopia closely, one could argue that human beings need utopia in order to recognize a sense of being and becoming more distinctly - to define themselves in this world. However, this definition raises the question how to distinguish between utopia and the simple notion of progression.[14]

A simple answer could be that utopian visions may cause intellectual or material progress, and may even be the source of societal change, while the concept of progression does not necessarily hold utopian features.

Moreover, the notion of progression reflects the basic human need to improve everyday life (the process of civilization) and often deals with rational aspects, which mainly apply to the physical/material world. Progression thus relates to an immediate reality, as an upgrading of the present body of knowledge and the general state of affairs.

The essence of progress can be characterized as the need to raise standards from a lower to a higher level of being, reflecting a mechanical conception of order.[15]

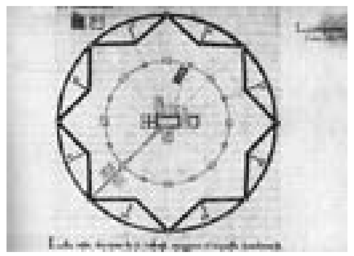
Utopia and Architecture

The conscious and subconscious energies that drive ideal visions in architecture manifest themselves as projects aiming at ideal forms or spaces.

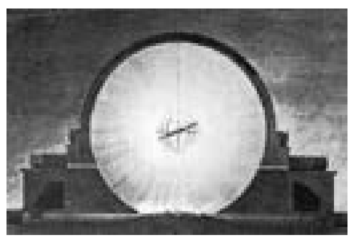
The earliest architectural utopias recorded within the history of western civilization stem from the Old Testament, in which they are described as city images.[16] In continuation of these early theological attempts to identify the Garden of Eden, philosophical treatises such as the Republic (ca. 370 BC) of Plato (ca.427-347 BC) and Utopia (1526) of Thomas More have systematically portrayed the ideal commonwealth.[17]

Plato's Republic examines the question of morality through an imagined ideal commonwealth. Despite his objective, Plato does not describe any physical model. However, his vision of a new societal order defined by ideal institutions could have generated a new architectural idiom that maybe could have been brought to realization.
Written almost two thousand years later in a more narrative style, Thomas More ventured the same challenge, to define the ideal environment for man.

Besides containing jocose reflections and criticism of the sixteenth century's social and political organization, More's Utopia also describes perfect architectural environments.[18] Thomas More literally envisioned new urban organizations and different architectural structures as betterments of society. Utopia describes detailed architectural settings, such as the layout of the city, Amaurot, models for new housing types, and different use of new materials and constructions. More's visionary aspirations speak through the descriptions of Amaurot that is founded by King Utopus in the treatise:



16
Plan of Sforzinda, Averlino Filarete, treatise of Architecture (1461-64) folio 41 r.



17
Monument to Newton, at night. Etienne - Louis Boullée, Essai sur l'art.

> The town is surrounded by a thick, high wall, with many towers and bastions. […] The streets are conveniently laid out for use by vehicles and protection from the wind. Their buildings are by no means paltry; the unbroken rows of houses facing each other across the street through the different wards make a fine sight. The streets are twenty feet wide. Behind each row of houses at the center of every block and extending in full length of the street, there are large gardens. Every house has a door to the street and another to the garden. The doors which are made with two leaves, open easily and swing shut automatically, letting anyone enter who wants to – and so there is no private property. Every ten years they change houses by lot. […] The first houses [of the Utopian's] were low, like cabins, or peasant huts, built out of any sort of timber, with mud-plastered walls and steep roofs, ridged and thatched with straw. But now their houses are all three stories high and handsomely constructed; roofs are flat, and are faced with stone, stucco, or brick, over rubble construction.[19] The roofs are flat, and are covered with a kind of plaster that is cheap but fireproof, and more weather-resistant even than lead. Glass is very generally used in windows to keep out the weather; and they also use thin linen cloth treated with oil or gum so that it lets in more light and keeps out more wind. [20]

More's philosophical construction bridges the gap between the ideal world and reality by describing the physical implementation of his ideal visions. His interpretation of Utopia is relevant within an architectural context, as a dynamic force containing both symbolic and physical manifestations, which raises questions of the correlation between ends and means.

Architectural Utopias

The architectural themes suggested by Thomas More, such as city planning, social improvements, and innovative constructions are dealt with in visionary schemes in various ways throughout architectural history. During the Renaissance, proportional systems derived from cosmological images, as well as from anthropomorphic figures, were dominating features of architectural utopias and ideal cities. However, as principles for design, they were defined in different ways.

Architects, who utilize a poetic or narrative approach are Antonio Averlino Filarete (1400-69), who envisioned the city of Sforzinda that formed the architectural setting of his Treatise on Architecture, (1461-64); and Francesco Colonna (1433-1527), who recounted the dream journeyings of Polifilo in his

Hypnerotomachia Poliphili (1499).[21]

Architects like Vincenzo Scamozzi (1548-1616) with L'idea della architettura universale (1615), and Giorgio Vasari il Giovane (1562-1625) with his Cittá Ideale (1598) represent a more platonic or rational approach.[22]

Through the course of time, these early renderings of architectural utopias have evolved into numerous thematic orientations. They all may be defined as relative utopias, offering solutions to architectural problems at any scale dealing with either aesthetical, iconographic, functional, social, human, technological or narrative questions, or several of these themes concurrently.

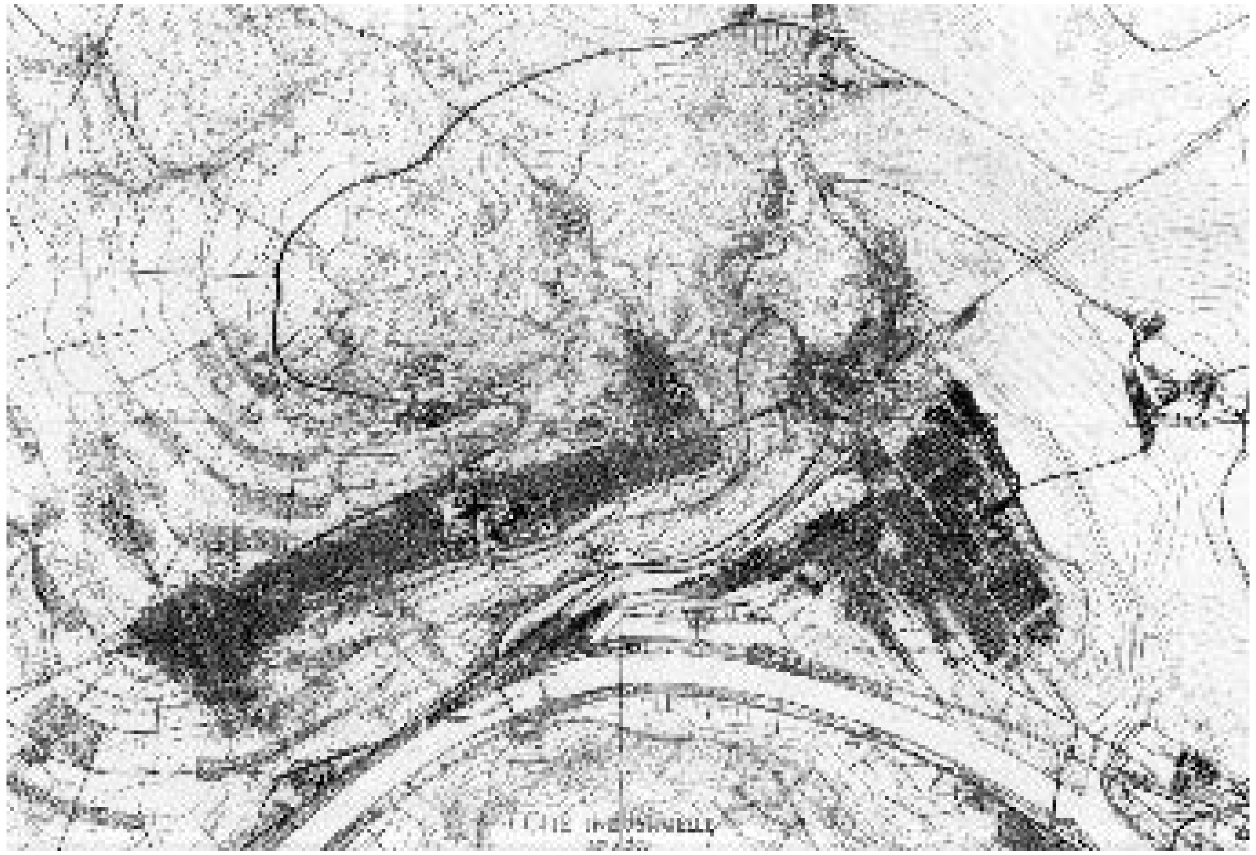
The French Revolutionary architects, Eteinne-Louis Boullée (1728-99) and Claude-Nicolas Ledoux (1736-1806), and a modern architect like Le Corbusier are perfect examples of visionaries who have pursued the iconographical and aesthetics ideals as primary aspects in their utopian designs and monuments.[23]

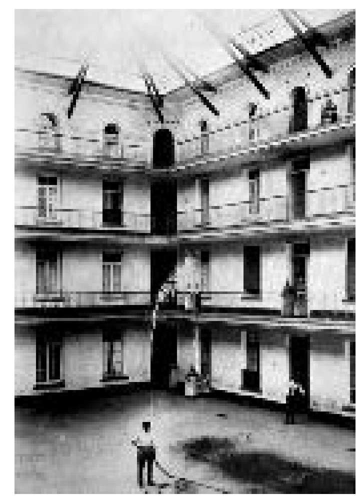
Boullée's spherical monument for Sir Isaac Newton defies any attempt for use. The hollow dome was meant as a representation of the universe and it was almost done better than reality and the naked eye had previously managed between them. The American art historian Robert Harbison, claims that the boldest stretch of Boullée's scientific ambition with the monument was its inversions:

> In the Newton monument day is night and night is day: small holes in the skin which let daylight in are perceived as stars by the spectator standing near the base of the sphere. At night when the stars are darkened an artificial source in its centre illuminates the whole closed universe.[24]

In addition, Harbison notes that the monument is critical as a building project, exemplified by the mere thought of the scaffolding needed for the construction is outrageous. Whereas Boullée and Ledoux gained their inspiration from science and from the proportional systems of the universe, Le Corbusier believed that geometry was the true way by which architecture could reach perfection. In his manifesto, The City of Tomorrow and its Planning, he claims:

> Geometry is the means, created by ourselves, whereby we perceive the external world and express the world within us. Geometry is the foundation. It is also the ma-terial basis on which we build those symbols, which represent to us perfection and the divine. It brings with it the noble result of mathematics. Machinery is the result of geometry. The age in which we live is therefore essentially a geometrical one; all its ideas are orientated in the direction of geometry. Modern art and thought - after a century of analysis - are now seeking beyond what is merely accidental; geometry leads them to mathematical forms, a more and more generalized attitude.[25]





18
City plan for Cité Industrielle, 1917. Tony Garnier.

19
Covered courtyard of a Famili-esteres, 1853-87.
Jean-Baptiste Godin.

Le Corbusier argues for a system that by its mere objectivity leads to universal laws for design. By stressing the aspect of mathematics he introduced a rational dimension, which in its most simplified form reduces architecture to the question of numbers and quantities.

Le Corbusier was truly convinced of the virtue of his ideas, which his revolutionary city plans for the old city of Paris, the Voisins, illustrates. Years later, he realized that the theories were too radical, over-simplifying the question of urban organization, and they were moderated by e.g. including environmental aspects in the designs for multi-story urban housing.

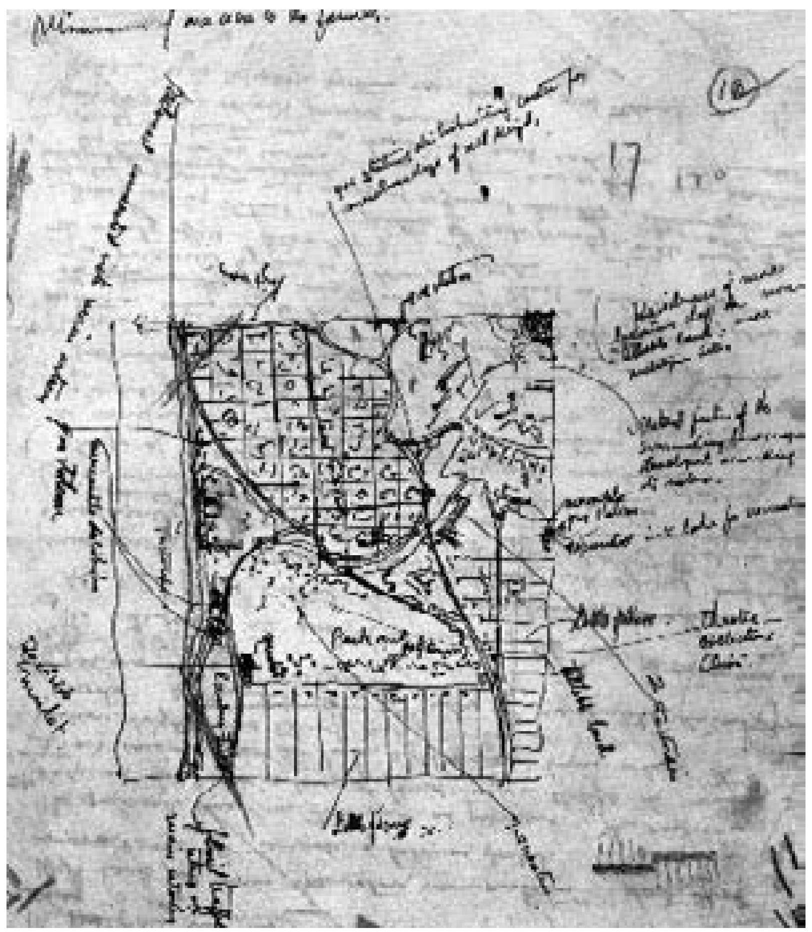
As for the social utopias, the ideas of the French writer and socialist reformer Charles Fourier (1772-1837) were of great inspiration for later architects.[26] Fourier saw the bourgeois society as a hindrance for man to develop his natural social behavior. He suggested a societal construction of large communities, Phalanxes, based on theories of biological science, in which the individuals could prosper and each unfold their personal nature.[27]

Motivated by the ideas of Fourier, the Belgian engineer, Jean-Babtiste Godin (1817-88) established his so-called Familiesteres (1853-87) next to his kettle-factory at Guise. The Familiesteres were laid out as large apartment blocks organized as communities, where the physical environment mirrored the social life. As recommended by Fourier, the internal courtyards were covered with glass roofs in order to provide sheltered outdoor spaces to improve the communal integration. They also served as an extended space for the housework and for recreation protected from the weather. From a technological point of view, the large glass structures were very extraordinary and daring constructions at the time.

Also the German Philosopher, Walter Benjamin (1892-1940), has described the cultural consequences of the 'city of arcades' in his pivotal essay, Paris, Capital of the Nineteenth Century.[28] Benjamin notes that the critical aspect of Fourier's ideas was his rendering of the arcades as places for dwelling instead of places serving commercial purposes.

Similar ideas about integrating industry into urban texture, uniting work and dwelling, have been studied by Tony Garnier (1869-1948) in his project for Une Cité Industrielle (1904-17) and by F.L. Wright in the Broadacre City Project (1934-58). Despite the profound utopian spirit within these projects, they were thought out as true plans to be realized.

Tony Garnier saw the city as an entity; a whole made of numerous, small parts. To Garnier, city-planning was not just a matter of defining various locations for railways, factories and housing; he also designed the individual housing projects, worked out their plans and exteriors, all the way down to the ornamental details of the facades. Garnier chose the tittle for his project, Une Cité Industrielle, with great care, using the article Une (A) instead of Le (The), and designed the city as



20
Plan Voisin for Paris, 1925.
Le Corbusier.

21
Sketch for the Broadacte City project, 1934.
F.L. Wright.

a flexible entity, a living organism programmed for change and growth, rather than as an ideal city-plan of completion.[29]

Une Cité Industrielle was never realized, although Garnier proposed the scheme several times (1901/1917).
However, in his building project for Marché aux bestiaux et Abattoirs de la mouche, the Meat-market of Lyon, one finds similar design features as in the building design for the covered shipbuilding dockyards of the Cité-project.[30]

The architectural design was much influenced by the construction technology, an aspect that fascinated Garnier. In the introduction to his Une Cité Industrielle (1904), he praised Beton Brut and reinforced concrete like this:

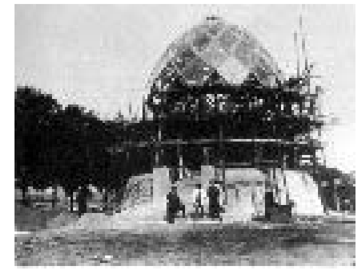
These two materials are cast in moulds made for the purpose. The simpler the shape of the mould, the easier the construction and the cheaper the expenses. These simplified means leads to an [architectural] idiom of logical simplicity …these materials provide designation of horizontality and verticality that is necessary in order to give the construction peace and balance, which harmonize with the delineation of nature.[31]

The essential questions of the modern utopia seemed to concern how to define an ideal model for organizing housing and working areas, and how to integrate new technology as a parameter of design. F.L. Wright's design for Broadacre City project (1934-58), and Le Corbusier's Ville Radieuse (1928-46) are two late examples of this notion of the city, having their point of departure in the rapid change of cultural values and of new commodities of modern living and industry, such as the car, TV, telecommunication and, most of all, standardized factory production.[32]

F.L. Wright envisioned a horizontal layout of decentralized farm units, whereas Le Corbusier anticipated housing as clearly defined, autonomous units, vertically stacked in towers and blocks. It is interesting to note that despite F.L. Wright and Le Corbusier seemed motivated by the same questions, their architectural answers turned out to be completely different, both physically as well as ideologically.

Representing different ideologies and growing out of various particular circumstances, some of the previously mentioned utopian ideas and schemes have matured into actual built projects. Today, More's ideas represent the ethical core in successful city planning, and Fourrier's glass-passages have developed into our glazed satellite-cities, known as shopping malls. Furthermore, American suburbia echoes Wright's landscape-city and Le Corbusier's rational cityplans have been models for solving the need for housing in large European and American cities.

Architectural visions seem to have altered the physical world, yet its own conceptual basis has changed throughout time, from pure constructions of the



mind to actual solutions of architectural problems. As such, these circumstances generate questions: what sorts of elements constitute modern architectural utopias; and how can they be identified in architectural design?

New Figurations of Reality or Crisis of Utopia

During this century, architectural utopias have changed from grand narratives into a diverse range of imaginary tales. The Glass architecture of Scheerbart and Taut; Fuller's dome project for Manhattan; the megastructures of Archigram; and the inflatable spacesuits and dwellings by Haus-Rucker-Co and Coop Himmelblau represent such modern utopian tales.[33]

Despite their visionary radicality, they seem to imply a certain degree of realism, as critical comments on actual environmental questions or perceptions of space. Often, they represent very isolated comments on the present architectural discourse and therefore they tend to become autonomous statements. Professor Dalibor Vesely has described the ambiguity of modern utopia in his essay, Design and the Crisis of Vision:

Modern utopia is not directed any more towards the contemplative understanding of the ideal political order but towards an active transformation of the actual world…This bringing of the heaven to earth turns modern utopia into a problematic phenomenon which it would be better to describe as negative utopia or simply dystopia. The negation of the transcendental function of utopia reduces and very often eliminates its power to transcend the actual reality and give it true meaning and order. Modern utopias tend to substitute the actual reality with an idealized and partial representation of meaning and order which are possible only in their actuality. It is not difficult to see how the paradox of modern utopia became a source of deep confusion, and why the real possibilities cannot be differentiated from any more from possible realities.[34]

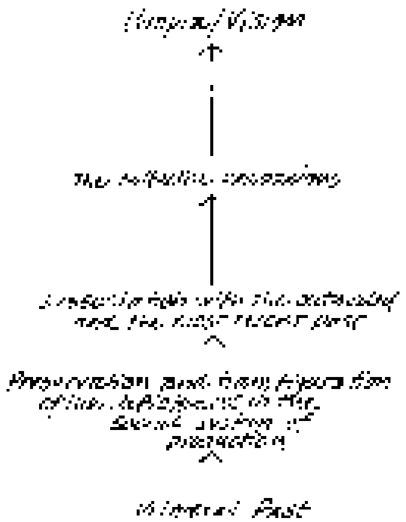
Commenting on this confused understanding of utopia in modern times, one may suggest that it might have to do with the lack of a common ideological objective and the increasing complexity of the world. Manfredo Tafuri argues that the crisis of modern utopia is due to the change of ideological basis of modern art and architecture and compares it with ideas formulated in the economical field by Keynes. He described it as a matter of:

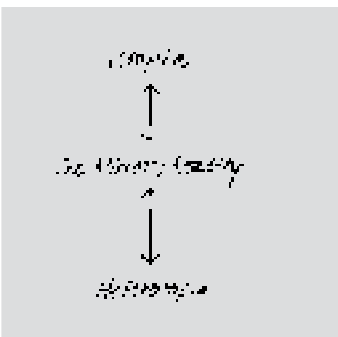
Free oneself from the fear of the future by fixing the future in the present.[35]

Tafuri claims that Corbusier's urban theories reflect a similar attitude, how to 'control menace by absorbing it at an always new level'. Although, this way of

22
The Glass House under construction, Werkbund Exhibition, Cologne, 1914.
Bruno Taut.

23
Capsule Pier, 1965.
Ron Herron.





24
The concept of Utopia defined
by Walter Benjamin, 1932.

25
The concept of Utopia defined
by Michel Foucault, 1984.

conceiving 'future' architectural edifices describes the very nature of the architectural design process. Envisioning new architecture is a poetic affair, a process of imagining non-existing spaces, structures and details and fixing it on paper - "a hypothetical design of the unknown" as Frascari says.[36]

Therefore, one may question if architectural utopias are facing a crisis, or just more explicitly have assumed a new form at a different conceptual level, mirroring the general change of society where the individual forms the historical agenda.

Constructing the 20 th. Century's Utopia

In order to understand the different interpretations of architectural vision within this century, three profound definitions of the modern utopia have been selected for further investigation. Each of them representing critical versions of the nature of utopia and illustrating different ways of relating to reality. These definitions are formulated by distinguished thinkers such as: Walter Benjamin (1892-1940), Michel Foucault (1926-1984) and Dalibor Vesely (1932 -).

As mentioned earlier, Walter Benjamin has drawn up one of the most acute characterizations of architectural development and its impact on modern cultural identification (or vice versa), in Paris Capital of the Nineteenth Century. In this essay, Benjamin analyses how the physical change of human environment has developed through railway and bridge building. Moreover, he emphasizes how increasing use of 'artificial materials' (glass and steel) has created completely new conceptions of architectural spaces. Therefore, his definition of utopia relates directly to a historical context, mirroring the structure of reality, and characterizing a linear figure, an ascending process of consciousness:

Corresponding in the collective consciousness to the forms of the new means of production, which at first were still dominated by the old (Marx), are images in which the new is intermingled with the old. The images are wishful fantasies, and in them the collective seeks both to preserve and to transfigure the inchoateness of the social product and the deficiencies in the social system of production. In addition, these wish-fulfilling images manifest an emphatic striving for dissociation with the outmoded - which means, however, with the most resent past. These tendencies direct the visual imagination, which has been activated by the new, back to the primeval past. In the dream in which, before the eyes of each epoch, that which is to follow appears in images, the latter appears wedded to elements from prehistory, that is, of a classless society.

Intimations of this, deposited in the unconscious of the collective, mingle with the new to produce the utopia that has left its traces in thousands of figurations of life, from permanent buildings to fleeting fashions.[37]

In the text Des Espaces Autres, "Of Other Spaces: Utopias and Heterotopias", Foucault's describes the concept of utopia through the perceptual experience of different spaces provided by the mirror. However, he also includes its counter-arrangement, heterotopia, which represents institutions like the insane asylum and the prison, and similar places where deviant behavior is subjected to a process of normalization.[38] These themes form part of his general philosophical discourse, although in this context, his definition of utopia is primarily to be seen as a model of thought applied to explain architectural visions:

First of all, the utopias. These arrangements which have no real space. Arrangements which have a general relationship of direct or inverse analogy with the real space of society. They represent society itself brought to perfection, or its reverse, and in any case utopias are spaces that are by their very essence fundamentally unreal. There also exist, and this is probably true for all civilizations, real and effective spaces which are outlined in the very institution of society, but which constitute a sort of counterarrangement, of effectively realized utopia, in which all real arrangements, all the other real arrangements that can be found within society, are at one and the same time represented, challenged and overturned: a sort of place that lies outside all places which are and yet is actually localizable. In contrast to the utopias, these places which are absolutely other with the respect to all arrangements that they reflect and of which they speak might be described as heterotopias. Between these two I would then set that sort of mixed experience which partakes of the qualities of both types of location, the mirror. It is, after all, a utopia that it is a place without a place. In it, I see myself where I am not, in an unreal space that opens up potentially beyond its surface; there I am down there where I am not, a sort of shadow that makes my appearance visible to myself, allowing me to look at myself where I do not exist: utopia of the mirror. At the same time, we are dealing with Heterotopia. The mirror really exists and a kind of comeback effect on the place that I occupy: starting from it, in fact, I find myself absent from the place where I am, in that I see myself in there.Starting from that gaze which to some extent is brought to bear on me, from the depths of that virtual space which is on the other side of the mirror, I turn my back on myself, beginning to turn my eyes on myself and reconstitute myself where I am in reality.[39]

By using a familiar device, the mirror, Foucault transfers the abstract notion, utopia, into an everyday experience. This way, utopia is formed by metaphysical/mental and sensory experiences at once through the human body. The body acts as a means for definition of other spaces, utopia and heterotopia, and at the same time the utopias are tools for perceptual transformation. This way he portrays utopia as a layered experience generated by reflections.

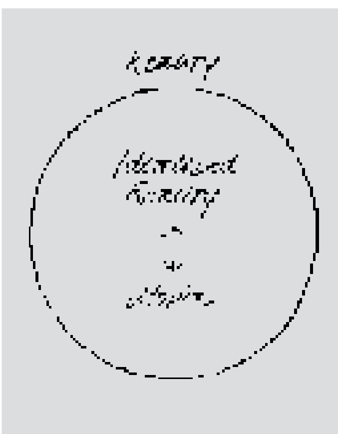
In the essay, Design and the Crisis of Vision, Dalibor Vesely describes modern architectural utopia through the architectural design process. He draws a parallel to the scientific experiments of the laboratory, where questions have been singled out and detached from the real world:

> The utopian aspirations of design have their analogy in the experimental methods of science. Similarly, the utopian 'nowhere' of science can be seen as being the place of the laboratory. The laboratory is a place where nature is systematically transformed into idealized models. The experiment is a dialogue between the a priori mathematical rules (design) and idealized reality. As ideal places for the conduct of experimental dialogue laboratories represent a new reality where artificial, construction becomes the privileged form of knowing. The laboratory space, like utopia, is not supposed to be contaminated by reality.[40]

Concluding this chapter one could argue that ideal visions regarded as means to approach the nature of present reality or to capture the future and our dreams can be characterized as technologies - ways to deal with being or reality. This notion is well summarized by Giedion:

> Ever in flux and process, reality cannot be approached directly.
> Reality is too vast, and direct means fail. Suitable tools are needed, as in the raising of an obelisk.
> In technics, as in science and art, we must create tools with which to dominate reality. These tools may differ. They may bee shaped for mechanization, for thought, or for the expression of feeling. But between them are inner bonds, methodological ties. Again and again, we shall recall these ties.[41]

As such, the perception of reality (and utopia) becomes a matter of technology. Therefore, in light of Tafuri's and Vesely's orientations, it is tempting to ask if modern architecture is lacking utopian presence or is dominated by the notion of the ideal? And moreover, if contemporary design processes have moved architecture from the realm of an ordinary reality, to the utopia of an ideal reality, similar to practices of natural science, how have these circumstances affected architectural practice as well as the nature and processes of construction?



26
Modern Utopia defined by
Dalibor Vesely, 1994.

[1] Pallasmaa, Juhani, The Eyes of the Skin: Architecture and the Senses, Academy Group Ltd., London, 1996, p. 50

[2] It is important to note that in the introduction to his book, Gaston Bachelard distinguishes between the various French terms for dreams and classifies them into masculine and feminine significations. Dreams (reve, m.) and reveries (reverie, f.), dreams (songe, m.) and daydreams (songerie, f.) and Bachelard emphasizes that "these terms indicate a need to make everything feminine which is enveloping and soft and beyond too simply masculine designations for our states of mind". p. 29. The quote originates from p. 176

Bachelard, Gaston, The Poetics of Reverie: Childhood, Language, and the Cosmos, Beacon Press, Boston, 1969

[3] Marco Frascari is a former employee of Carlo Scarpa.

Frascari, Marco, "The Tell-the-Tale Detail", VIA, 7, 1984, p. 30

[4] Pallasmaa, Juhani, The Eyes of the Skin: Architecture and the senses, Polemics, Academy Editions, London, 1996, p. 50

[5] Levitas, Ruth, The Concept of Utopia, Syracuse University Press, Herthfordshire, 1990, p. 181

[6] Vision, [1250–1300; ME < L vision- (s. of visio) a seeing, view, equiv. to vis (us) , ptp. of videre to see + -ion- -ION] 1. The act or power of sensing with the eyes; sight. 2.The act or power of anticipating that which will or may come to be prophetic vision; the vision of an entrepreneur. 3. An experience in which a personage, thing, or event appears vividly or credibly to the mind, although not actually present, often under the influence of a divine or other agency: a heavenly messenger appearing in a vision. Cf. hallucination (def. 1), Random House Unabridged Electronic Dictionary: based on the 2. Ed., 1994

[7] Ideal; perception that is in accordance with an idea or satisfying one's idea of what is perfect or true. Stem from the term, idea Gr. That means: looks, appearance, species, form, thought, notion. In sum, these interpretations define intellectual activities. Oxford Advanced Learner's Dictionary of Current English, Oxford University Press, 1974, p. 420 and Fremmedord, Gyldendals Forlag, København, 1987, p. 239

[8] Utopia; [< NL (1516) < Gk ou not + tóp (os) a place + -ia -Y3]

1. An imaginary island described in Sir Thomas More's Utopia (1516) as enjoying perfection in law, politics, etc. 2. (usually l.c.) an ideal place or state. 3. (usually l.c.) any visionary system of political or social perfection., Random House Unabridged Electronic Dictionary, 1994

[9] Sir Thomas More (1487-1535) Eng., lawyer and sheriff of London, contributor to contemporary notions of humanism through his philosophical treatise, Utopia. The literary work, Utopia, compared the state of Great Britain of that time with an ideal society named Utopia. The commonwealth Utopia was based on the essential idea that all citizens were to have equal right/access to the goods of life. The book was a daring statement of the time, questioning present societal structure and authorities (King Henry the Eighth), and was written in a critical and witty tone that left the reader provoked; yet mystified. More, Sir Thomas, Utopia, (1516-18), W.W. Norton & Company, New York, 2. Ed. Trans. Robert M. Adams, , 1992, p. 3

[10] Levitas, Ruth, The Concept of Utopia, Syracuse University Press, Hertfordshire, 1990, p.1

[11] Dystopia [1865–70; DYS- + (U) TOPIA] derives from the term utopia.

Random House Unabridged Electronic Dictionary, Random House Inc., 1994

[12] Mannheim defines Utopia as "orientations transcending reality". Mannheim, Karl, Ideology and Utopia, N.Y. New York, first Eng. ed., 1936, p. 245

[13] Within this field of utopian typologies, tectonic visions in architecture relate to utopias of both nostalgic and avant-garde nature.

[14] Progress, Lat. pro'gressus; advance, pro'gredi; proceed, of pro- + 'gradi; to walk, related to 'gradus; step. Gyldendals Fremmedord, Gyldendal, København, 1987, p. 475

[15] van Wright, Hans Georg, Myten om Fremskridtet, (The Myth of Progress), Rosinante, København, 1994, p. 42

[16] Rowe, Colin, "The Architecture of Utopia", The Mathematics of the Ideal Villa, MIT Press, Cambridge, Massachusetts, Ninth ed. 1993, p. 206

[17] The original manuscript for Republic was written in the 370's BC. The title Republic is poorly translated from the Greek Poleiteia. Poleiteia defines the public and political life of a community that in Latin is res publica, 'public business', so the English title is a Latinization of the Greek term. Plato, Republic, trans. Robin Waterfield, Oxford University Press, Oxford, New York, 1993, p. xi

[18] The population density and lack of city planning in large medieval cities like London worsened the social problems and the general state of health. Housing constructions were not fireproof, lacked of proper insulation, and had poor ventilation and lighting conditions.

[19] It is interesting that in the original Latin manuscript, More refers to cæmentis (cement) in the construction of the facades: "[…] parietum facies aut silice aut cæmentis aut latere coctili constructæ, in avlum introrsus congesto rudere". Mori, Thomae, Opera Omnia Latina, "Utopia: De Optimo Reipublicæ", Libri Due, Francofurti et Lipsiae 1689, Unveränderter Nachdruck, Minerva GmBh, Frankfurt am Main, 196, p. 204. Cement was not a common building material at the time and regular use of cements in Britain began in the 1770's with introduction of stuccowork. The important Portland cement was not patented until, 1824. Strike, James, Construction into Design: The Influence of New Methods of Construction on Architectural Design 1690-1990, Butterworth Architecture Oxford, 1991, p. 52

[20] More, Thomas, Utopia, p. 35

[21] The Renaissance work of Francesco Colonna (The Dream of Poliphili) combines the metaphors of religious mysticism and love poetry. In this architectural vision, Poliphili travels through transparent and reflecting illusory landscapes. First, he travels to quest for his ultimate love, Polia at Queen Eleuterilida's Palace and subsequently, united with Polia, he goes to face the Goddess Venus at a translucent amphitheater that is constructed by such illusive means that it confuses the senses. The settings of the story holds echoes from the Solomon Legends as well as from the Legends of the Holy Grail and signifies transformation from base instinct to purified love. It is important to notice that when the metaphor of transformation, whether spiritual or secular, implies a general social change it takes on architectural form, but when it stands for individual gnosis alone, the image is reduced to the shape of a stone.

Rosemary Haag Bletter, "The Interpretation of the Glass Dream - Expressionist Architecture and the History of the Crystal Metaphor", Journal of the Society of Architectural Historians, vol. XL, March 1981, pp. 27-28

[22] Many of these architectural schemes were related to strategic military layouts and designs of medieval fortifications.

[23] Ledoux planned Ville de Chaux (1775-79) – the town of the royal saltwork in the forests of Jura. Ledoux initiated the construction of the saltworks, along with the administrative and residential buildings. However, the scheme was never finished, due to political circumstances.

[24] Harbison, Robert, The built, the unbuilt and the unbuildable: In pursuit of architectural meaning, MIT Press, Cambridge, Massachusetts, 1994. pp. 164-166

[25] Le Corbusier, (Urbanisme, 1929) The City of Tomorrow and its Planning, Dover Publications Inc., New York, 1987, p. xxi

[26] Charles Fourier formulated his radical vision for a new industrial world in his, Le Nouveau Monde Industriel Frampton, Kenneth, Modern Architecture: A Critical History, 3. Ed. Thames and Hudson Ltd, London, 1992, p. 22

[27] Ibid., The Phalanxes (approx. 1.800 people) represented ideal communities that were housed in Phalanstères. The Phalanstry were miniature towns whose streets would be covered from the weather. Fourier saw this structure as a model and replacement of the small individual fre-standing houses that already then were filling the interstices of towns.

[28] Benjamin, Walter, Reflections, Harcourt Brace Jovanich, Inc., New York, NY, 1978, pp. 146-163

[29] Bertelsen, Jens, "Den verdensberøte, men ukendte franske byplanlægger Tony Garniers skjulte liv og glemte bygningsværker"., Arkitekten , no. 15, 1986, København, p. 348

[30] Ibid., The Marché aux bestiaux et Abattoirs de la mouche (1906-28) is now demolished and only the Great Slaughter Hall has been saved. As for the design and construction, Garnier was much inspired by the Gallerie des Machines from the Exposition Arts et Decoratif, 1925 in Paris. The proportions of the Gallerie des Machines were 115 x 423 m, whereas the Great Slaughter Hall is, 80 x 220 m and 22 m to the rooftop.

[31] Garnier, Tony, Une Cité Industrielle, 1917, 2.ed., Paris, 1932

[32] Frampton notes that the most significant building type for the Broadacre City project was the Walter Davison Model Farm (1932). The dwelling type was designed to accommodate the economy of both home and land.

Frampton, Kenneth, Modern Architecture: A Critical History, p. 191

[33] The German writer Paul Scheerbart wrote the book Glasarchitektur (1914) in which he described in great detail how the 'new world' was to be built and changed by the use of glass in architecture. Scheerbart insisted on the direct connection between the architecture we live in and our thoughts and feelings. Paul Scheerbart and Bruno Taut are closely related; thus most of Taut's significant projects were inspired by or literal physical manifestation of Scheerbart's thoughts. In the portfolio Alpine Arcitektur (1919), Bruno Taut envisioned crystal structures covering the mountain peaks of the Alps. The utopian scheme did not only allude to pure fantasy, but also called for political and societal change.

Beim, Anne, "Cosmos and Glass: an inquiry into the cosmology of glass", Proces, Kunstakademiets Arkitektskole, Copenhagen, 1996, pp. 3-5

[34] Vesely, Dalibor, "Design and the Crisis of Vision", Scroope Seven, Cambridge Architecture Journal, 1995/96, p. 68

[35] Tafuri, Manfredo, Architecture and Utopia: Design and Capitalist Development, MIT Press, Cambridge, Massachusetts, 1976/94, p. 135

[36] Frascari, Marco, Monsters of Architecture: Anthropomorphism in Architectural Theory, Rowman & Littlefield Publishers, Inc., Savage, ML, 1996, p. 113

[37] Benjamin, Walter, "Paris, Capital of the Nineteenth Century", Reflections: Essays, Aphorisms, Autobiographical Writings, Schocken Books, New York, 1986, p. 148

[38] Ockman, Joan, Architecture Culture 1943-1968: A Documentary Anthology, Rizzoli, New York, NY, 1993, p. 419

[39] Ibid., p. 422

[40] Dalibor Vesely, Scroope Seven Cambridge Architecture Journal, 1995/96, p. 69

[41] Giedion, Siegfried, Mechanization Takes Command, W.W. Norton & Company, New York, NY, 1975, p. 14

Tectonics in Architecture

Forming Construction

> If architecture can be said to have a poetic meaning we must recognize that what it says is not independent of what it is. Architecture is not an experience that words translate later. Like the poem itself, it is its figure as presence, which constitutes the means and end of the experience.[1] Alberto Pérez-Gómez

Alberto Perez-Gomez describes architecture as a world of both physical sensation and poetic representation. Regarded as such, building technology and practices of construction can be characterized not only as pragmatic means, but also loaded with signification, provided by architectural intention.

The object of this chapter is to identify the concepts of technology that are presented and discussed in the following chapters: Case Studies and Conclusion. This seems necessary, since the different architects address building technology and practices of construction in various ways, each of them using a different tone of voice. Still, they deal with the same architectural question, whether or not new materials and ways of construction are in position to establish or move architectural meaning.

This chapter unfolds the concept of tectonics, which refers to meaning of construction in architecture. Furthermore, terms like structure, construction and technology are examined, terms that are generally applied to describe the rational parts of an edifice. However, in this context they are analyzed in accordance with their inner formal nature and the use of metaphors in architecture.

Definition of Terms

In present architectural vocabulary, the term, tectonic, is commonly used, primarily referring to aesthetic questions in building construction. However, it is also used to describe material nature, and intentions in construction solutions; as well as structural systems and principles of organization. As such, it implies a different interpretation of technology and construction, elevating this realm beyond simple instrumental definitions. A great part of this revitalized discussion on the meaning of technology is due to Kenneth Frampton's recent book, Studies of Tectonic Culture, in which he pursues the meaning of tectonics in contemporary architectural discourse, defining it as 'poetics of construction'.[2]

However works by additional scholars, such as Marco Frascari, Gevork Hartoonian, Alberto Pérez-Gómez, Moshen Mostafavi and David Leatherbarrow have also played an important role in contributing to this poetic discussion about architectural construction.[3]

The term, tetonic, derives from the Greek word, tekton, which means carpenter or builder, and in Greek classical literature it also alluded to the art of construction.[4]

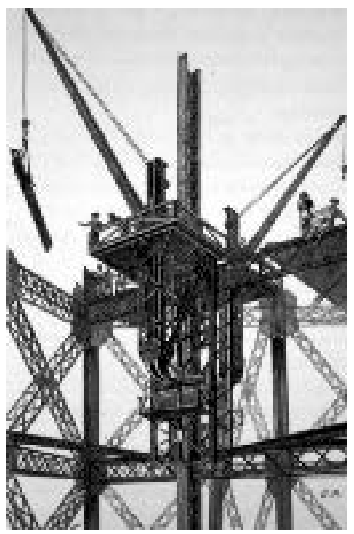
27
Entrance Hall,
Bryn Mawr College,
Pennsylvania, 1960-65.
Louis I. Kahn.

Defined as such, it can be compared to another Greek term, techné, signifying the art of bringing forth or fabrication. The American architect, Gevork Hartoonian, notes that:

techné in the classical concept of work, did not signify a means, but the unity of means and end (work and meaning).[5]

According to Frascari, the essence of techné is by no means technological, but belongs to the notion of poesis (Gk. art), which reveals or discloses aletheia, the truth, and goes hand in hand with episteme or scientia (Greek and Latin for knowledge). Moreover, Frascari notes that the derivative words like, technique, technical and technology have lost their original meaning in common language because they are understood to be of instrumental nature only.[6]

Hartoonian explains that this change of signification took place towards the end of the seventeenth century, as due to "techné in its classical sense was replaced by technique, or the manner in which an artist or artisan uses technical elements of an art or a craft".[7]



Furthermore he notes that by mechanization of working processes in the late eighteenth century, "technique provided solutions for problems without necessarily evincing any particular concern with the object of the problem or its historical values".[8]

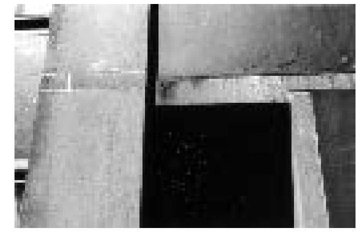
In contemporary divtionaries technology is generally defined as, the study, mastery and utilization of manufacturing and industrial methods; systematic application of knowledge to practical tasks in industry.[9]

Regarding this modern notion of technology, Hartoonian says that modern definition "takes nothing into concern but the process of production".[10]

However, Frascari provides one of the most revealing definitions, defining technology with a double-faced presence. As mentioned in the introduction, he uses the binomials logos of the techné, that refers to constructing and techné of the logos that refers to construing. He notes:

… technology becomes a reality acting between sensory experiences and physical expressions, being the union of the homo faber [the creating man] with the homo ludens [the playing man]. Technology is a subjective presence rather than an objective procedure to which the client and architect must be subjected.[11]

In order to summarize these various definitions of construction in architecture, a rough characterization could be that, techné represents the act of making - tectonic, the poetic of making - technique, the method of making and technology the knowledge of making. And most importantly, technology can be perceived as



something that is constantly changing, being a process - a movement in itself. Formed by these definitions the notion of construction also gains a full meaning that can be characterized as: a holistic analysis, consisting of constituent elements such as: logic – order and symbolic forms; selection of materials and the properties of materials; joining of materials – joining of the primary structure; the joint between the horizontal ground plane and vertical enclosure plane; the interaction of the building elements, micro-macro elements e.g. types of enclosure, the by-passing membrane or the infilled frame.[12]

This list of parameters form the essential process of questioning and analysis in dealing with problems of construction, thus, they can be regarded as keys to understanding or decoding the intention of the designing architect. Definitions of the terms structure and construction, provided by the Austrian/ American architect Eduard Sekler (1920 -) support this argument. He identifies the difference between structure and construction as:

The real difference between the two words is that 'construction' carries a connotation of something put together consciously while 'structure' refers to an ordered arrangement of constituent parts in a much wider sense. With regard to architecture the exact relationship between structure and construction now appears clear. Structure as the more general and abstract concept refers to a system of principle of arrangement destined to cope with forces at work in a building, such as post-and-lintel, arch, vault, dome, and folded plate. Construction on the other hand refers to the concrete realization of a principle or system - a realization may be carried out in a number of materials and ways. For example, the structural system which we call post-and-lintel may occur in wood, stone and metal and its elements may be fastened together by a number of methods.[13]

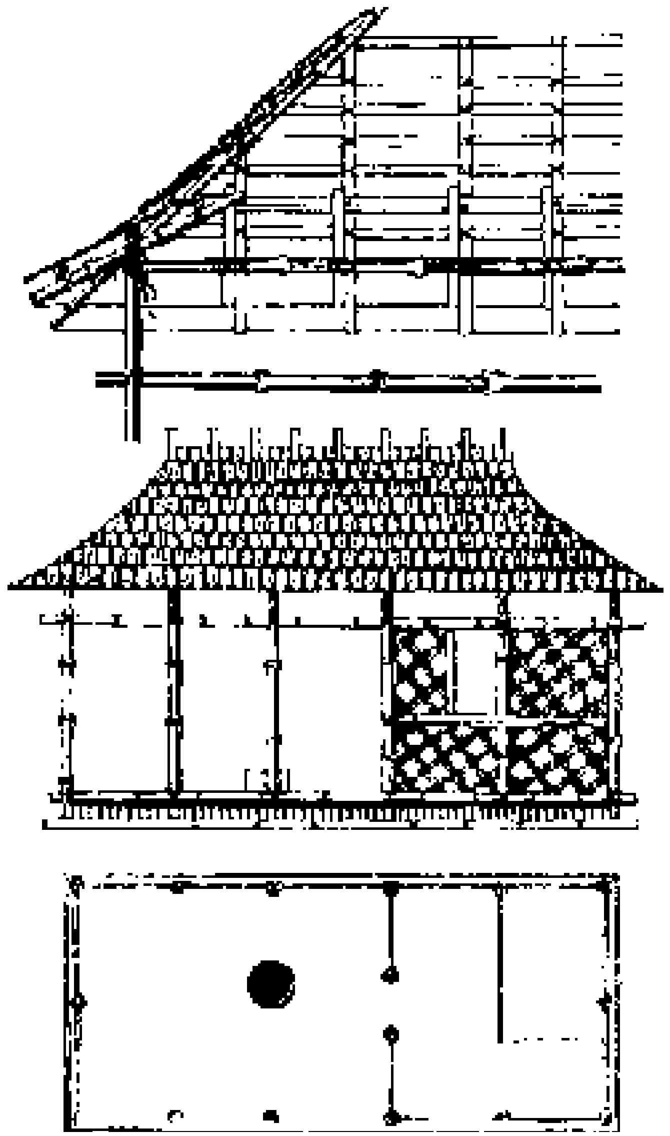
This interpretation partly corresponds to Mies's definition of structure, which he meant, reflected a philosophical idea and should be regarded as a whole based on the same ideas from the detail to the overall building lay out. Thus, structure expresses the idea of construction. Peter Carter, who worked in Mies's office has explained that Mies believed that:

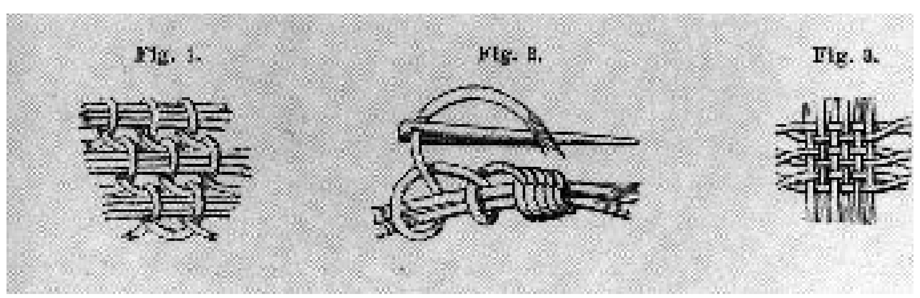
In architecture structure implies a complete morphological organism, and not merely columns and girders. An organism of precise necessity, the resulting form, which is a consequence of the structure and not the reason for the construction.[14]

In light of the definitions provided by Sekler and Mies van der Rohe, one can conclude that both structure and construction depend on the knowledge and

28
Construction of
the Eiffel Tower, 1985-88.
Gustave Eiffel.

29
Corner detail slate cladding,
concrete pillars and beams.
Bryn Mawr College,
Pennsylvania, 1960-65.
Louis I. Kahn.





30
Gottfried Semper, the Caribbean hut in the Great Exhibition of 1851.
From "Der Stil" vol. 1, 1860.

31
Gottfried Semper, stiching patterns in lace,
From "Der Stil" vol. 1, 1860.

intention of the designing architect, which involves two different levels of approach, one that has point of departure in an abstract realm and another that relates to the world of concrete problems.

Gottfried Semper and the Notion of Tectonic

The German architect Gottfried Semper (1803-1897) is more or less claimed to have invented the modern understanding of tectonic and his architectural theories charged the term with new meaning. According to Hartoonian, Semper defined tectonics in architecture as a cosmic art analogous to dance and music:

> Tectonics deals with the product of human artistic skills, not with the utilitarian aspect but solely with that part that reveals a conscious attempt by the artisan to express cosmic laws and cosmic order when molding the material.[15]

Semper's theories about the tectonic had its point of departure in studies of traditional and vernacular architecture, and were inspired by Karl Böttiger's theories of Kernform (core-form) and Kunstform (art-form).[16]

Hartoonian describes Semper's ideas as neo-avant-garde in opposition to his contemporaries, who nostalgically dreamed of the survival of craftsmanship and the Gothic guilds. Semper, on the other hand, suggested that:

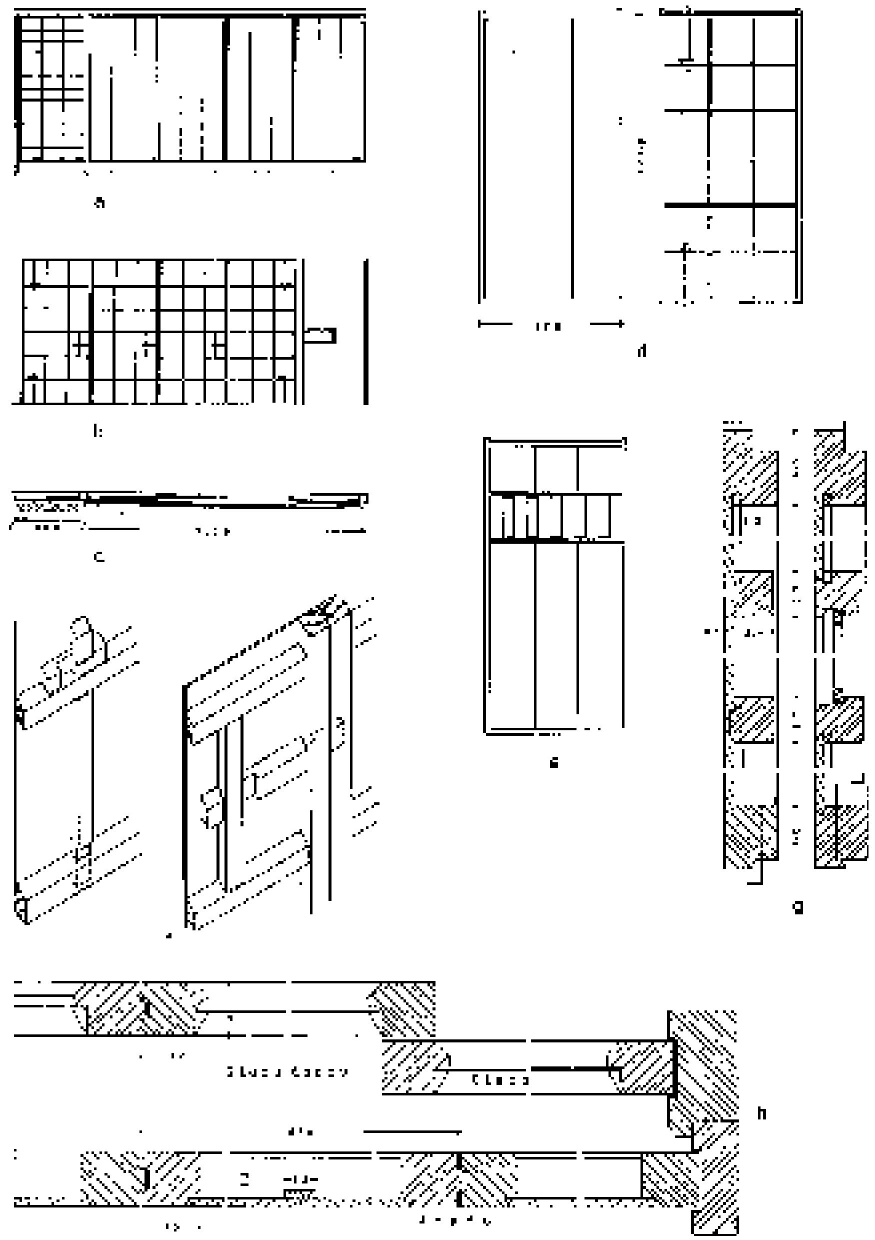
> This process of disintegrating existing art types must be completed by industry, by speculation and by applied science before something good and new can result.[17]

Hartoonian notes further, that Semper's hermenutical understanding of the new sat him apart from the common modernist rejection of history, and "as he [Semper] witnessed the disappearance of traditional forms of art made him formulate a theory that integrated ur-forms with new techniques and materials".[18]

Finally it is important to include Hanno-Walter Kruft's description of Semper's contribution to modern architectural theories. He notes:

> Semper cannot be seen as a prophet of a modern, material-based aesthetics, although individual statements taken out of context might give that impression. His modern significance lies rather in the vision [...] that construction consisting solely of materials in accordance with the laws of structural engineering was in need of being raised to symbolic status. His theory represents the most comprehensive attempt made in Germany in the nineteenth century to understand architecture as the expression of the extremely complex interplay of material and ideational forces.[19]

Die Vier Elemente der Baukunst (1851) played a significant role in shaping his theoretical discourse. In this book, Semper studied vernacular dwelling and



32
Details of traditional and modern amado sliding wooden shutters.

building construction and proposed that architecture had developed out of the experience of four basic elements: the earthwork, the hearth, the framework/roof, and the lightweight enclosing membrane.[20]

Through analyses based on these four elements, Semper classified the building crafts into two basic procedures, as summarized by Frampton:

Tectonics of the frame, in which lightweight, linear components are assembled so as to encompass a spatial matrix, and the stereotomics of the earthwork, wherein mass and volume are conjointly formed through the repetitious piling up of heavyweight elements.[21]

Frampton suggests in his further elaboration on the distinction between light and heavy constructions that tectonics and stereotomics also allude to representational and ontological aspects of tectonic form. In his examination of lightweight screens in traditional Japanese architecture he draws this parallel:

The concept of layered transitional space as it appears in traditional Japanese architecture (fig. 1.21) may be related indirectly to the distinction that Semper draws between the symbolic and the technical aspects of construction, a distinction that I have attempted to relate to representational and ontological aspects of tectonic form: the difference, that is, between the skin that re-presents the composite character of the construction and the core of the building that is simultaneously both fundamental structure and its substance. This difference finds a more articulated reflection in the distinction that Semper draws between the ontological nature of the earthwork, frame, and roof and the more representational symbolic nature of the hearth and the infill wall. [22]

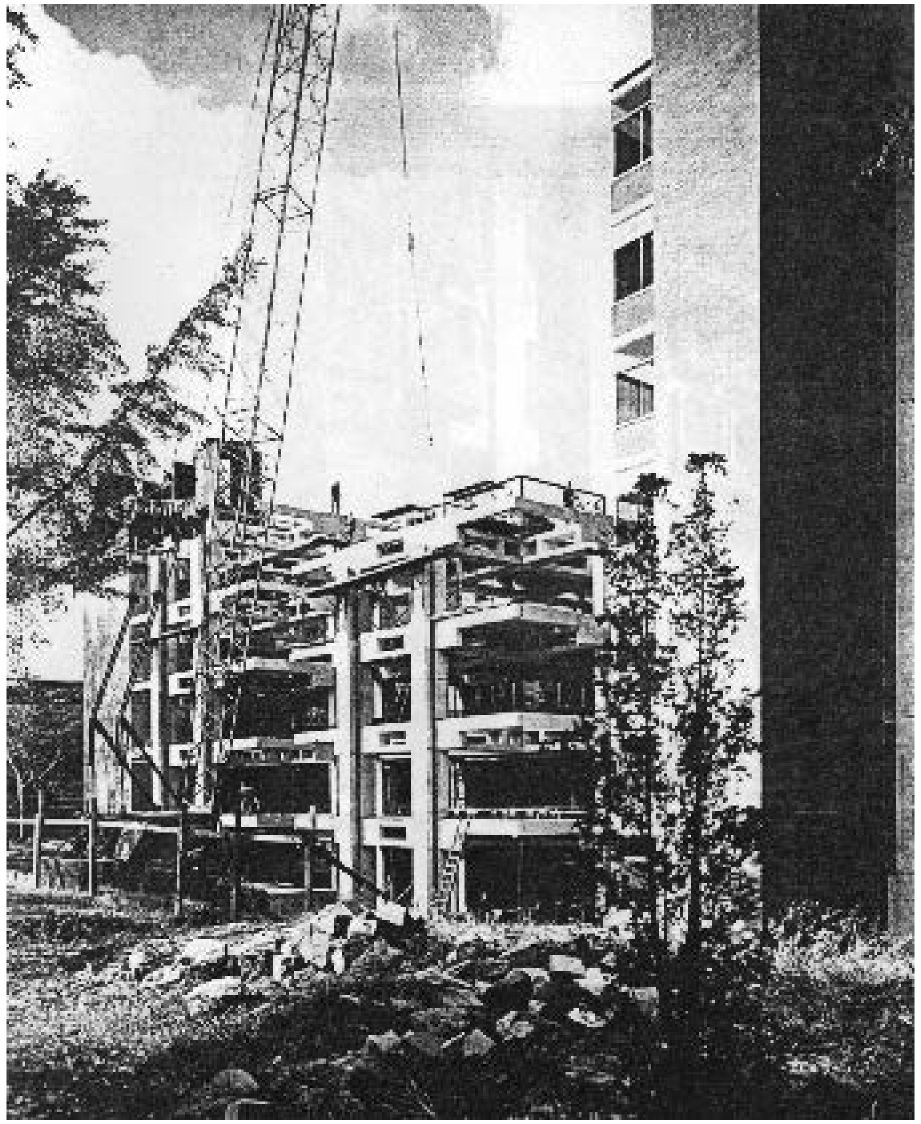
Frampton says further that:

This dichotomy must be constantly rearticulated in the creation of architectural form, since each building type, technique, topography, and temporal circumstance brings about a different cultural condition. [23]

In accordance to this conclusion, tectonics can be characterized as systems of thought or processes of signification and therefore related to an accumulation of knowledge. E.g. crafts or industrial practises that have developed from working with construction.

Signified Signification

Along the question of how to approach signification (meaning) of technology it



33
Richards Medical Research Laboratory. Fraction of Biology Laboratory tower, 1957-61. Louis I. Kahn.

is tempting to ask whether materials and building construction have any meaning of their own or whether they only gain (architectural) significance through human action and intention?

This discussion forms the essence of architectural endeavor and represents the core of how to define the poetics (techné) of architecture.[24]

Vitruvius made one of the first attempts to define the question of signification in architecture. In Ten Books of Architecture he stated:

In all matters, but particularly in architecture, there are these two points: - the thing signified, and that which gives it its significance. That which is signified is the subject of which we may be speaking; and that which gives significance is a demonstration on scientific principles.[25]

According to Frascari, the Vitruvian axiom unifies the corporal with intention in a process of signification that results from fantasy (or vision?).[26]

Relating this argument to the objective of this thesis, 'to define the visions and ideas that form tectonics in architecture', one can venture the simple analogy: that which gives significance, is the stuff architecture is made of – its substance, processes, cultural and historical setting etc. – the constituting elements shaped by human activities and practices. Whereas, the thing signified refers to symbolic meaning provided by - ideas and intentions implemented into building – and the rhetoric of the architect.

In light of these ideas, building technology and practices of construction becomes a matter of signification - tectonics - only when they are handled consciously. As summarized in the enigmatic aphorism of Mies van der Rohe:

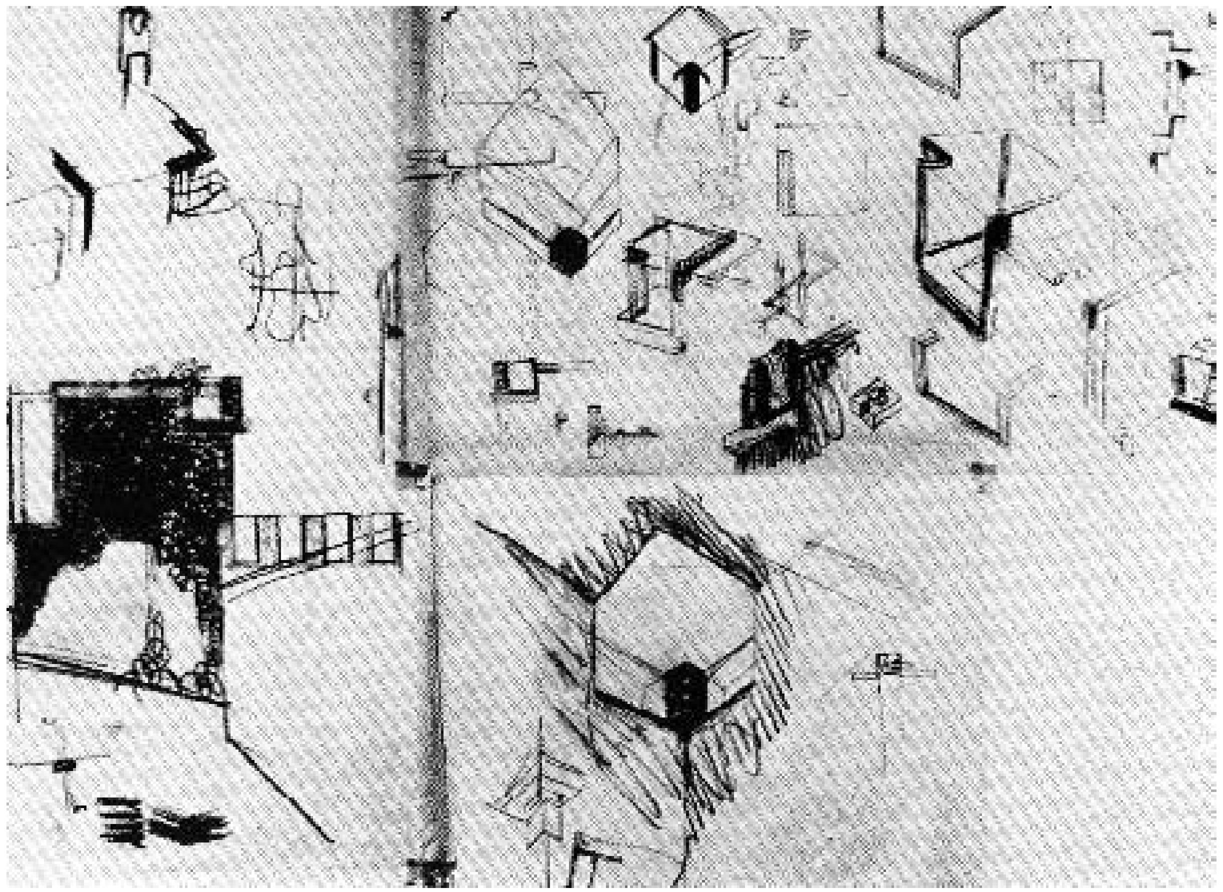
Architecture begins when two bricks are put carefully together.[27]

Means of Transformation and Questions of Knowledge

Technology, regarded as the process of joining thinking and practice - a means of transforming ideas into edifice and edifice into symbolic meaning, may characterize the very event of conceiving architectural form.

As an illustration of this synergetic process, Louis Kahn's divine experience of the crane being an agency of meaning, which shaped his conception of industrial design describes a good example. One day, visiting the construction site of Richards Medical Research Laboratory, he had this vision:

One day I visited the site during the erection of the prefabricated frame of building. The crane's 200-ft. boom picked up 25-ton members and swung them into place like matchsticks moved by the hand. I resented the garishly painted crane, the monster



34
Gipsoteca Canoviana in Possagno, study sketches, 1955-57. Carlo Scarpa.

which humiliated my building to be out of scale. I watched the crane go through its many movements all the time calculating how many more days this 'thing' was to dominate the site and the building before a flattering photograph could be made. Now I am glad of this experience because it made me aware of the meaning of the crane in design, for it is merely the extension of the arm like the hammer. Now I began to think of members 100 tons in weight lifted by bigger cranes. The great members would be only the parts of a composite column with joints like sculpture in gold and porcelain and harboring rooms on various levels paved in marble.
These would be the stations of the great span and the entire enclosure would be sheathed with glass held in glass mullions with strands of stainless steel interwoven like threads assisting the glass and the mullions against the forces of the wind.
Now the crane was a friend and stimulus in the realization of a new form.[28]

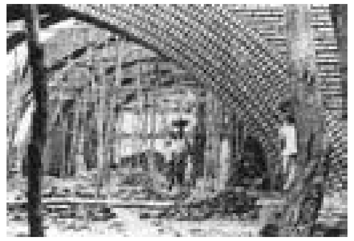
The modern crane and its efficiency is simply a response to the rational nature of industrial construction; its task is to handle large, prefabricated components to achieve efficient operations and products e.g. high-rise buildings. But Kahn's particular reading of this rational means and its mechanized processes surpassed its instrumental rationality and loaded it with another layer of meaning.[29]

The construction details illustrate another good example of architectural signification. This theme is thoroughly analyzed by Marco Frascari in his critical article The Tell-The-Tale Detail.[30]

Through the work of Carlo Scarpa, Frascari describes the role of the detail within two different, but interlocking realms, the theoretical and empirical. He refers to Scarpa's buildings as: 'texts wherein the details are the minimal units of signification', and where 'the joints between different materials and shapes and spaces are pretexts for generating texts'.[31]

Frascari exemplifies this layered process of signification in Scarpa's detailing of Gipsoteca Canoviana in Possagno, claiming that "…Scarpa was able to change the convention that asks for the background walls of a collection of gypsum casts to be tinted. Scarpa's solution was to put the white casts against a white background wall that was washed with light, without directly lighting the casts. The problem and the solution are in the use of light. Scarpa solves it in a detail in the joint of three walls in a corner made of glass…. The achievement of the effect of light occurs by a formal manipulation. The solution of the formal cause solves the final cause. He described it as 'clipping of the blue of the sky', a formal cause, but the result was the lighting of the wall, the final cause". [32]
However Frascari prefers Scarpa's own words to describe the making of his architectural details:

I love a lot of…natural light: I wanted to clip off the blue of the sky. Then what I



wanted was an upper glass recess.… The glass corner becomes a blue block pushed up and inside [the building], the light illuminates all the four walls. My bias for formal solutions made me prefer an absolute transparency. Consequently I did not want the corner of the glass to tie in a frame. It had been a tour de force because it was not possible to obtain this idea of pure transparency. When I overlap the glasses I see the corner anyway, especially if the glass is thick. One may as well put in the frame. Then, besides this, if it is a clear day one may see the reflection. Look, when I saw the reflection I hated myself. I did not think of it. These are the mistakes which one makes in thinking, acting, and making, and therefore [it] is necessary to have a double mind, a triple mind, the mind like that of a robber, a man who speculates, who would like to rob a bank, and it is necessary to have that which I call wit, an attentive tension toward understanding all that is happening.[33]

Also materials may carry signification. Materials may be signified in accordance with their inherent nature, and various architects have been inspired by their different physical qualities, e.g. surfaces textures, structural strength, firmness or softness, etc.

One of the most cited inquiries into nature of materials has been given by Louis Kahn, who had an intimate conversation with the brick about its hidden desires concerning its use in construction.

This dialogue held almost a classical format, presented in a lecture at Pratt Institute, School of Architecture in 1973:

Realization is realization in form, which means nature. You realize that something has a certain nature. A school has a certain nature, and in making a school the consultation and approval of nature are absolutely necessary. In such a consultation you can discover the order of water, the order of wind, the order of light, the order of certain materials. If you think of brick, and you're consulting the orders, you consider the nature of brick. You say to brick, "What do you want brick?" Brick says to you, "I like an arch." If you say to brick, "Arches are expensive, and I can use a concrete lintel over an opening. What do you think of that, brick?" Brick says, "I like an arch". It is important that you honor the material you use. You don't bandy it about as though to say, "Well, we have a lot of material, we can do it one way, we can do it another way". It's not true. You must honor and glorify the brick instead of shortchanging it and giving it an inferior job to do in which it looses its character, as, for example, when you use it as an infill material, which I have done and you have done. Using brick so makes it feel as though it is a servant, and brick is a beautiful material.[34]

Kahn's questioning involves a certain amount of knowledge, theoretical as well as empirical. However, this process of inventive thinking still require a receptive

mind in order to gain new knowledge about the possible use of materials and new technology, in this case the bricks. Kahn's own architectural answers to the brick that wanted to be a vault respected the classical structural principles of masonry construction; however, in the Indian Institute of Management in Ahmedabad, he challenged its physical limits helped by modern construction technology and the use of concrete tie-beams to support the large vaults.

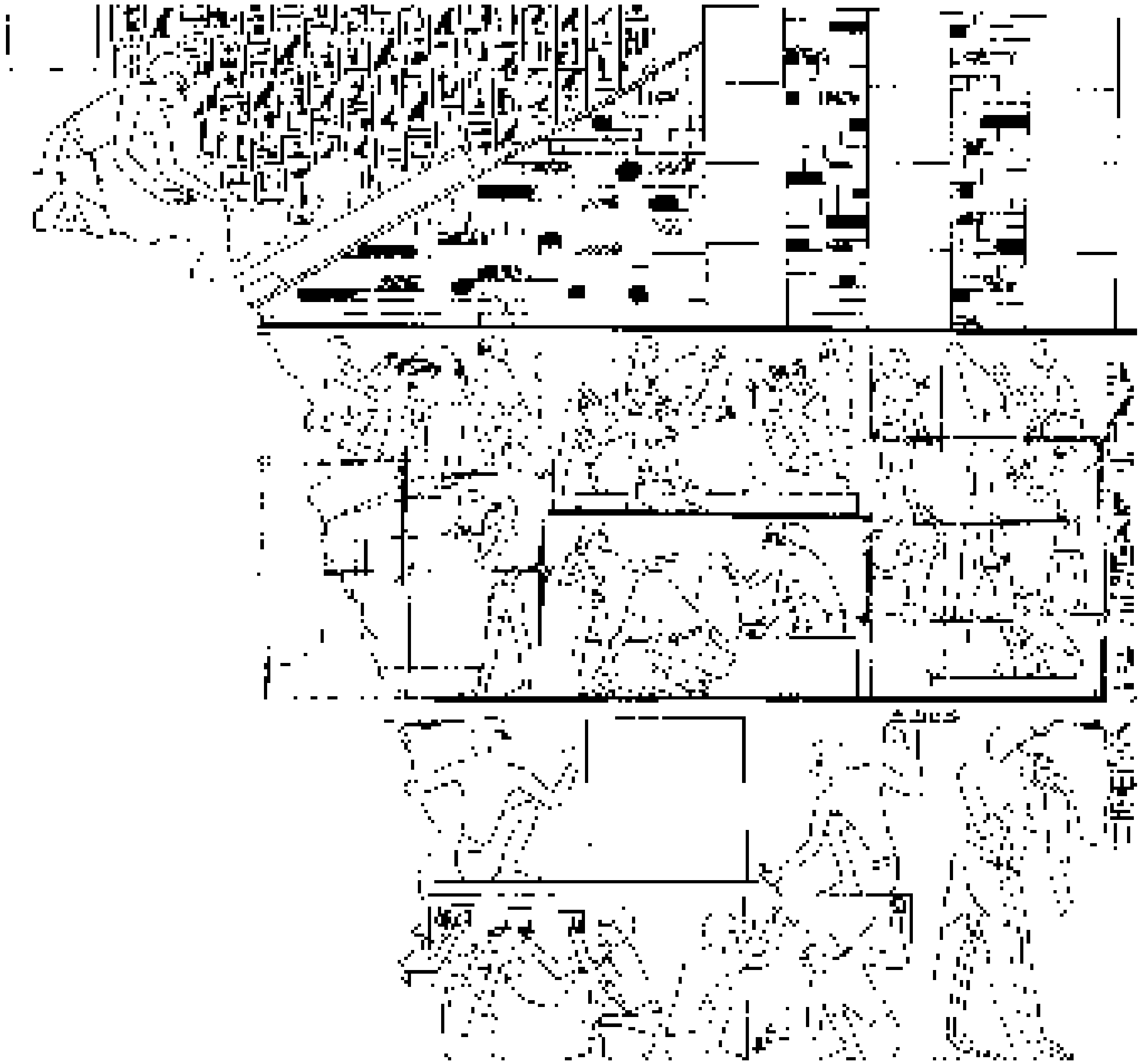
Interesting investigations into knowledge in relation to technology has been carried out by the French philosopher, Michel Serres. In the essay, Mathematics & Philosophy: What Thales saw…, he unfolds the concept of knowledge through the classical text by Diogenes Laertius, in which Thales measured the height of the pyramids by the shadow they cast in the sand at the hour of the day when the length of the shadow equals the length of our height.[35] In his own poetic manner, Serres analyses how Thales might have reached his theoretical knowledge through the physical presence of the Pyramids:

What is the status of the knowledge implied by a certain technique? A technique is always an application that envelops a theory. The entire question – in this case the question of origin – boils down to an interrogation of the mode or the modality of that enveloping process. If mathematics arose one day from certain techniques it was surely by making explicit this implicit knowledge. That there is a theme of secrecy in the artisan's tradition probably signifies that this secret is a secret for every body, including the master. There is an instance of clear knowledge that is hidden in the worker' hands and in their relation to the blocks of stone.

This knowledge is hidden there, it is locked in, and the key has been thrown away. It is in the shadow of the pyramid. Here is the scene of knowledge, the dramatization of the possible origin, dreamed about, conceptualized. The secret that the builder and the rock-cutter share, secret for him, for Thales, and for us, is the shadow-scene. In the shadow of the pyramids, Thales is in the domain of implicit knowledge; on the other side of the pyramid, the sun must make that knowledge explicit in our absence. Henceforth the entire question of the relationship between the schema and history, of the relationship between implicit knowledge and the artisan's practice, will be posed in terms of shadow and sun, a dramatization in the Platonic mode, in terms of implicit and explicit, of knowledge and practical operations: on the one hand, the sun of knowledge and of sameness; on the other, the shadow of opinion, of empiricism, of objects.

…One cannot conceive the origin of technique except as the origin of man himself, faber as soon as he emerges, or rather emerging because he is faber. Technique is the origin of man, his perpetuation, his repetition. Hence Thales repeats his very origin, and our own: his mathematics, his metrics of geometry, repeats in another way the modality of our technical relationship to objets, the homology of the fabri-

35
Sher-e-Bangla Nagor, capital of Bangladesh. Presidential Square, substructure under construction, ca. 1965. Louis I. Kahn.



cator to fabricated. [36]

Serres's theories may be difficult to understand due to his condensed style of writing, but a thorough examination of the text makes one realize that he touches upon the universal question of how to decode the hidden meaning of technology and use its generating force to provide new meaning. Serres's analysis embraces all the elements previously mentioned describing the realm of tectonics, building technology and practices of construction. Through the myth of Thales, Serres describes 'architectural reality acting between sensory experiences and physical expressions', as Frascari says.

Serres unveils its poetry and logic; the maker and its making; ideality and reality; the past and the future; the concealed and revealed; processes of thought and action; informing reflections of knowledge; change of conduct. The realm, which Frampton characterizes as something that 'must be constantly rearticulated in the creation of architectural form'.

As such, the realm of building technology and practices of construction reflect ethical and ideological discourses by the very fact that whenever one applies a tool or a certain method in order to solve a problem, it is then a subjective act, depending on selection, and value judgments by having chosen one model over another. Thus, construction and therefore technology cannot be characterized as an objective means, but rather as critical ethical instruments that define and shape our living conditions and way of thinking.[37]

36
The art of stone cutting
during the time of Farao Zoser,
ca. 2900 bc.
The upper part: block of stone
is pushed on a tramp.
The middle part: stone-cutters
working on a large sculpture.
The lowest part:
various stages of stonecutting.
From Rekhmaras's tomb.

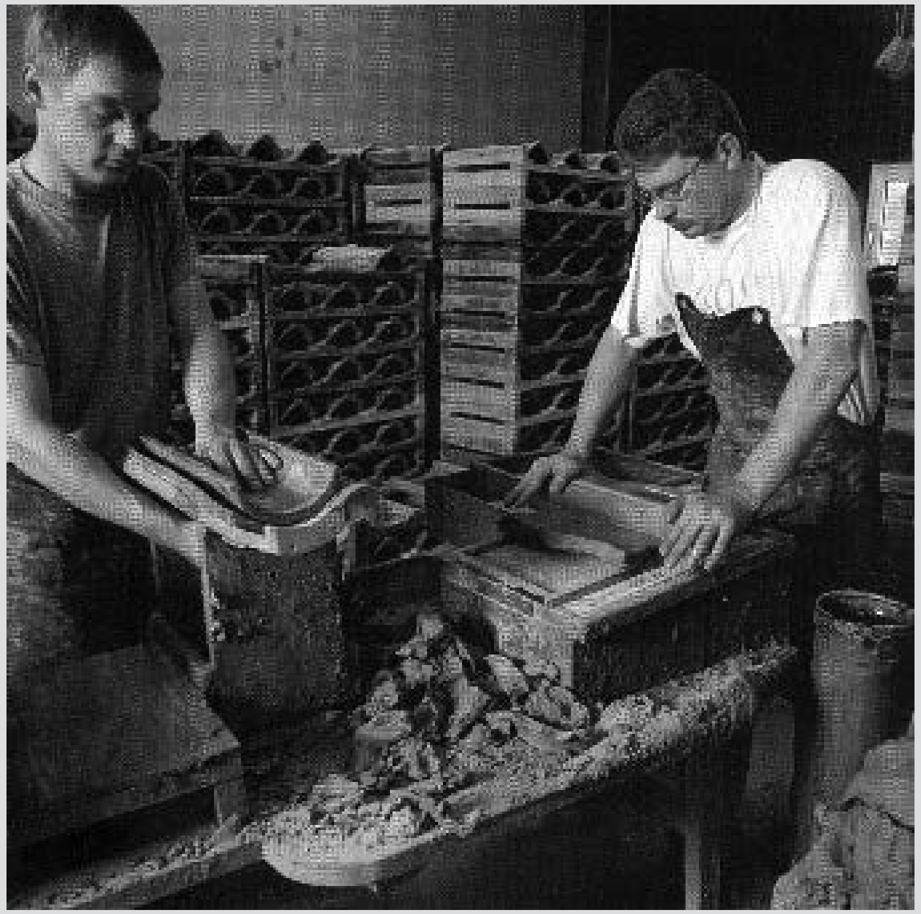
[1] The opening paragraph of Alberto Perez-Gomez's text, "The Space of Architecture: Meaning as Presence and Presentation", Holl, Steven, Juhani Pallasmaa, Alberto Perez-Gomez, Questions of Perception: Phenomenology of Architecture, A+U, July, 1994, p. 8

[2] In Studies of Tectonic Culture, Frampton summarizes the original meaning of tectonics, and rediscovery of the concept in eighteenth century French, German and English architecture and architectural theories. Most importantly, he demonstrates how both constructional form and material character have been integral in an evolving architectural expression in the work of Perret, Wright, Kahn, Utzon, Mies van der Rohe and Scarpa. Kenneth Frampton, Studies in Tectonic Culture: Poetics of Construction in Nineteenth and Twentieth Century Architecture, MIT Press, Cambridge, Massachusetts, 1994

[3] The general work of Marco Frascari, but in particular his article The Tell-The-Tale Detail (1984), has acted as a primary generator for this discourse, as well as works by: Perez-Gomez, Architecture and Crisis of Modern Architecture, MIT Press, (1983); Gevork Hartoonian's; Ontology of Construction, Cambridge University Press, (1994); Mostafavi &Leatherbarow's; On Weathering, MIT Press, (1993)
[4] Frampton, Studies in Tectonic Culture, p. 3
[5] Hartoonian, Ontology of Construction, p. 11
[6] Frascari, Marco, Monsters of Architecture: Anthropomorphism in Architecture, Rowman & Littlefield Publishers, Inc., Savage, MD, 1991, p. 117
[7] Hartoonian, Ontology of Construction, p. 29
[8] Ibid.
[9] Oxford Advanced Learners Dictionary of Current English, Oxford University Press, 1974, p. 887
[10] Ibid., p. 13
[11] Frascari, Monsters of Architecture: Anthropomorphism in Architecture, p. 115
[12] Notes from theory course with Marco Frascari, November 1996, University of Pennsylvania.
[13] Sekler, Eduard F., "Structure, Construction, Tectonics", Structure in Art and in Science, ed. Gyorgy Kepes, George Braziller Inc., New York, NY, 1965, p. 89
[14] Carter, Peter, "Mies van der Rohe", Architectural Design, March, 1961, p. 97
[15] Hartoonian, Ontology of Construction, p. 23
[16] Like Violet-le-Duc, Böttiger was interested in iron and its structural principles, searching for the formation of a new system of covering space. The means of covering space was the essence of Böttiger's discourse on the core-form (Kernform) and the art-form (Kunstform). Böttiger interpreted the term tectonic as signifying a complete system binding all the parts of the Greek temple into a single whole. Hartoonian, p. 23 and Frampton, Studies in Tectonic Culture, p. 4
[17] Ibid., p. 20-21
[18] Ibid.
[19] Kruft, Hanno-Walter, " Germany in the nineteenth century", Architectural Theory: from Vitruvius to the Present, Zwemmer, London, 1994, p. 315
[20] Semper, Gottfried, Die Vier Elemente der Baukunst, Brunswick, 1851
[21] Frampton, Studies in Tectonic Culture, p. 5
Stereotomic originates etymologically from Greek and is linked to building practices with stone and solid or cast constructions, from stere'os, firm, corporeal, spatial and to'me, cutting, slice, temnein to cut.
[22] Frampton, Studies in Tectonic Culture, p. 16
[23] Ibid.
[24] "Art originates in techné, which in its Greek sense is a knowledge related to making and its always known in its final sense as techné/poietike. …As a project of possible knowledge, techné receives most of its knowledge from accumulated experience but elevates it to a priori knowledge that can be taught". Vesely, Dalibor, "Architecture and the question of technology", Architecture Ethics and Technology, ed. Louise Pelletier & Alberto Pérez-Gómez, McGill-Queen's University Press, Montreal, 1994, p. 32
[25] Vitruvius, Marcus Pollio, The Ten Books of Architecture (De Architectura), Trans. Morris H. Morgan, Dover Publications Inc., NY, 1960/1, I.I.III, p. 5.
[26] Frascari, Marco, Monsters of Architecture: Anthropomorphism in Architecture, Rowman & Littlefield Publishers, Inc., Savage, MD, 1991, p. 16
[27] Carter, Peter, "Mies van der Rohe", Architectural Design, March, 1961, p. 96
[28] Kahn, Louis I., "Form and Design", Architectural Design, No. 4, April 1961, p. 151
[29] This argument is a reinterpretation of Gevork Hartoonian's, description of the conceptual differences between construction versus tectonics. Hartoonian, Gevork, "Poetics of Technology and the New Objectivity", JAE, Fall, 1986, p. 18
[30] Frascari, Marco, The Tell-The-Tale Detail, VIA, no. 7, 1984
[31] Ibid., p. 31
[32] Ibid.

[33] Ibid. The Scarpa quote stem from, Scarpa, Carlo, "Frammenti, 1926-78", Rassegna 7 (1981), p. 83-83
[34] Kahn, Louis I., "Materials", part of the lecture Kahn held at Pratt Institute, School of Architecture, in New York, 1973
[35] Thales of Miletus, c.640-546 BC, Greek philosopher and the father of mathematics.
[36] Serres, Michel, ' Mathematics & Philosophy: What Thales Saw…", Hermes: Literature, Science, Philosophy, The Johns Hopkins University Press, Baltimore, MD, 1982/92, pp. 89-91
[37] eth·ic (èth'ĭk) noun, a. A set of principles of right conduct. b. A theory or a system of moral values. Ethics (used with a sing. or pl. verb). The rules or standards governing the conduct of a person or the members of a profession: Medical ethics. (from Greek êthikê), both from Greek êthikos, ethical, from ethos, character

Case Studies



The Dream of Industrialized Building

Over the past century new materials - such as steel, reinforced concrete and float glass; industrial production methods, and prefabricated building products have altered building technology and construction practices. Furthermore, the general development of technology has accelerated, offering new products and scientific results almost every day. These circumstances have led to new cultures of construction and architecture, different from the small, thick-walled cell-like buildings that prevailed just a century ago.[1]

This development has also provided completely different means for the architect - as the translator of ideas and matter into built form. However, if building-technology and practices of construction are identified as tectonic means, and thus act as carriers of meaning it is tempting to ask, what happens to architectural expression when building moves from craftsmanship to industrialization?

To answer this question, one first has to define the character of craft and industrialization, respectively. The American sociologist, Lewis Mumford (1895-1990), has defined the difference claiming that industrialization regarded as the machine "fulfills the bare essentials of an object", following a rigid mechanized pattern. Craft, on the other hand is characterized by the individuality of the worker and his delight in production. Therefore, handicraft allows for different ways of tackling a job and numerous aesthetic solutions.[2]

Regarded as such, industrialization may obviously lead to homogeneity and standardization in building construction and architectural design. However, Mumford has criticized this bold conclusion saying:

> The error with, […] these new forms of building is the attempt to universalize the mere process or form, instead of attempting to universalize the scientific spirit in which they have been conceived.[3]

A reductive interpretation of industrialization seem to be the dominating feature of contemporary building construction, despite its inherent potentials. In relation to these conditions, it is therefore interesting to examine how architects have sustained a creative and open design process that have lead to new forms, while they at the same time have strived for rationality in construction.

860-880 Lake Shore Drive and Pavillion de L'Esprit Nouveau

Mies van der Rohe (1886-1969) and Le Corbusier (1887-1965) are two of the most significant architects in this century, each having provided their interpretation of modern construction in their architectural design.

Even though they were trained under different circumstances and went different ways in their artistic courses, they were both much inspired by the potentials of the new materials steel, concrete and glass, and believed that build-

37
Volstrup tileworks,
tile manufacturing for restaurations, 1999.

ing construction had to be industrialized in order to invigorate the conservative construction industry and renew the ambiguous architectural style, prevailing at the time.[4] They both envisioned how industrial manufacturing, mass production, and mechanized transportation could be incorporated as processes in building construction; however, they settled on two different models for industrial revolution.

Although twenty-four years apart, 860-880 Lake Shore Drive (1949-51) and Pavillion L'Esprit Nouveau (1925/1977), can be claimed to have the same point of departure in the spirit characterizing the architectural setting during the early twenties in Europe. In 860-880 Lake Shore Drive, Mies van der Rohe got the chance to fulfill the dream of his glass tower projects from the twenties through highly industrial American steel construction technology. Whereas Le Corbusier pursued the construction technology of concrete, which had truly developed in France around the turn of the century.

However, the way the projects differs in thought is quite significant. While Le Corbusier was fascinated by the flexibility and formability of reinforced concrete, Mies preferred the precision and refined details of steel construction. As such, Le Corbusier's Dom-ino system added a new dimension to wet procedures in masonry and stone construction, whereas Mies aimed at dry procedures in order to be in control of all the phases of construction, from the handling of raw materials to the assembling of members on site.

These different attitudes also showed in their definition of the building site. Le Corbusier perceived the building site as the place of industrialization, regarding it as a working organism that transformed into building itself. Mies believed in factories and the benefits of the assembly-line and prefabricated building components delivered to the building site.

Finally, these two tectonic visions are also present in their interpretation of architectural space. Even though Mies could have challenged the steel frame as a spatial matrix, he designed only horizontal spaces. Le Corbusier strived for spatial fluidity horizontally as well as vertically, despite the structural limitations of reinforced concrete that require thorough planning before construction and following the rules of the reinforcement.

38
860-880 Lake Shore Drive.
Looking downwards the facade,
1951.
Mies van der Rohe.

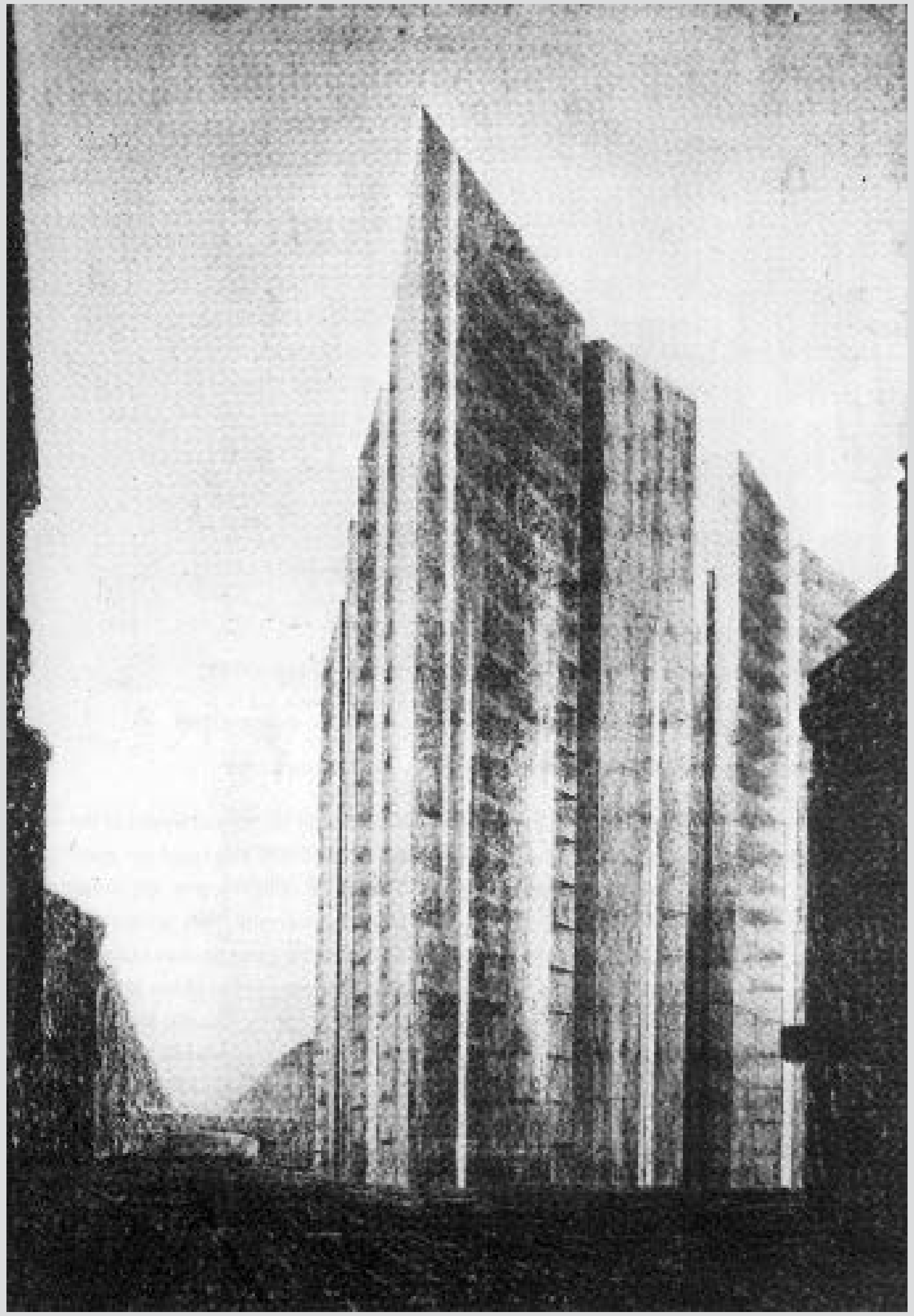
39
Pavillion de L'Esprit Nouveau,
Exposition Internationales des
Arts Decoraftifs de 1925.
Le Corbusier.

[1] One of the most lucid and informative books on this subject is James Strike's Construction into Design. Drawing the parallel between new technologies and architectural design in a very direct manner he allows for the reader to interpret the actual consequences of the development.

[2] Mumford, Lewis, Sticks and Stones: a study of American architecture and civilization, Dover publications Inc., New York, 1924/1955, p. 216-218

[3] Ibid., p. 179

[4] In the early years of their careers, Mies van der Rohe primarily concentrated on single-family housing and exhibition design, whereas Le Corbusier already in 1924 conceived ideal city plans such as Ville Contemporaine, reflecting modern industrial society.



Stahlskelletbau and the Essence of Bauen

860-880 Lake Shore Drive
Built: Chicago (1949-51)
Architect: Ludwig Mies van der Rohe

The industrialization of the building trades is a matter of materials. That is why the demand for new building materials is the first prerequisite. Technology must and will succeed in finding a building material that can be produced technologically, that can be processed industrially, that is firm, weather resistant, and sound and temperature insulating.
It will have to be a lightweight material, the processing of which not only permits but actually demands industrialization. The industrial production of all parts can only be carried out systematically by factory processes, and the work on the building site will then be exclusively of an assembly type, bringing about an incredible reduction of building time. This will bring with a significant reduction of building costs. The new architectural endeavors, too, will find their real challenge. [1]

Ludwig Mies van der Rohe

The notion of industrialized construction fascinated Mies van der Rohe from the early days of his career; however, he did not get to test true industrial construction technology before he began practicing architecture in the U.S.A.

The apartment complex, 860-880 Lake Shore Drive, represents one of the most significant examples of Mies's architectural course, how to expose the inner nature of contemporary (industrial) construction. In his own terms, he pursued the essence of Bauen.[2]

860-880 Lake Shore Drive revives his early theories about the skyscraper being one of the most critical building types of this century. Furthermore, its architectural design introduced a new interpretation of the American skyscraper, reduced to its very essence, a naked steel structure and a power symbol. 860-880 Lake Shore Drive represents the boldest expression of his profound ideas and his succeeding skyscraper projects can be read as refinements on the same theme therefore, they are scarcely touched upon in this essay.

To Mies, the skyscraper represented the crystallization of its time – an architectural synthesis of new materials, modern technology, and a new way of thinking.[3] In the text accompanying one of the skyscraper projects of 1922, he declared:

Only skyscrapers under construction reveal the bold constructive thoughts and then the impression of the high-reaching steel skeletons is overpowering.[4]

According to the German scholar, Fritz Neumeyer, this statement shows how to perceive Mies van der Rohe's architectonic reality. He is not concerned with construction due to the technical potentials, but with construction as a symbol of an architectural idea. Neumeyer argues that:
"It is the aesthetic fascination with the 'bold constructive thoughts' that anticipates the new possibilities dwelling in form and space. Mies does not approach

40
Design for the Friedrichstrasse skyscraper, 1921.
Mies van der Rohe.

41
860-880 Lake Shore Drive.
The towers seen from lake
Michigan, 1952.
Mies van der Rohe.

construction from the point of its reality of purpose and function but from the intensity of experienced impression. This is why its condition 'under construction' determined the final appearance of the building. The incomplete and not yet realized is seen aesthetically as the most satisfying state. The skeleton, with the severe grace of engineered construction clearly manifested, becomes the ideal."[5]

Neumeyer's reading of Mies's tectonic approach is valid. However, it is only possible to separate issues of actual construction from the idea of construction in theory, since in practice they are always formed by the orientation of the other. That is why both aspects must be included in studies of tectonic nature.

Mies van der Rohe's approach to these issues shows an equal attention to material properties, their treatment and proccessing, as well as their appearance. He explained about the sketching model for his second skyscraper project of 1922:

I tried to work with small areas of glass and adjusted my strips of glass to the light, then pushed them into the flat, horizontal plasticine planes of the floors. […] I wanted to show the skeleton, and I thought that the best way would be simply to put a glass skin on.[6]

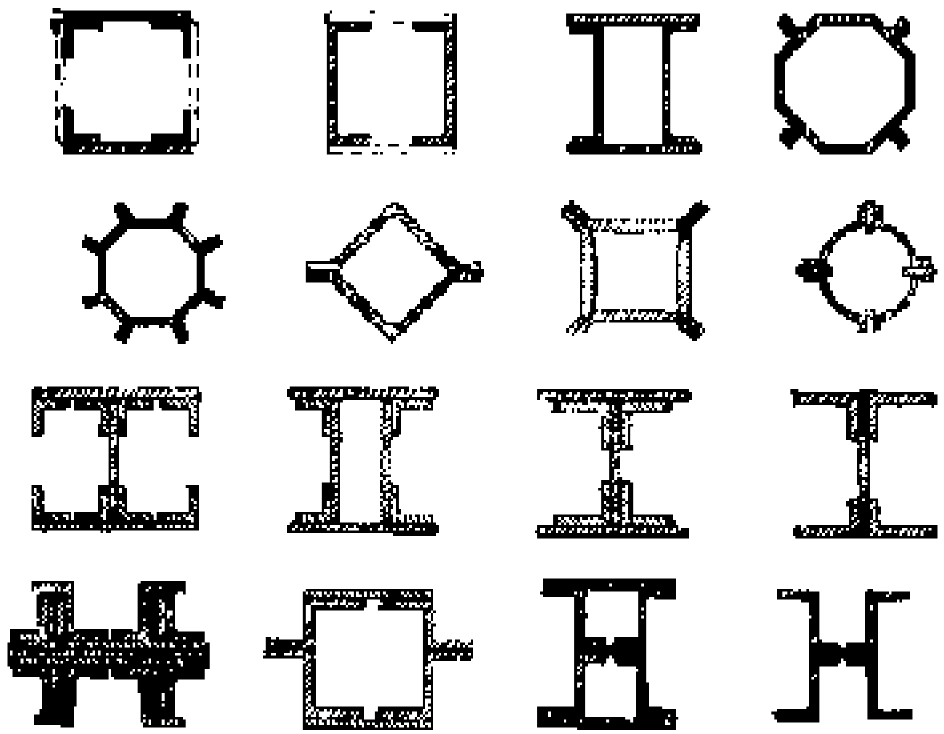
The analysis of the position of the glass plane (skin), adjusted to the appearance of the structure (skeleton), seemed to be the primary question in the skyscraper projects. Similar tectonic attitude can be traced in the design of the facades for the 860-880 Lake Shore Drive.

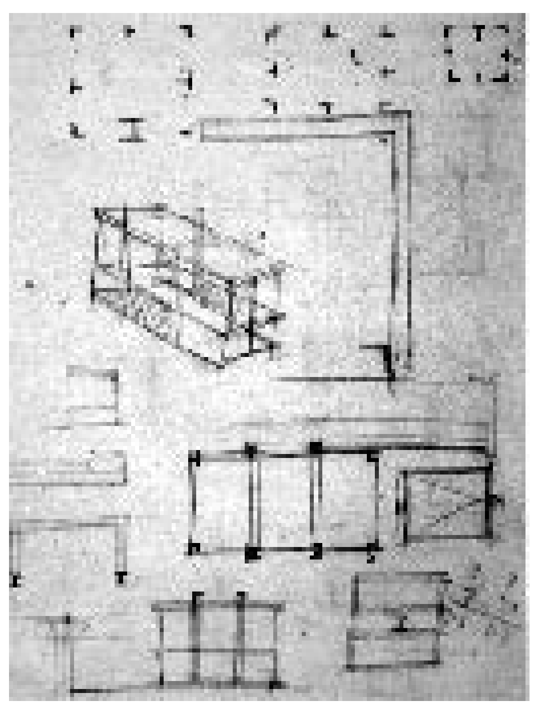
860-880 Lake Shore Drive

The two prismatic, steel and glass towers stand by Lake Michigan on a triangular plot. They are placed at right angles to one another across an interval of space - the one forward of the other. The 26-story towers consist of six-room apartments and of three-and-a-half-room apartments, respectively. They were built as cooperative apartments and originally the tenants shared communal service areas such as laundry and deep-freeze rooms on the second floor.[7] The towers have separate entrances and lobbies that house the doorkeeper and sitting areas for visitors. The lobbies are totally exposed, clad in glass. Two elevators and staircases serve each building and drop directly to an underground garage. An outdoor terrace links the towers together under a suspended roof.

The 860-880 Lake Shore Drive was an outcome of Mies's professional relationship with the real estate developer, Herbert Greenwald, whom he met in 1946. Previously to the Lake Shore Drive project, they collaborated on the Promontory Apartments (1946-49) in Chicago, Illinois.[8]

The Promontory tower was initially designed as a steel construction, but due





42
Column sections riveted together by plates, angles and z-bars.
(W.H. Birkmire, Skeleton Construction in Buildings, 1894)

43
Detail drawings of the steel-structure of the towers. Mies van der Rohe Archive, vol. 14. MOMA, 1992.

to steel shortages after WWII, the structure was altered into a concrete frame with an infill of masonry. Mies was worried by the 'aesthetic fluidity' of the concrete construction and much more at ease with the idea of a steel construction, which he called a natural construction of a high-rise building.[9]

The I-beam and the Notion of Materiality

Mies believed that each material possesses specific properties, which referred to its proper use.[10] That is why he declared that industrialized construction depends on the materials that by their very nature demands industrial processes. Due to this conviction, steel was a natural choice for both the load bearing structure and facade construction of the 860-880 Lake Shore Drive. Moreover, steel possessed a number of physical qualities which Mies seemed to prefer, such as: firmness, rational processes, dry controllable procedures, and precision in the details and joints.

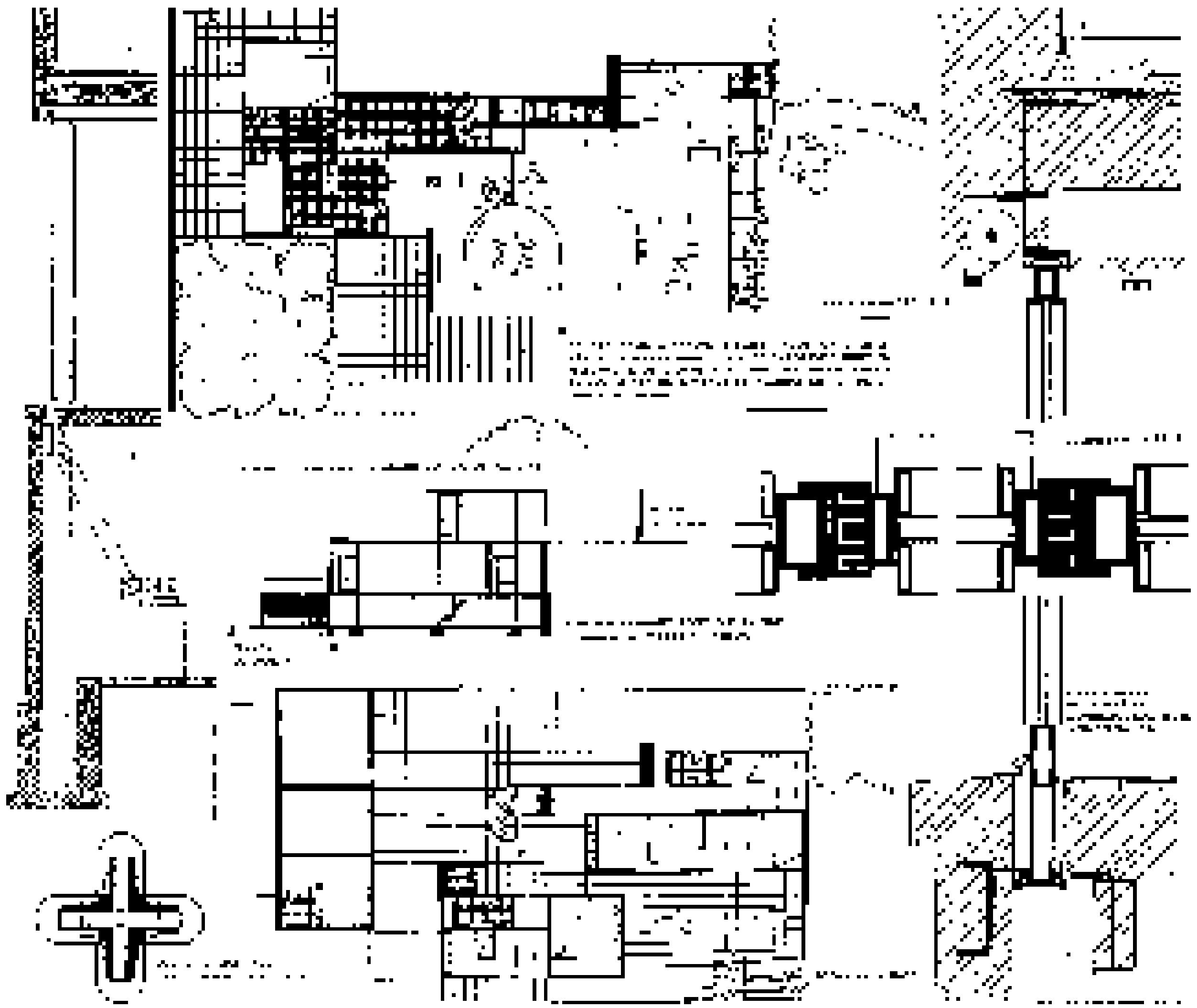
Mies van der Rohe was known for use of extravagant materials and elegant construction solutions. Thus, one wonders why he chose a simple, unrefined structural element, the I-beam of crude steel, as the primary feature of the facades. It also seems curious that he picked the I-shaped profile, considering the fact that other profiles would have worked just as well, structure-wise.

Steel was the primary material in high-rise construction in the fifties. However, steel frames had been used in architectural constructions for almost a century - Chicago was the cradle of its development and application.[11] The steel that we know of today slowly developed from cast iron products to the more purified steel material. Advanced steel manufacturing did not really occur before well into this century. Therefore, when Mies designed his steel structures, the steel members often consisted of various rolled shapes and profiles. The I-beam, which we recognize as an standard steel-member today, was originally assembled of our angles and a single plate.[12]

This also counts for the shapes of columns and beams such as H, I, T, U etc., which have gradually been refined to accomplish different structural needs.

That the I-shaped steel member consists of these other profiles is interesting in relation to Mies's consistent use of an orthogonal idiom.[13] He truly favoured the clarity of the orthogonal and the right angle. He once said:

One does not gain anything if one makes a curve instead of a right angle. Round is also difficult to furnish, there everything is made to measure. And to construct - anyone who does it once is cured.
[...] One can understand the preference of the round, we were born with it, but the circle is limited, the rectangle on the contrary is illimitable, increasable and divisible. The system of the order is based on the square.[14]



44
Plans, sections and details of the Tugendhat, 1928-30.
Mies van der Rohe.

45
Interior of the Tugendhat House, Brno.
Mies van der Rohe.

This statement explains why Mies preferred the I's instead of, e.g. a closed profile. The open, crucifix form, composed of four angles, appears slender and delicate in comparison to the closed RHS -profile. The angled surfaces of the I, reflect light and shadow, which highlight and emphasize its three-dimensional figure and spatial qualities. To Mies, the I-beam was more than a rational and economical element of construction - it was a generator of experience.[15]

Constructing Space

According to a former employee of Mies's American architectural office, the towers could be regarded as were layered horizontal space - " Mies was solely preoccupied with horizontal space."[16]

Bearing this in mind when studying the construction of the 860-880 Lake Shore Drive, one has to take a closer look at his early one-story pavilions. Three projects, prior to 860-880 Lake Shore Drive, seem particularly interesting in that they illustrate the change in Mies's practice of construction, from his European days to the American period.

The selected building projects are, the Farnsworth House (1956-1951), the IIT Pavilions (1942-1957), and the Tugendhat House (1928-1930).

Beginning with the last one first, the Tugendhat House characterizes a synthesis of Mies's language of construction, carried out in the late years of his European period. It was designed with similar refined materials and details as used in the Barcelona Pavilion. Mies achieved the same sense of lightness and spatial flow by using similar cruciform, chromium-plated columns. The angled and reflecting surfaces of the columns blur their visual appearance and structural logic. The walls - indifferent of their materiality - seem to act as solid oblique screens fixing the space. The visual expression of the constructions intensifies and separates the structural elements and makes them appear as autonomous pieces: the column, the slab, the enclosing wall, and the grand window.

However, the simplicity of the surfaces conceals complicated constructions. Supporting steel profiles and fittings are hidden in the wall, floor and roof constructions. The Tugendhat House represents a conglomerate of different construction principles, being a hybrid of a masonry construction, a slab/column or a slab/plane construction.[17]

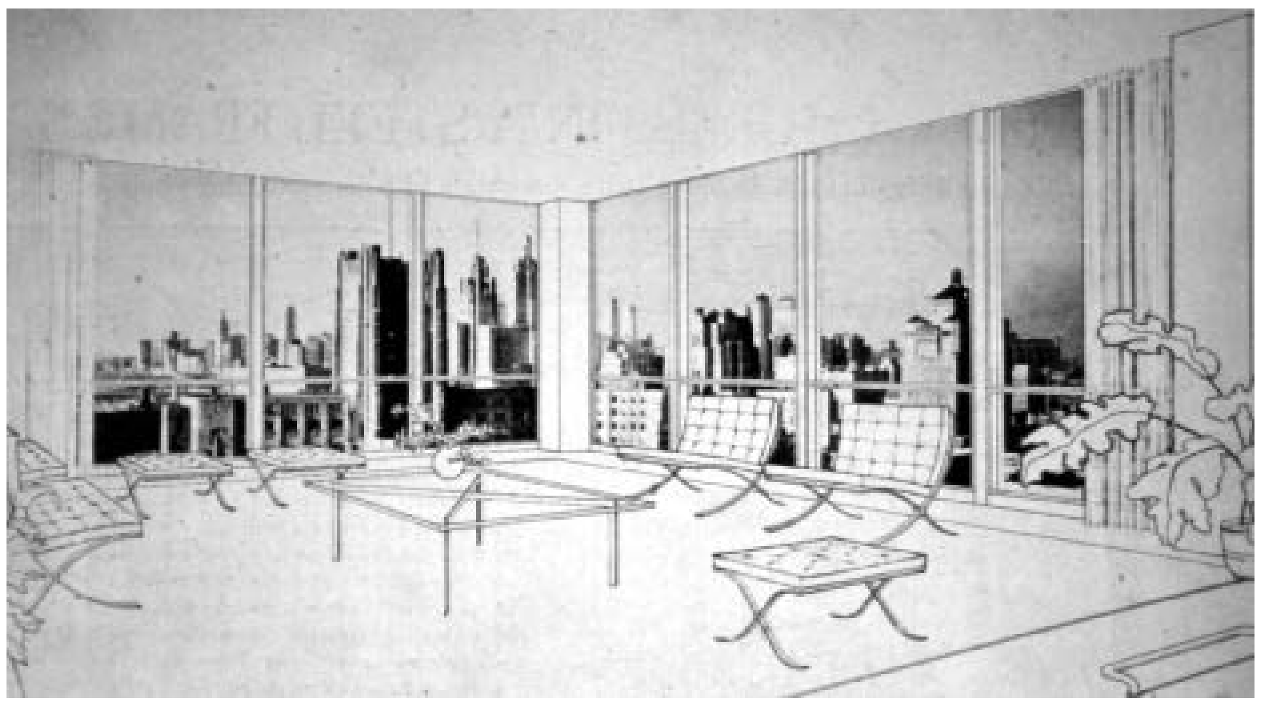
The pavilions carried out in the U.S.A. reflect a different discourse. The various pavilions of the IIT campus are constructed of steel-frame systems that shape the facades. Mies referred to this construction system as Fachwerk (timber-frame system), where the structure and infill are built separately, but tied together, working as a joint construction.[18]

This construction provided a flexible frame work for the composition of the different infill of bricks and glass. The surfaces of the steel frame, the bricks, and

the glass are fixed almost in the same plane, which make the exterior walls appear as light screens. However, despite few construction components, it is quite amazing to notice the great variety in the design of the facades. The different material textures of the surfaces reflect day/night light, varying the exterior environment. When moving inbetween the pavilions, the feeling of space is constantly changing, challenging ones senses.

The final example, Farnsworth House, shows a new dimension in his structural appoach. For the first time, the structural frame is placed outside the building envelope, and the construction materials are reduced to steel and glass only. The columns are perceived both as load bearing structural elements and as mullions. Each element of construction is reduced to its very essence, e.g. the few columns that are painted white, almost fade away visually. By reducing the appearance of the window frame, the border between inside and outside, the spaces dissolve. Mies gains a purified sense of horizontal space, defined by the planes of floor and roof. The view is not framed, but rather held - between the planes.

860-880 Lake Shore Drive contains similar constuction features and conceptions of space as the Farnsworth House. The border between interior and exterior spaces is equally minimized by the exterior walls that are glazed from floor to ceiling, only divided vertically by steel mullions. It seems as if Mies wanted the same kind of gaze from the apartments as he had achieved in the Farnsworth House.[19]



46
860-880 Lake Shore Drive.
Interior view-looking out on the skyline of Chicago.
Architectural Forum, 1952.
Mies van der Rohe.

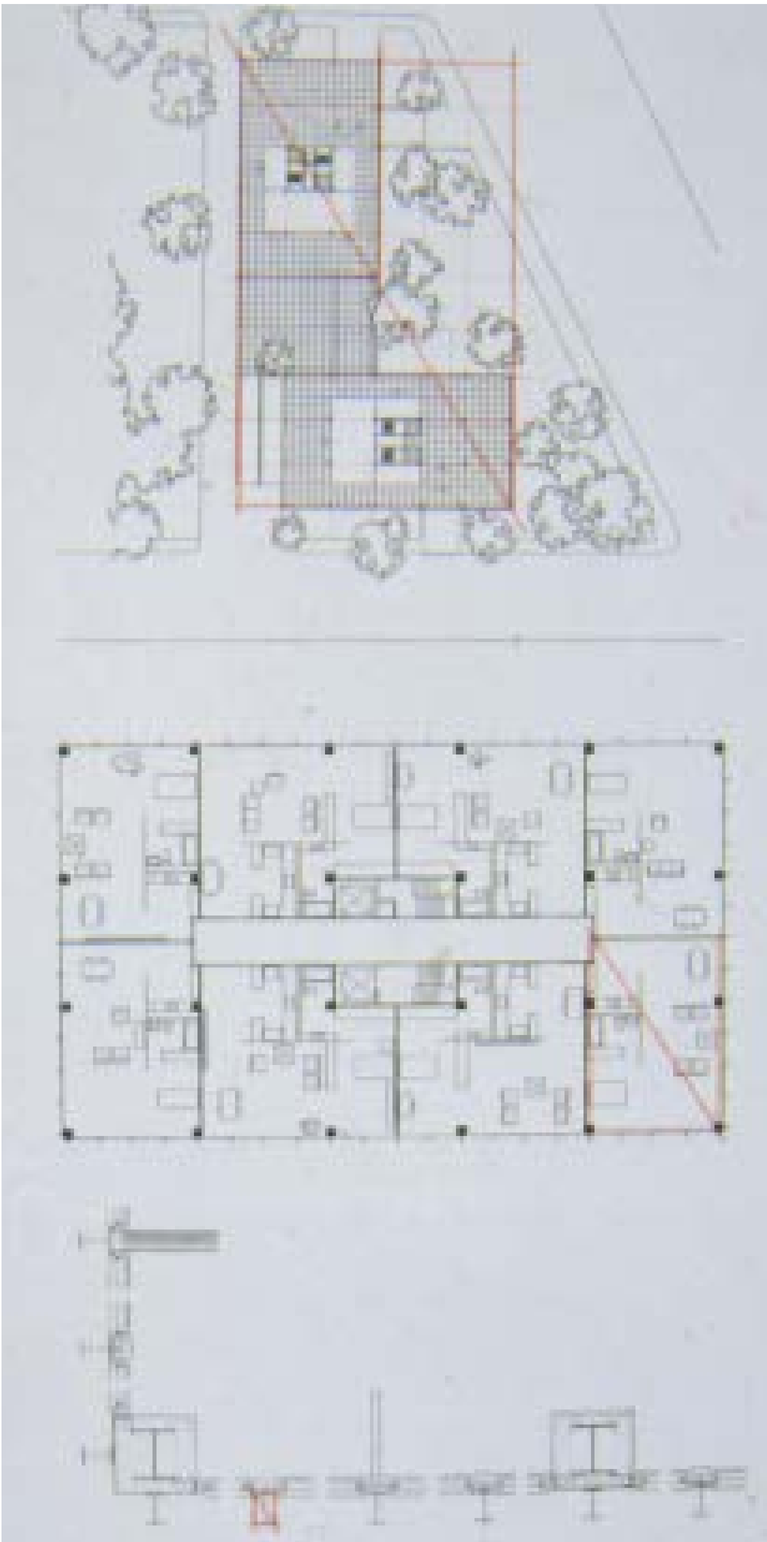
47
Minerals and Metals Research Building, Illinois Institute of Technology, Chicago, 1943.
Mies van der Rohe.

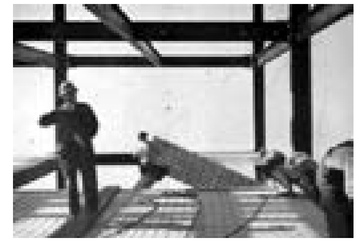
Process of Construction

The design project for the towers was carried out between 1949-50 and the buildings were erected in 1951. The project was a product of great detailing and analysis and the whole process of construction was considered as part of the design. A cross-sectional plan of the construction in 860-880 Lake Shore Drive shows the visible structural grid of the window wall, reflecting the actual structure that is hidden behind the enclosing membrane. The structural columns of the towers had to be clad in concrete for fire protection.

As such, the outer wall construction of the towers resembles both the Fachwerk of IIT and the minimal steel structure of the Farnsworth House. However, the mullions are placed outside the building envelope, adding a third dimension to the surface of the facades.

As for the process of construction, the American scholar, William Jordy, has described it in great detail: "The projecting I-beams were welded across the flat steel plates, which cover the outer edges of columns and floor slabs. Prefabricated two-story window sections were in turn, welded to the small L's that poked through the fireproofing of the structural H-columns. The wall sections were jig-assembled and welded on the roof, then dangled down into place.





48
860-880 Lake Shore Drive.
The proportional relationships between site plan, apartment plan and I-beam.

49
860-880 Lake Shore Drive.
Placing the corrigated sheeting to receive the concrete floor panel.
Mies van der Rohe.

50
860-880 Lake Shore Drive.
Placing the wall-frame, 1950.
Mies van der Rohe

Once the basic grid had been fixed to the structural skeleton, installation of the prefabricated window units in aluminum took place from the inside. This was done in several stages by extending the building up to 12 stories and then stopping while the jigging went on for both towers up to that point. This rapid assemblage from prefabricated parts made the 860-880 Lake Shore Drive into economical buildings, costing five to ten percent less than comparable apartment buildings at the time. Even though small irregularities at the joints would have jeopardized the apparent straightness of the projecting I's, when viewing upward the long perspective of the facades. Mies insisted on their erection on the elevations of the buildings in the same order they had been cut from the rolled lengths at the mill."[20]

According to this description Mies was absolutely devoted to the building processs. He may have chosen to erect the I's as cut from the mill for the same reason as the carpenter takes the floor boards from the stack of the sawmill, in order to achieve a greater homogeneity of the floor surface.

The Whole and the Detail

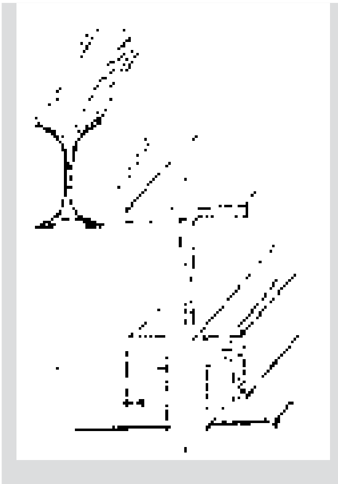
The geometric principles of 860-880 Lake Shore Drive reveals a grid decisively made; yet simultaneously being made of its discrete components. The towers are proportioned by a spatial grid: 21x 21 x 10 ft., therefore each bay being 21x 10 ft. Due to Mies's rigid attention to the grid of the plan, one traces a significant change in the rhythm of the facade, varying the width of the windows by the structural columns. This way, Mies fulfilled his intention; to follow the rules of proportion and to add tension to the appearance of the facade. The dimensions of the towers, (three bays to five), were based on the Golden Section, which provided them with a classical gravity of proportion. This geometric principle also defines the layout of the building complex on the site, as well the apartment plans, the elevations of the bays, and even the I-shaped mullions. This phenomenon may be due to Mies's interpretion of architectural integrity, 'the idea informing the whole', which he believed was a true architectural quality. He once said:

If you take a section through the column of Cologne Cathedral you are in a position to work out the whole plan of the building.[21]

In Miesian terms, the detail and the whole contains the same signification and must be valued by similar terms and treated with similar respect, which explains why he treated the I-beam of 860-880 Lake Shore Drive with same attention and dignity as the minute detailing of the lobby facades.

Therefore, Mies's approach to industrial building construction and the I-beam becomes a matter of technology, regarded as an educative means.

As such, he used modern construction technology as an analytic tool on



order to define the essence of his own time.

[1] Mies van der Rohe, Ludwig, "Industrial Building", (published in G, no. 3, June 1924), Neumeyer, Fritz , The artless Word: Mies van der Rohe on the Building Art, MIT Press, Cambridge, Massachusetts, pp. 248-49

[2] The notion of Bauen (building) refers to, in Misian terms, the logic, authencity and integrity, present in proper construction procedures. In the text: "Bauen" [Building], G, no. 2 sep., 1923, p.1; he said: "It is our specific concern to liberate building activity [Bauerei] from aesthetic speculators and make building [Bauen] again what alone it should be BAUEN." Neumeyer notes that, "Bauerei, as opposed to Bauen, carries a disdainful overtone; furthermore it alludes to Bauer (peasant). Neumeyer, The artless Word: Mies van der Rohe on the Building Art, p. 242

[3] "Architecture depends on its time. It is the crystallization of its inner structure, the slow unfolding of its form", Architecture and Technology, a speech held at IIT in Chicago, 1950. Mies van der Rohe, Ludwig, "Architecture and Technology", Architectural Review, vol. 67, no. 10, 1950, p. 30

[4] Mies designed two visionary skyscraper projects in the early twenties. One for the Friedrichstrasse Office Building Competition (Jan.) 1922 and one for the Great Berlin Art Exhibit of 1922. Frülicht, 1, no. 4, 1922, pp. 122-124

[5] Neumeyer, The artless Word: Mies van der Rohe on the Building Art, p. 110

[6] Honey, Sandra, "Who and What Inspired Mies van der Rohe in Germany", Architectural Design, 3-4, 1979, p. 100

[7] Mies van der Rohe, Ludwig, Architectural Forum, Nov. 1952, p. 96

[8] Mies van der Rohe's first high-rise building in America.

[9] "An Annotated Inventory of the Tower building", UIA International Architects, 1984, vol. 3, p. 10

[10] "Each material whether natural or artificial, posses specific characteristics that one must know if one wants to work with it. New materials and constructions, too, are not necessarily signs of superiority. What matters is the right application. Each material is only worth what we make of it. Mies van der Rohe, Ludwig, "Principles for Education in the Building Arts".
Neumeyer, Fritz, The Artless Word, p. 336

[11] Strike, James, Construction into Design, Butterworth-Heinemann, London, 1991, pp. 73—79

[12] Elliott, Cecil D., Techniques and Architecture, MIT Press, Cambridge, Massachusetts, 1994, pp. 102-107

[13] The various cruciform columns of the Barcelona Pavilion and Tugendhat House, were also assem-

bled of four angled profiles. As well as the profiling I's of the facade constructions in the succeeding high-rise buildings carried the same feature.

[14] Mies in a conversation with Heinrich Rasch after a lecture by Hugo Häring of 1925 (on the question of a Leitungsform, which was to be found in the forms of the nature). Mies sketched while he talked.
Honey, Sandra,"Who and what inspired Mies van der Rohe in Germany", Architectural Design, p. 100

[15] The openness of the I's also reflect Mies's notion of unlimited space. Yet the I's describe a square - his symbol of order. This feature is also apparent in Mies's design for the Barcelona Pavilion and the Farnsworth House, where he applied cruciform columns. Moreover,he elaborated the I beam as a tectonic feature in his succeeding skyscraper designs.

[16] Honey, Sandra, UIA International Architects, p. 44

[17] Illustrations of plans, sections, and details as well as thorough descriptions of the constructions can be found in Kenneth Frampton: Studies in Tectonic Culture, p. 179

[18] Honey, Sandra, UIA International Architects, p. 44

[19] Early perspective drawings of the interior of the 860-880 Lake Shore Drive, illustrate how this experience was to be perceived. Architectural Forum, January, 1950, p. 7

[20] Jordy, William H., American Buildings and their Architects, vol. 5, Oxford University Press, NY, 1972, pp. 247-249

[21] Honey, Sandra, "The Office of Mies van der Rohe in America: The Towers", UIA International Architects, 1984, vol. 3, p. 43

51
860-880 Lake Shore Drive.
Detail sketches of the I-beam.
Mies van der Rohe Archive,
vol. 14. MOMA 1992.
Mies van der Rohe.

52
Pavillon de L'Esprit Nouveau,
Bologna, 1977.
Le Corbusier.

Reinforced Concrete and L'Esprit Nouveau

Pavillon de L'Esprit Nouveau
Built: Paris (1925), reconstructed: Bologna (1977) [1]
Architect: Le Corbusier (Charles Eduard Jeanneret)

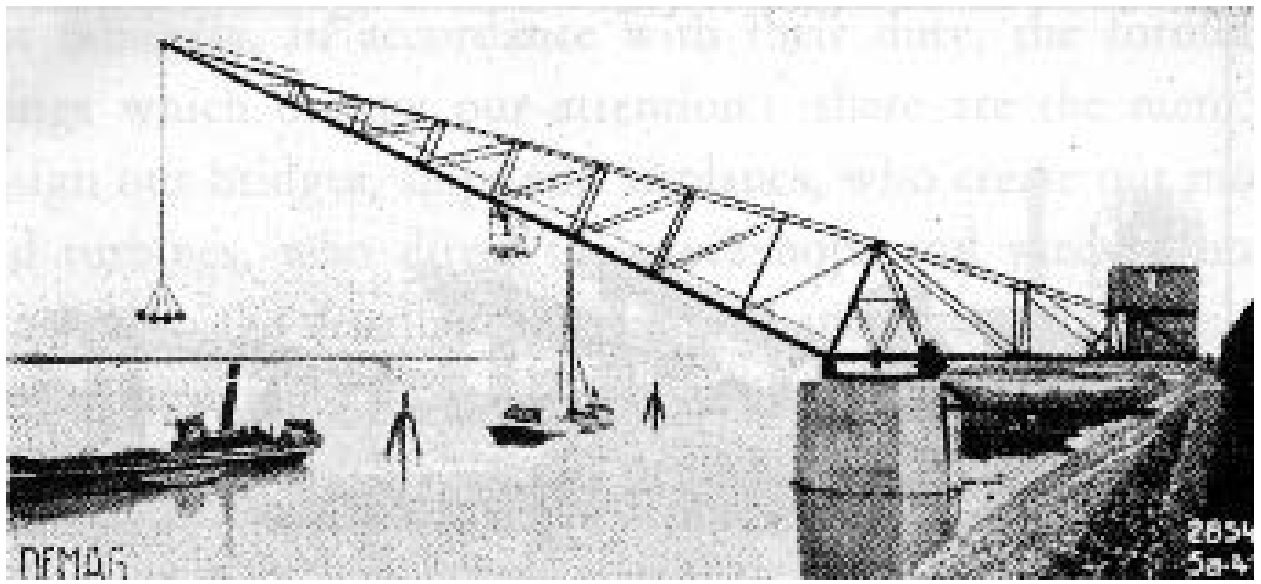
A great epoch has begun.
There exists a new spirit.
Industry, overwhelming us like a flood which rolls on towards its destined ends, has furnished us with new tools adapted to this new epoch, animated by the new spirit.
[…] The problem of the house is the problem of the epoch. […] Architecture has for its first duty, in this period of renewal, that of bringing about a revision of values, a revision of the constituent elements of the house.
Mass-production is based on analysis and experiment.
Industry on the grand scale must occupy itself with building and establish the elements of the house on a mass-production basis.
We must create the mass-production spirit.
The spirit of constructing mass-production houses.
The spirit of living in mass-production houses.
The spirit of conceiving mass-production houses.
If we eliminate from our hearts and minds all the dead concepts in regard to the house, and look at the question from a critical and objective point of view, we shall arrive at the "House-machine", the mass-production house, healthy (and morally so too) and beautiful in the same way that the working tools and instruments which accompany our existence are beautiful. […] [2]

Le Corbusier

Le Corbusier's architectural response to this change of spirit was to define prototypes for the new industrial city. One of his first physical experiments with new construction technology and dwelling types, was the Pavillon de L'Esprit Nouveau. This building represents a synthesis of his fascination with reinforced concrete, his 5 points program for the new dwelling, and his ideas about the ideal city, based on a standardized structural system for house building.

Le Corbusier believed that new, industrialized construction technologies and new materials, such as steel and concrete, had immense potentials, able to change the idiom of contemporary architecture. Thus, he found decorative and ornate architecture of fellow architects impure, characterizing only stylistic exercises and with no true sense of present societal conditions - with no sense of the new spirit.[3]

Le Corbusier claimed that the role of the architect was to find the essential spirit of his time and pursue its architectural expression. In the chapter, "Architecture or Revolution" from Vers Une Architecture, he wrote:



53
A crane. Towards a new Architecture, 1923.
Le Corbusier

The history of architecture unfolds itself very slowly across the centuries as a modification of structure and ornament, but in the last fifty years steel and concrete have brought new conquests, which are the index of a greater capacity for construction, and of an architecture in which the codes have been overturned.
If we challenge the past we shall learn that "styles" no longer exist for us, that a style belonging to our own period has come about; and there has been a Revolution.[4]

Facing these 'revolutionary' circumstances himself in the early 1920's, Le Corbusier entrusted the architect to take part in the process of societal change as an all-embracing figure. New architectural environments were to be created in the large scale of city planning, through the details of mass-produced units.

According to the scholar William Curtis, Le Corbusier gave the planner an inordinate amount of influence over the lives of others, and he sums up Le Corbusier's architectural vision very accurately in his work, Le Corbusier: Ideas and Forms: " […] like Plato's philosopher king who visualizes the constitution of the ideal state and paints a picture of it in an ideal city plan. Le Corbusier's utopianism assumed that technology, guided by the right framework, had the power to reintegrate men with natural harmony."[5]

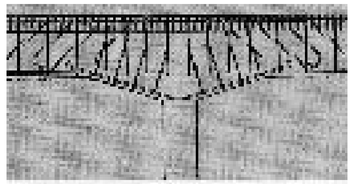
In accordance with the above characterization, Le Corbusier seemed to regard technology from an instrumental point of view providing it with no particular attributes of its own. Thus, he was interested in new construction technology mainly as a means to attain new ideological and aesthetic ends for architecture, rather than a world in itself that could be cultivated as tectonic expressions.

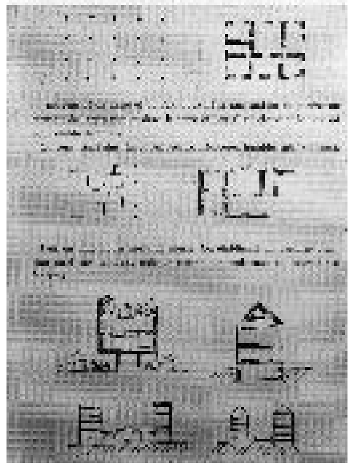
Reinforced Concrete

Concerning the question of new materials, Le Corbusier was primarily interested in the combination of steel and concrete as reinforced concrete, later to become a basic structural material of all his buildings. The concealed skeleton of reinforced concrete represented a structural logic of its own and provided him with firm and smooth surfaces for new spatial investigations. He phrased his fascination very explicitly:

Reinforced concrete has brought about a revolution in the aesthetics of construction.
By suppressing the roof and replacing it by terraces, reinforced concrete is leading us to a new aesthetics of the plan, hitherto unknown.[6]

As for the structural potentials of reinforced concrete, Le Corbusier was inspired by the work of Max Du Bois, who was structural engineer and Le Corbusier's professional soulmate of his early days. Du Bois assisted Professor E. Mörsch, who was a leading expert on reinforced concrete, and in 1909 he published a





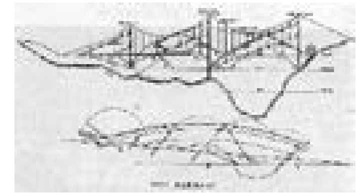
French translation of Mörsch's pioneering book, Le Béton Armé. [7]

Through the influence of Du Bois, Le Corbusier got acquainted with a new building material and a different perception of construction. Reinforced concrete, which could be poured and molded, held new potentials. He found its physical properties and the construction procedures pure and honest, and regarded it as a qualified alternative to the problems of traditional materials and constructions. He wanted to abandon the muddy waters of composite construction for the benefit of structures that fulfilled his quest for Purist architecture.[8] He characterized the need for change in contemporary building construction like this:

The prime consequences of the industrial evolution in "building" show themselves in the first stage; the replacing of natural materials by artificial ones, of heterogeneous and doubtful materials by homogenous and artificial ones (tried and proved in a laboratory) and by products of fixed composition. Natural materials, which are infinitely variable in composition, must be replaced by fixed ones.
On the other hand the laws of Economics demand their rights: steel girders and more recently, reinforced concrete, are pure manifestations of calculation, using the material of which they are composed in its entirety and absolutely exactly; whereas in the old-world timber beam there may be lurking some treacherous knot, and the very way in which it is squared up means a heavy loss in material.[9]

Even though Le Corbusier is not well known for his interest in tectonic aspects of construction, he seemed to believe that material properties and manufacturing processes were interrelated. Therefore, he regarded reinforced concrete as a crucial parameter for the implementation of industrialized and mechanized building processes. However, his conception of industrialization did not only apply to prefabrication, but also to the actual building site, which he defined as a place for fabrication of houses. The erection of the barrages in the Swiss Alps served as source of inspiration for his idealized building site, and he emphasized aspects as speed, rationality and control as important aspects:

The celebration of concrete describing the construction of the barrage in the Swiss Alps: And every day tons of materials in their correct proportions have quietly flowed into the concrete mixers arranged in a line. High up there in the mountains, therefore, is the aggregate; and there the various materials are mixed in their proportions, moistened to exactly the right degree and the concrete is made; this is then poured quickly into the containers, which are carried sharply up to the tops of the pylons which overhang the barrage. The concrete is then automatically tipped out and flows down the flexible "runs". […] They take these immense serpents and guide the flow of concrete to its proper place; thus hour after hour, during this short summer



54
Le Béton Armé, distribution of the iron piles in their intersection zone of supports and cross beams, 1909.
E. Mörsch.

55
Examples of contrasts from "Les 5 point," 1926.
Le Corbusier.
On the right, plans and sections of the old house with humid cellars.
On the left, the new, dry house without a cellar.

56
Plan and elevation of the concrete distributions; the whole temporary structure in connection with these has a lenght of 400 yrds. and reaches a height of 400 ft. The steel "pylons" can be seen, by means of which the concrete is raised to the necessary level, and the "toboggan-runs" by which it is distributes; these are suspended by a system of cables.
The city of Tomorrow and its planning, 1929.
Le Corbusier.

season, the concrete flows without pause.[10]

Reinforced concrete served as the perfect material ingredient for this vision of industrialization and Le Corbusier carried his fantasies further:

Will the yard soon be a factory? There is talk of houses made in a mould by pouring in liquid concrete from above, completed in one day as you would fill a bottle. [11]

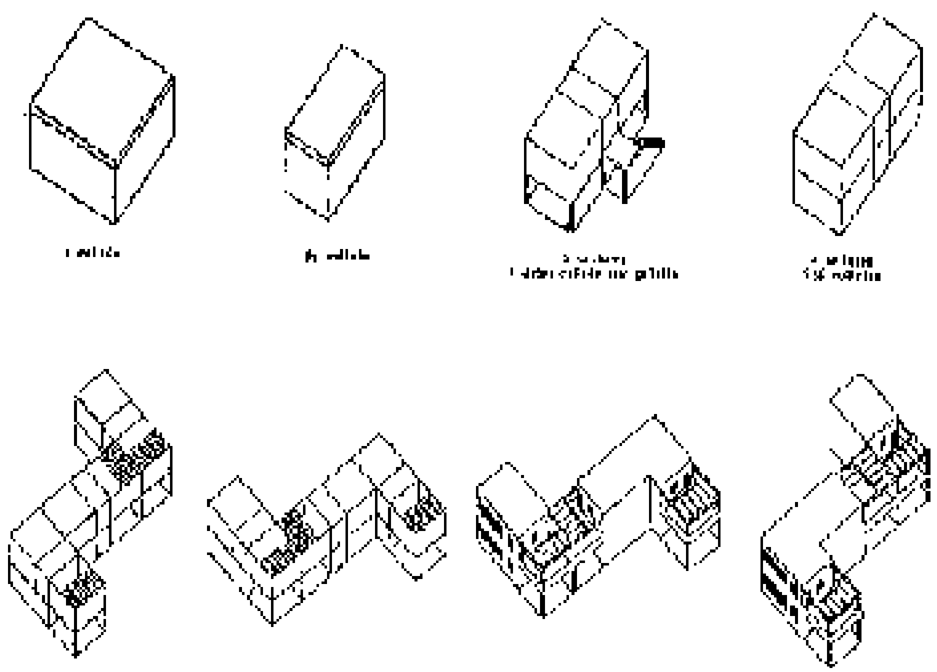
He emphasizes here the flexibility and fluidity of the material as rational properties for construction; nevertheless, the metaphor of the bottle rather refers to the world of formal idioms than the pragmatics of construction.

Standardization, the Cellular System and Mass-production

Le Corbusier's faith in reinforced concrete represented only part of the basis for new architectural construction practices. Concepts like repetition, standardization, mass-production and 'absolute' economy were also considered as necessary means to improve contemporary construction, and, thus, architecture. However, he approached these issues from a geometrical point of view and applied the objectiveness of mathematics in order to determine the rules for a suitable standard. He found evidence for his theories in the undisciplined growth of the traditional city and explained that the architectural problems were due to the lack of proper geometrical systems and universal standards for city planning. He described the problem like this:

The city of to-day is a dying thing because it is not geometrical […]. The result of a true geometrical lay-out is repetition. The result of repetition is a standard, the perfect form. (i.e. the creation of standard types). As geometrical lay-out means that mathematics play their part. There is no first-rate human production but has geometry at its base. It is of the very essence of Architecture. To introduce uniformity into the building of the city we must industrialize building.[12]

Le Corbusier's listing of interdependent elements necessary for the formal aspect of industrialization, draws a hermeneutic circle. However, his conclusion contains a kind of paradox, because part of his definitions for the ideal outcome of industrialization, also forms constituent elements of industrialization. There is no clear distinction of concepts, they are used as both means and ends.
Le Corbusier applied the cell as a model for standardization and dwelling units, through which he analyzed the needs of modern family within a city context. To this end, he also worked out a program that included a great number of demands:[13]



Let's analyze the need of the family (i.e. a "cell"): also, what is necessary for a given number of such cells in their mutual relation to each other, and let us see how many cells can usefully be combined together to make a manageable colony in the way an hotel or village is manageable; a community which could be a clear organic unit in the urban scheme, […]. Let us go a little more fully into the scheme for dwelling on the "honeycomb" or cellular principle or "freehold maisonnettes". The basis of Pavillon de L'Esprit Nouveau. […] Every flat is in reality a house of two storeys, a sort of villa with its own garden […]. This is a cell […], ventilated by a great circular well […]. Each of these cells act as a ventilator and the building resemble an immense sponge for the absorption of air: the whole building breathes.[14]

In his application of geometry and anatomy, as well as biological science, for his analysis and reinvention of architecture, Le Corbusier pursued a scientific format. He seemed to want the rigorous spirit of these professional fields transferred into his theories of architecture.

Even though he never referred to his sources of inspiration he most likely derived the cellular principle and geometric laws of nature from the theoretical work of the biologist, D'Arcy Thomson, who published his book; On Growth and Form in 1917. Several of the references Thompson uses to illustrate his topic with, are comparable, if not identical to the ones Corbusier applies both in, Vers Une Architecture and Urbanisme. As for the notion of the 'cell', which Corbusier regarded as a 'new' standard unit for nearly all architectural problems, Thompson describes it's nature like this in the chapter of "Living Cells":

Nature has her materials of predeterminate dimensions, and keeps to the same bricks whether she build a great house or a small.[15]

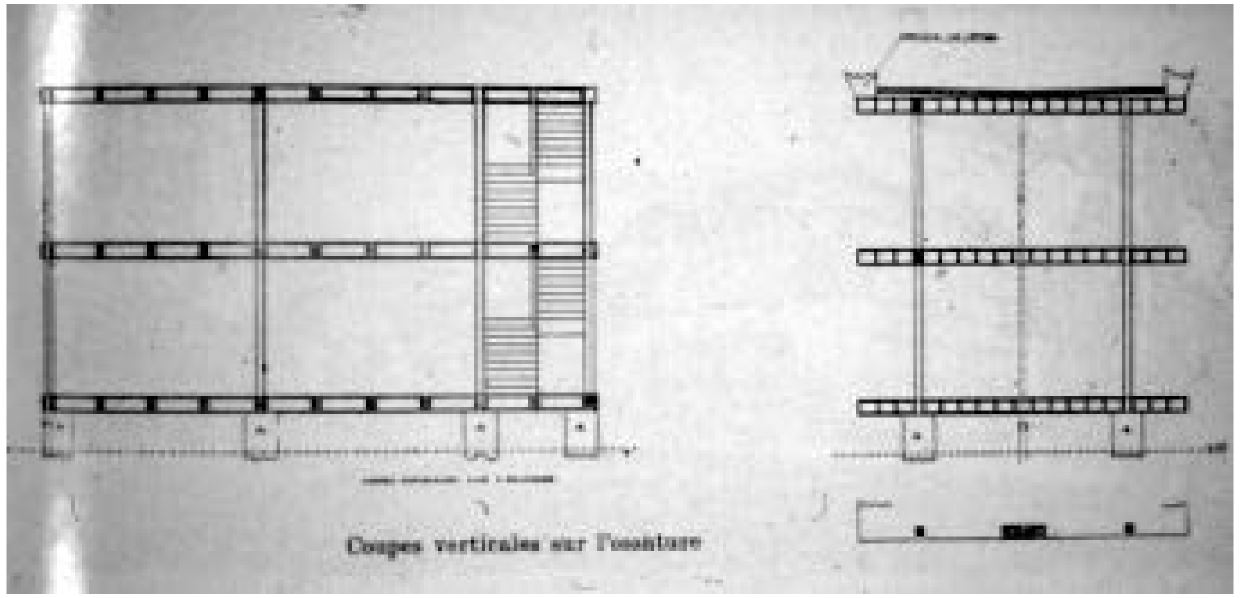
Also, Corbusier's terminology such as mass, surface and volume, as well as his references to the cellular principle based on the honeycomb structure sound almost like Thompson in his chapter on, "The Bee's Cell".[16]

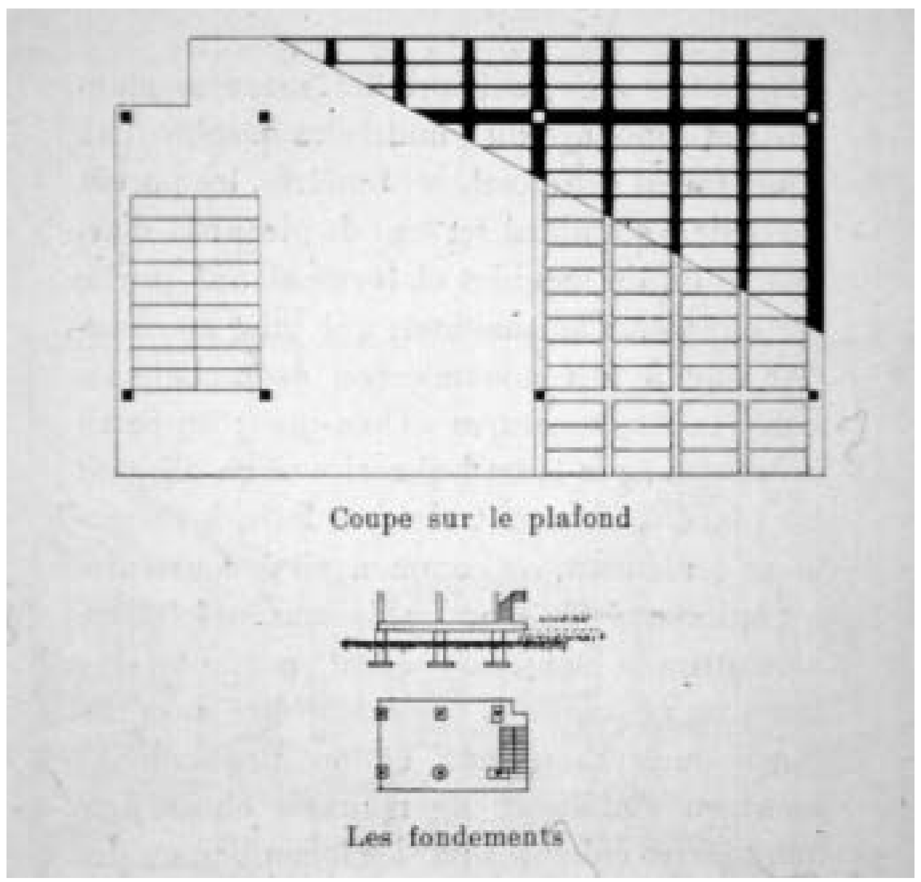
Le Corbusier used the metaphor of the bee-cell, not only to describe the formal order of building structures, but also as a firm organic system for variation in city planning, and last but not least, a system which could anticipate the problem of mass-production.

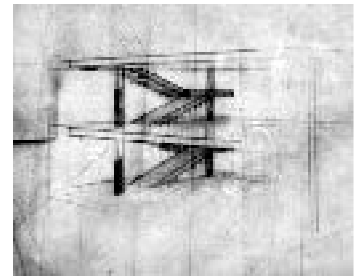
Though he tried to follow an objective format in Vers Une Architecture (1923) and Urbanisme (1929), his investigations and analyses may be characterized quasi-scientific. His rational assumptions tend to be driven by personal preferences and euphoric enthusiasm. Reading between the lines, Le Corbusier seemed to prefer particular properties of the living cell, such as its autonomy, reproduction, and

57
"Standardised house", 1923.
Composed of whole and half cells closed by walls or opened by pillots.
Le Corbusier.

58
Illustration from the chapter on 'The Bee's Cell'. Portion of a honeycomb, 1917.
D'Arcy Thompson.







59
Les Maisons, Dom·ino Section of the structure, 1914.
Le Corbusier.

60
Les Maisons, Dom·ino Section of the concrete deck, and section through foundation.
Le Corbusier.

61
The Dom·ino System.
Sketch hanging on the wall of the L'Esprit Nouveau Pavillion in Bologna.
Le Corbusier.

programmed purpose, and translated them into his definition of industrialized architecture.

Following Le Corbusier's line of thought, one could argue that the rational nature of the cell somehow resembles the nature of machine. Furthermore, the number of cells that make up a whole figuration or body, are comparable to the units of a machine that are made to fit automatically serving the function of the whole.[17]

This sort of description Le Corbusier used to characterize the anatomy of the car, which he regarded as the epitome of a mass-produced, economical, industrial article. The image of the car as a rational industrial object and aesthetic ideal served as model for a new perception of architecture and house construction throughout his early professional years. He simply referred to the new type of dwelling as 'house machine'. The 'house machine' was to be based on a standard structural system that contained flexibility for different dwelling types. It was conceived as prefabricated construction elements adaptable to the changing needs of the tenants.[18]

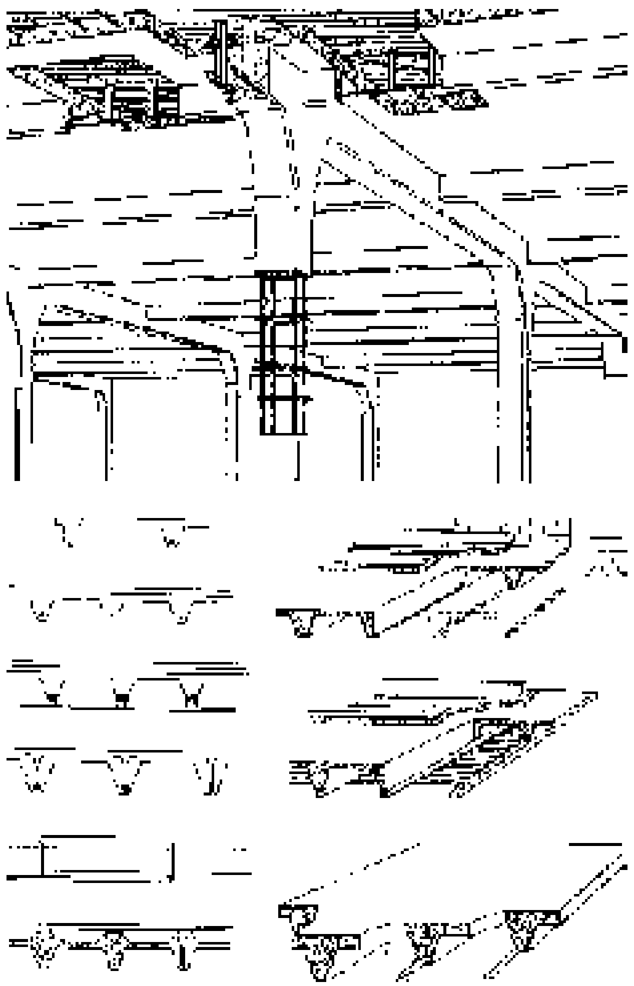
DOM·INO and the Five Points

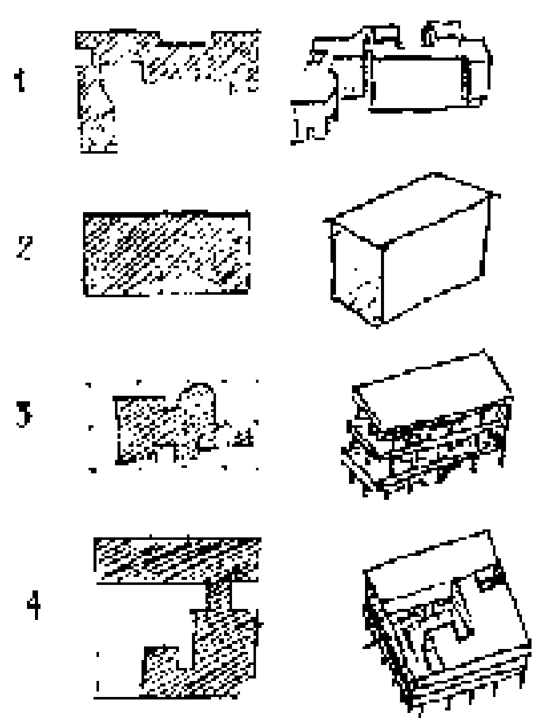
The Dom·ino system represents a significant answer to the questions raised about industrialized building in the early 1920's. Le Corbusier conceived Dom·ino as a prototype for a standardized structural system for house building, already in 1914.

The structure consisted of three rectangular horizontal slabs, supported by six slender columns that were square in plan section. A staircase, floating in space without support, linked the levels.[19] The structure was designed as a flexible system suitable for various sorts of infillings; and thus, easily adaptable to different dwelling types. All the structural elements were of reinforced concrete, smooth and crudely finished. They were designed as abstractions of their physical properties, revealing no sign of joints or assembly.

The standard frames, which made up the slabs, were to be made of pot-tile with steel reinforcing, designed without visible framework. To permit the pouring of absolutely plane floor slabs, special arrangements were to be set up on the site. Simple scaffolding of steel T-beams were fastened temporarily to collars fixed on the top of each column and the casting process was aided by movable shuttering.[20]

Le Corbusier envisioned this structural system in accordance with his notion of industrialization: mass-produced on site and completed by using standardized products, such as windows, doors, and various partitions to accommodate different types of plans for individual dwelling needs. In Vers une Architecture, he describes the Dom·ino system as applied to mass-production houses in reinforced





62
Reinforced concrete
construction system, 1897.
Francois Hennebique.

63
The Four Compositions
of 1929:
1. Maison la Roche
2. Villa at Garches
3. Weissenhofsiedlung
in Stuttgart
4. Villa Savoye
Le Corbusier.

concrete:

The walls and partitions were a light filling of bricks, breeze slabs and so on, capable of being erected by unskilled labour. The height of the two slabs was arranged to agree with that of the doors, cupboards and windows, which were all worked to one unit of measurement. Contrary to normal practice, the woodwork (mass-produced) was fixed before the walls, and so dictated the alignment of both of these and of the internal partitions; both walls and partitions were worked round woodwork, and the houses were thus completed by a single body of workmen: masons. All that remained was to install the pipes for the various services.[21]

Even though Le Corbusier was much influenced by the school of Perret and his predecessor Hennebiques, who both pursued a rational expression of timber-like frames in their concrete constructions, he came up with his own interpretation which held a different perception of architectural structures.[22]

Curtis describes Le Corbusier's definition very well, saying that "the Dom·ino was trabeation in an elemental form – reduced to pure column and pure slabs – an industrial equivalent to Laugier's primitive hut."[23]

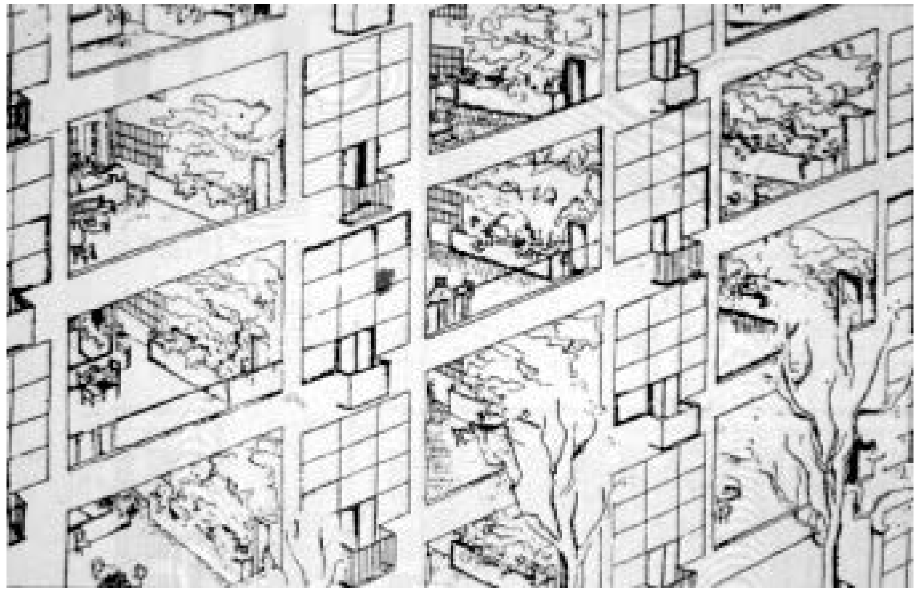
In the Dom·ino system, Le Corbusier crystallized the properties of reinforced concrete construction and translated them into figurative elements for architectural composition. The slabs of the Dom·ino system were cantilevered beyond the edge of the building and left the columns inside the building volume to do the structural work. Now, the building plan, as well as the facade was structurally liberated.

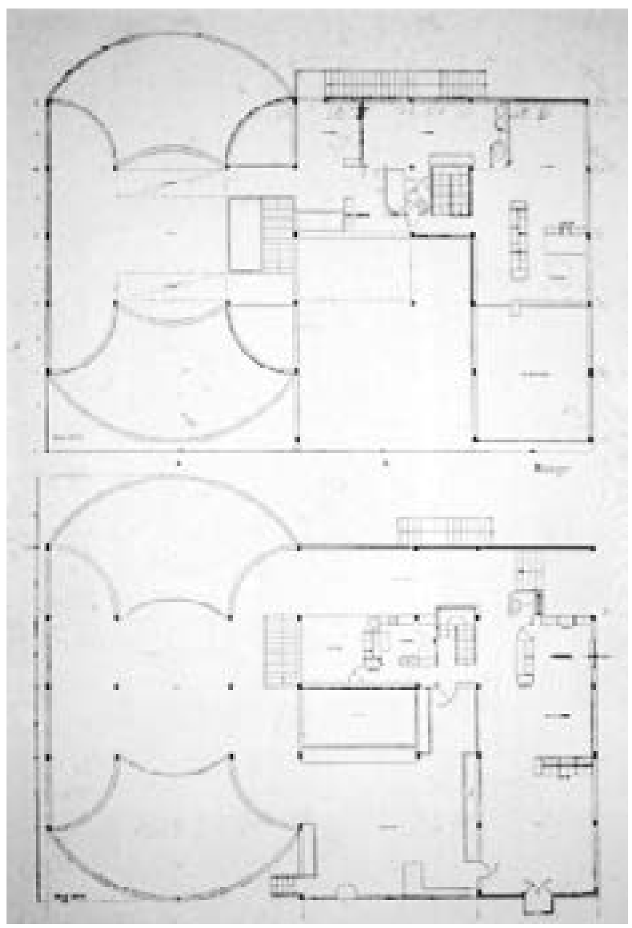
Du Bois claims that from the point of the engineer, Dom·ino was a naïve idea, and structurally without any new potentials. However, from an architectural point of view, Dom·ino gave a freedom in the organization of the building plan, the space of each floor and in the composition of the facade.[24]

Le Corbusier's investigations into the Dom·ino system provided him with the basic vocabulary for his formulation of Les 5 Points d'une Architecture nouvelles, published in 1926. The program included the following points:

1. Les pilotis, the columns elevating the mass off the ground;
2. Le plan libre, the free plan, separation of the load-bearing columns from partitions;
3. Le facade libre, the free facade, a vertical projection of the free plan;
4. Fenetre en longueur, the long horizontal window;
5. Le toit-jardin, the roof garden, replacing the ground area covered by the house.[25]

At the time, he had made several attempts experimenting with these ideas both





64
Blocks of Dwellings on cellular system: part of the facade - Les Maisonnettes, 1924.
Le Corbusier.

65
Plan of Pavillion de L'Esprit Nouveau, 1925.
To the right: the dioramas.
To the left: the dwelling unit.
Le Corbusier.

in theory and practice. The Les Maisons Citrohan projects (1920) and the Pessac housing estate near Bordeaux (1924-26), are worth mentioning as preliminary examples. However his five points were not fully integrated and demonstrated before Villa Garches (1927) and Villa Savoye (1929).

Pavillon de L'Esprit Nouveau

One of Le Corbusier's first practical experiments synthesizing the ideas presented in the above is the Pavillon de L'Esprit Nouveau, exhibited at the Exposition des Arts Décoratifs in 1925. The pavilion represented one dwelling unit of the immeubles villas (the apartment villa) and though it was laid out on the site as an isolated villa, it was to be perceived as part of a large apartment block. As such, the new dwelling type was worked out for the so-called cellular perimeter blocks of the Ville Contemporaine.[26] Le Corbusier characterized the building as:

[…] a "cell" in a block of flats, a unit in a housing scheme, built in the "honeycomb" principle.[27]

Two large diaramas of 100 m^2, in which architectural schemes for the new city were displayed were attached to the backside of the dwelling unit. They contained the Ville Contemporaine for three million inhabitants (1922) and the plan Voisin (1925) for the city center of Paris. As for the futuristic radicality of the schemes, Le Corbusier wrote:

For the Pavillion of the Esprit Nouveau […] in which the "Voisin" plan was on view, I painted a panorama whose aim was to make evident to the eye this new conception, so unfamiliar to us as yet. The panorama was most carefully executed and showed Paris as it is today […]. Behind it rose the new city.[28]

Le Corbusier did not only perceive the new city as a theoretical model, he wanted to animate its practical consequences by showing a true fragment of the city - close-up - exemplified by Pavillon de L'Esprit Nouveau.

The pavilion contained an apartment intended for two persons. It consisted of two floors with a total area of 300 m^2, a living area of 140 m^2 and an outdoor terrace of 46 m^2. The dwelling units were to be stacked, making up six double storys, including the garden terraces one for each apartment.

As for the structure of the pavilion, one of Le Corbusier's main concerns was to increase the height of the facade module from the traditional 3-4 m to 6-7 m. Through this he created a structural system which held a multitude of spatial variations and interpretations for the new dwelling, with an equal sense of both horizontality and verticality.[29]

66
Pavillion de L'Esprit Nouveau,
Bologna, 1977.
Le Corbusier

67
Exposition des Arts Decoratifs,
Paris, 1925.

Even though, Pavillon de L'Esprit Nouveau, was a temporary exhibition structure it was built as a permanent construction, as an experiment with reinforced concrete. Le Corbusier wanted to build his purist idea of elemental form and true construction, and he disregarded the other pavilions. He did not approve of their lightweight structures made of plaster, with a highly ornate finish, representing various architectural styles:

The 1925 Exhibition covered the Esplanade of the Invalides and the banks of the Seine from Concorde to Alma with constructions of plaster. Plaster was king, and there was an astounding display of fancy and foliate ornament.[30]

According to Le Corbusier, Pavillon de L'Esprit Nouveau stayed perfect through out the following winter while the other pavilions built in plaster crumpled. Le Corbusier expected the professional environment to share his enthusiasm about his vision of architecture; however, he met no sympathy. He described the struggle about getting the pavilion accepted by the exhibition jury like this:

When I submitted my scheme in January 1924 to the architects-in-chief to the Exhibition, it was categorically rejected. […] The difference of opinion was complete. The Pavilion was as it were smuggled in, no jury considered it, and we had no grant towards building it. What difficulties we experienced! [31]

He seemed disappointed by the lack of interest and by the general resistance towards his ideas, and his notes concerning the process of the exhibition show that he felt completely misunderstood.[32] Despite the general opinion, Le Corbusier believed that Pavillon de L'Esprit Nouveau was the beginning of a new era for construction and that it constituted an architectural document of standardization. He claimed that standardization was the keynote in every element of the construction and that it had been carried out minutely in accordance with this idea. One may doubt this assertion, however, since the industry for this type of construction was not yet established.

The details of the construction design support this argument. The pillotis were not, as in the Dom-ino system, freestanding columns, but part of the load bearing walls, placed in the periphery of the building. Instead of light, free floating slabs, barely supported by slender pillars - the structure of the pavilion looked like a regular frame construction with an infill of masonry or concrete.

Pavillon de L'Esprit Nouveau, was a crucial experiment for the numerous ideas of Le Corbusier's formative years and the design of the plan formed the basis in his succeeding work. However, subsequent attempts to market the Immeuble-Villa were not met with success, neither as a freehold maisonette in the city, nor as a freestanding villa in the suburbs.[33]

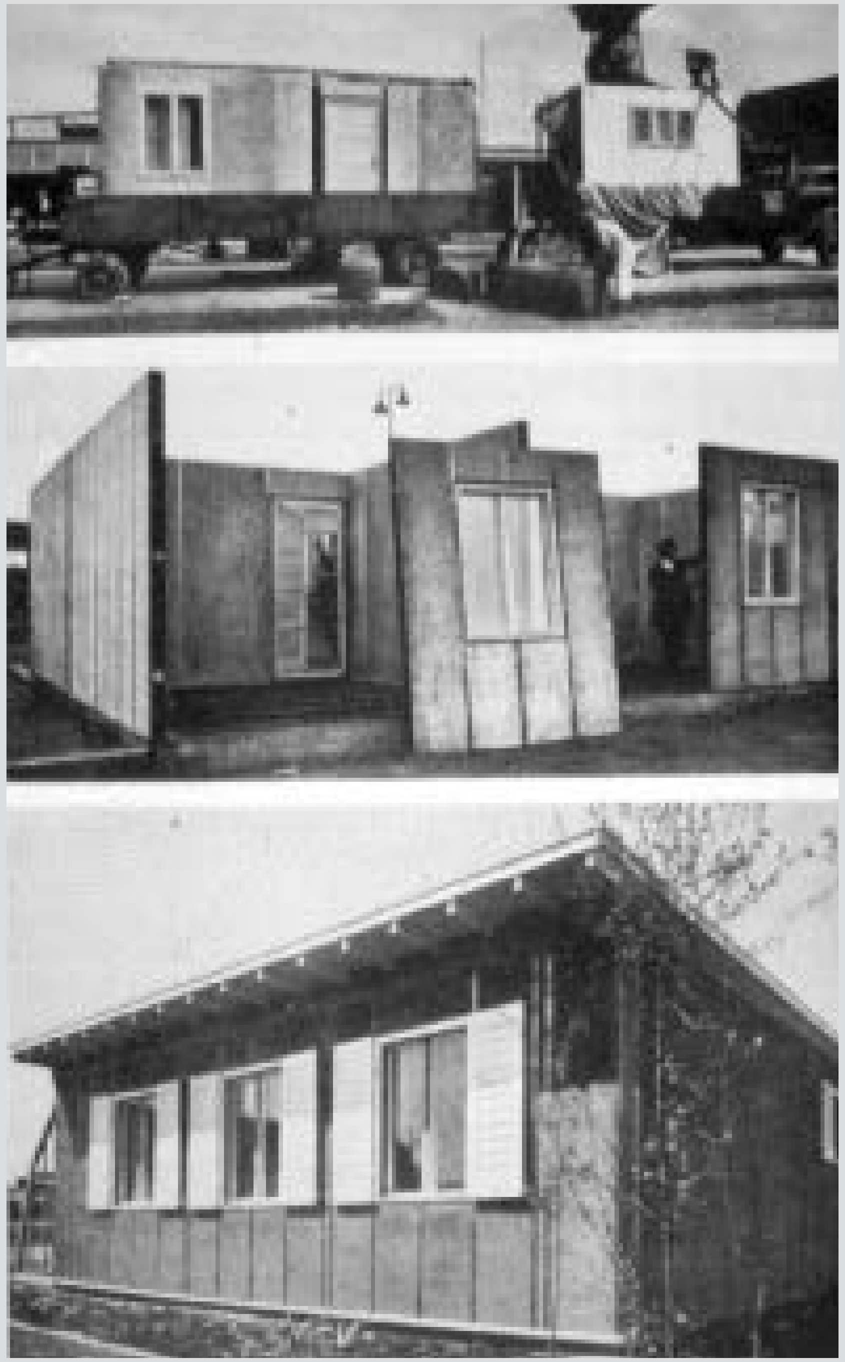
In light of these circumstances, it is interesting to note Le Corbusier's own concluding remarks about the whole project:

In 1959, i.e. thirty-five years later, industry (AT LAST!) is taking over building…[34]

Even though the structural principles and prefabricated construction elements of Le Corbusier's early prototypes was not easily manufactured, and thus not implemented as common practices of construction until one generation later, there is no doubt that Le Corbusier's visionary ideas affected, if not revolutionized, contemporary architectural design.

[1] Today the pavilion is inhabited by OIKOS, Research Institute of Habitation.
[2] Le Corbusier, (Vers une Architecture, Paris, Vincent, Fréal, 1923), Towards a New Architecture, Butterworth Architecture, Oxford, 1989, p. 6
[3] Ibid., p. 17-19
[4] Ibid., p. 7
[5] Curtis, William J. R., Le Corbusier: Ideas and Forms, Phaidon, London 1986/95, pp. 63-64
[6] Le Corbusier, Towards a New Architecture, p. 63
[7] Mörsch, E., Le Béton Armé, Librairie Polytechnique, Paris, 1909
[8] "The Purists thought that neither the human figure nor landscape were relevant, and were also suspicious of Mondrian's non objective painting. They wished to portray familiar everyday objects and to raise these to a level of symbols by extracting their most generalized characteristics".
Curtis, Le Corbusier: Ideas and Forms, p. 50
[9] Le Corbusier, Towards a New Architecture, p. 232
[10] Le Corbusier, The City of Tomorrow: and its planning, Dover Publications, Inc., New York, NY, 1987, pp. 145-146
[11] Ibid., pp. 233-235
[12] Ibid., p. 175
[13] Corbusier defined the requirements like this: "So let us state our problem, and […] we shall hit on a formula which must answer to good many requirements: as liberty; amenities; beauty; economy in construction; low cost; bodily health; harmonious functioning of vital organs; and a useful contribution to the many urban problems such as traffic, fresh air, police etc."
Ibid., p. 215
[14] Ibid., p. 215
[15] Thompson, D'Arcy W., On Growth and Form, abridged ed., J.T. Bonner, Cambridge University Press, 1971, p.38
[16] See Thompson, On Growth and Form, The subtitles of Chapter I and Chapter IV which includes "The Bee's Cell", p. 114
[17] Le Corbusier, Towards a New Architecture, p. 275
[18] Le Corbusier, The City of Tomorrow: and its planning: and its planning, p. 231

[19] It is interesting to study how the drawing of the Dom·ino structure changed appearance from initial sketches to the one, presented in Boesiger, (Le Corbusier 1910-60), Alec Tiranti, 1960 A sketch, hanging in the pavilion in Bologna, shows the two slabs as distinct features, and the columns and staircase as faint, hardly visible lines.
[20] As for the construction procedures of the Dom·ino skeleton, several sources have been studied: Le Corbusier, Towards a New Architecture, pp. 230-231, Boesiger, Le Corbusier 1910-60; James Strike, Construction into Design, p.127; William J. R. Curtis, Le Corbusier: Ideas and Forms, pp. 42-43
[21] Le Corbusier, Towards a New Architecture, pp. 230-231,
[22] For the timber-like structures of Perret and Hennebique see, Frampton, Kenneth, Studies in Tectonic Culture, pp. 121-124
[23] Curtis, William, Le Corbusier: Ideas and Forms, p. 43
[24] Vogt points out that the Dom·ino was an ambiguous structure and both Du Bois's and Le Corbusier's reading of its potential views were true.
Vogt, Adolf Max, Le Corbusier, the Noble Savage: Towards an Archeology of Modernism, MIT Press, Cambridge, Massachusetts, London England, 1998, p. 113.
[25] Curtis, William, Le Corbusier: Ideas and Forms, p. 69
[26] Stonorov and W. Boesiger, Le Corbusier et Pierre Jeanneret, 1910-1929, Zurich, Editions d'Architecture, 1937, pp. 98-101
According to Frampton, the Ville Contemporaine for three million was conceived as an elite capitalist city of administration and control, with garden cities for the workers being sited along the industrial areas.
Frampton, Kenneth, Modern Architecture: a critical history, Thames & Hudson, London, 1980/92, pp.154-55
[27] Le Corbusier, The City of Tomorrow: and its planning, p. 231
[28] Le Corbusier, The City of Tomorrow: and its planning, p. 281
[29] Stonorov/Boesiger, Le Corbusier et Pierre Jeanneret, 1910-1929, p. 98
[30] Le Corbusier, The Decorative Art of Today, The Architectural Press, London, 1987, pp. XIII-XIV
[31] Le Corbusier, The City of Tomorrow: and its planning p. 231
[32] Le Corbusier, The Decorative Art of Today, pp.xiv-xix
[33] Frampton, Kenneth, Modern Architecture: a critical history, p.156
[34] Le Corbusier, The Decorative Art of Today, The Architectural Press, London, 1987, p. XVI



68
The Growing House, Hirsch Copper House in the Exhibition "Sun, Air, and House for All", Berlin 1932.
Walter Gropius.

One of the major concerns of the building industry after WW II was to define ideal systems for building. This pursuit included the question of how to standardize prefabricated building components as convenient and aesthetic units for construction.

Even though the first steps towards industrialized system building were carried out in the nineteenth century, in bridge building, railroad constructions, and the great exhibition halls of the World Exhibitions, this method of construction was not getting implemented in common building practice until much later. (As realized by Le Corbusier) Building systems for housing were first truly developed in the period between the wars and not until then it became a true parameter of design in architecture. Nevertheless, the most significant and successful results did first occur after WW II, when an acute need for buildings in general, and housing in particular, intensified the development of inter-usable standardized components and building systems.[1]

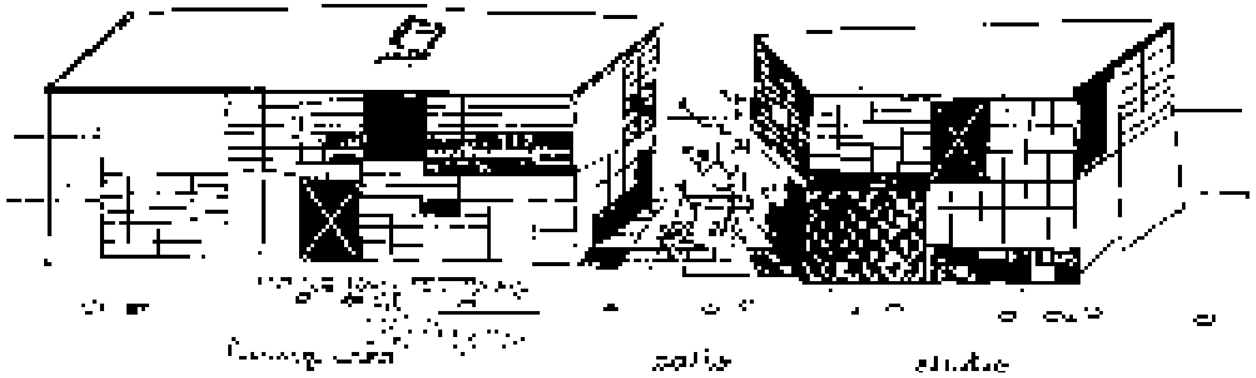
Walter Gropius (1883-1969) represents one of the most consistent promoters of standardized, prefabricated units for construction, truly believing in the architectural potentials of this construction method.[2]
Already in 1909, he was fascinated about the idea to incorporate these new construction practices into housing design, the realm of the architect:

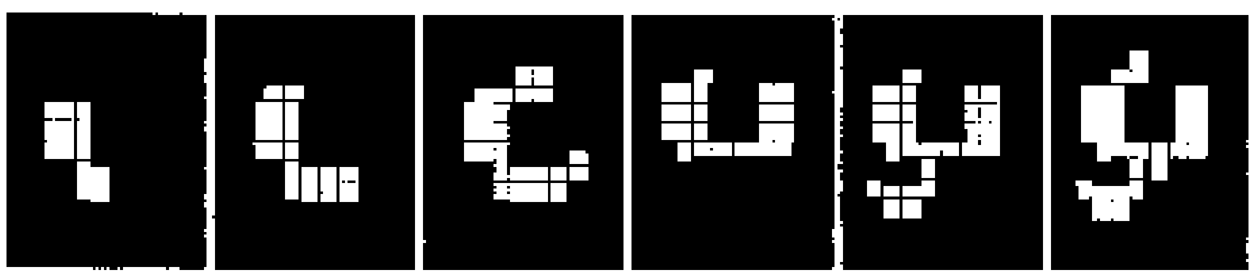
The idea of industrializing house construction can be realized by repetition of the same component parts in every building project …The possibilities of assembly of these interchangeable parts satisfies the public desire for a home with an individual appearance.[3]

Despite Gropius's good intentions, individual solutions did not always seem to be the final result of these new possibilities. In many cases, system building and prefabricated units of construction have primarily been defined as ways to economize construction, wherefore the objective has been to reduce the number of materials, components and combinations of assembling. One can ask if this sort of action led to richness in variation and architectural composition. However, several architects have tried to solve the difficult task to define design principles for the use of prefabricated construction components, and come up with various qualified answers.

Eames House & Espansiva

The following two case studies, Eames House (1954) by Charles & Ray Eames and Espansiva (1969) by Jørn Utzon delineate some of the clearest and most visionary statements about these issues. Fifteen years apart and different cultural settings provided them with different levels of technological possibilities; however, this





69
Diagram showing the flexibility of the frame. The many ways of rearranging the patterns of the facades.
Architectural Forum, 1950.
Charles Eames.

70
Espansiva, 1970.
combination of units.
Jørn Utzon.

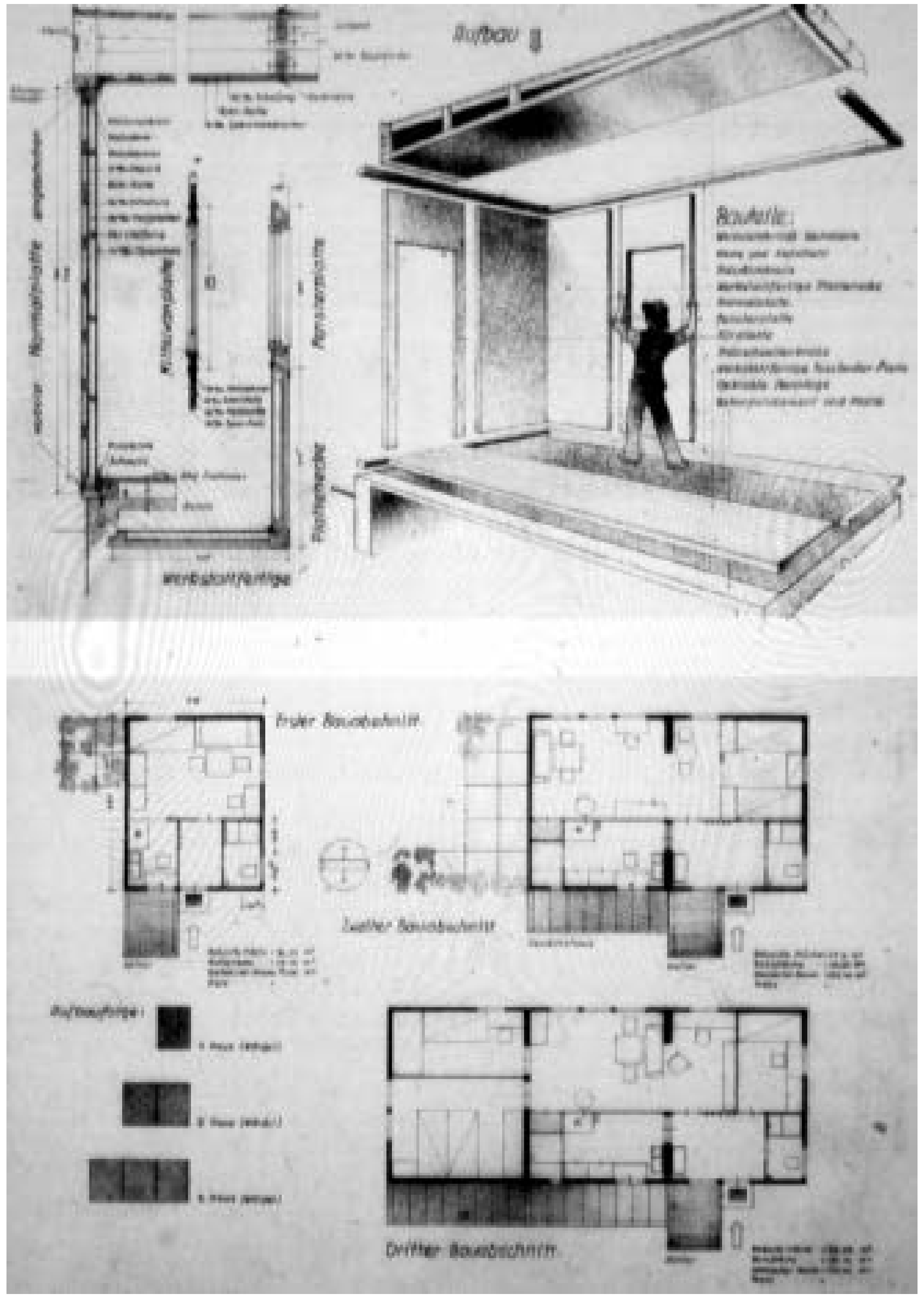
circumstance is not really evident in their final results. These cases, more than any other, reveal that the translation of architectural ideas is rather a matter of approach than of technological potentials.

As in the previous cases of Mies van der Rohe and Le Corbusier, both Eames House and Espansiva reflect Eames's and Utzon's genuine interest in new materials and modern methods of construction particularly prefabricated building components, and the architectural challenges and possibilities provided by these conditions. In this case, the building projects are characterized by somewhat similar circumstances, because both, the Eameses and Utzon acted as clients and designers. In both cases, they were also deeply involved in the processes of construction, as well as they collaborated with the various contractors and manufacturers of the building systems and components. Sharing this basic setting and pursuing the same quest of an ideal building system, they have a lot in common. However, they were exploring two different ways to approach the same question and therefore came up with very different answers.

Charles Eames wanted to explore the steel industry's ability and 'power' to renew the dwelling form of modern man, advocating the idea that form would become a by-product of modern industrial prefabrication rather than a point of departure.[4] He decided only to apply industrial, standardized building products and catalogue commodities for his unique architectural composition, the Eames House.

On the other hand, Utzon believed in uniquely prefabricated, designed building components conceived as a rational building system. Inspired by structural principles of nature, he wanted to define an ideal standard that could be assembled into any conceivable composition. These ideas he developed into a whole design program, the additive principle, which could be used for city planning, houses, and furniture design. The Espansiva building system exemplifies these ideas.

[1] Governmental programs in the U.S.A. and Great Britain played a leading role in this process of reforming the building industry by launching a number of rational and economic building systems.



71
The Growing House, wooden components.
Exhibition "Sun, Air, and House for All", Berlin, 1932.
Hans Scharoun.

In the U.S.A., this development began already during the thirties. From 1933-36, the Federal Government Resettlement Administration constructed low-cost greenbelt cities and homestead projects. Boyce, Robert, Keck & Keck, Princeton Architectural Press, New York, NY, 1993, p. 83.
Similar programs were initiated in Great Britain after the war, when the government recognized the necessity for mass orders of housing constructions, to realize the economic advantages of system construction. The Housing (Temporary Accommodation) Act of October 1944 authorized the construction of 400.000 prefabricated houses. Strike, James, Construction into Design: The Influence of New Methods of Construction on Architectural Design 1690-1990, Butterworth-Heinemann Ltd., Oxford,1991, p. 151

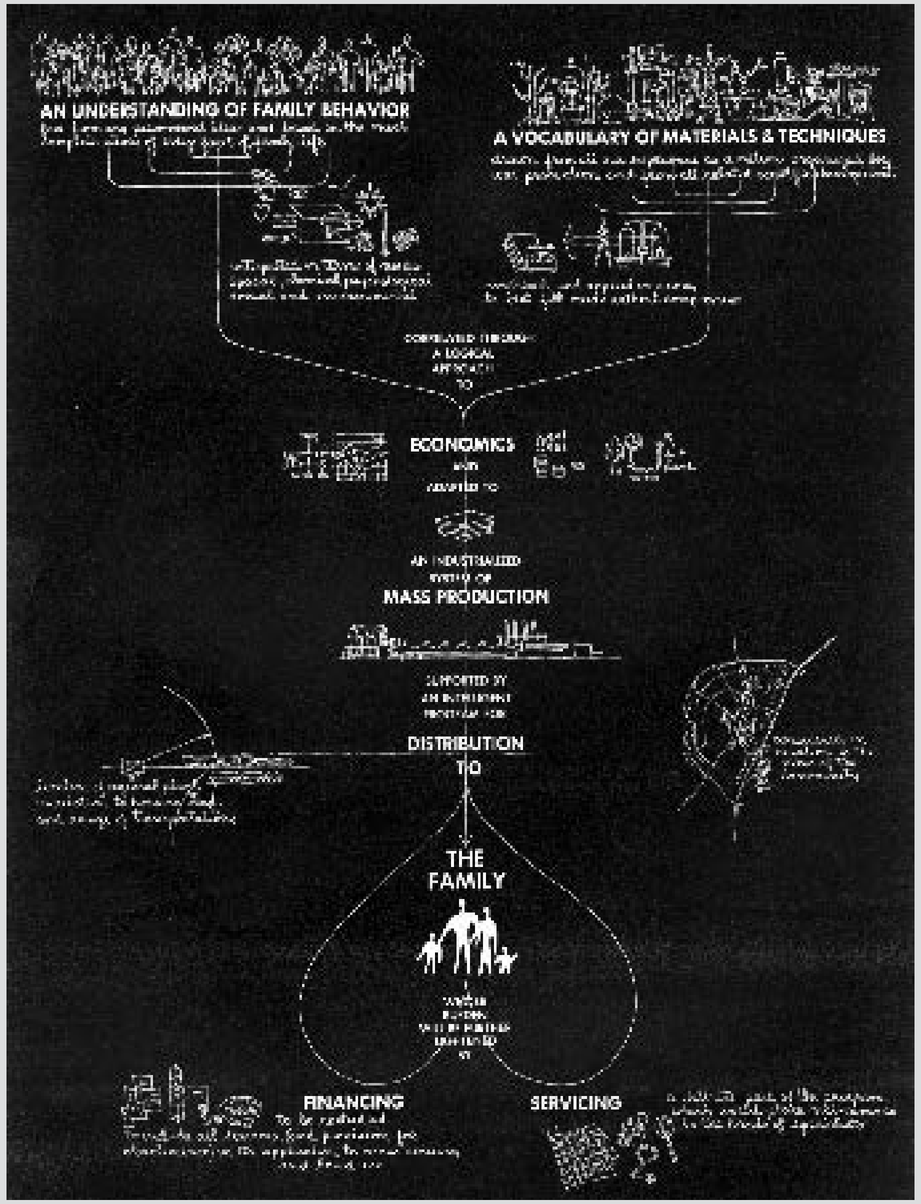
[2] Gropius was truly fascinated by the idea of Taylorism, which applied scientific methods to the problem of obtaining maximum efficiency in industrial work or the like. During the early thirties, many German companies applied so-called Taylor Systems. Gropius applied this idea in the workshops at the Bauhaus in Weimar. Laboratories were set up for experimentation, where new ways to produce designs and models for mass-production were tested. During that period he worked together with Adolf Meyer and the painter George Muche on various architectural designs. In 1926, Muche designed the prefabricated Steel House, in Torten/Dessau, which Gropius developed into the two houses built for the Weissenhofsiedlung Werkbund Exhibition in Stuttgart (1927). In 1932 he designed the CopperPlate House and Das Wachsende Haus for the exhibition "Sonne Luft und Haus für Alle", in Berlin. Nerdinger, Winfried, Walter Gropius, Bauhaus-Archiv, Berlin, 1985, p.11; pp.90-91; pp. 172-73
Strike, James, Construction into Design, pp. 130-134

[3] Walter Gropius, in Siegfried Giedion, Walter Gropius: Work and Teamwork, Reinhold Publishing, New York, NY, 1954, p. 193

[4] Eames, Charles, "Prefabrication", Arts & Architecture, July, 1944, p. 29

Composing Standard Elements

Eames House
Built: Santa Monica, CA, USA (1949-50)
Architects: Charles and Ray Eames



72
Diagram showing the various elements of Modern Society. "What is a House". Arts & Architecture, July 1944. Charles Eames.

Prefabrication in the truly industrialized sense is a very special approach to the problem of the "house" - an approach made possible NOW, for the first time, when industry, research and material exist in the right relationship to one another, making possible an intelligent application of these resources to the needs of housing.
Modern industrialized prefabrication, by its very nature, cannot be disassociated from the functions of living related to the house. It is, then, the complete use of all the facilities of mass production aided by the best research, the best techniques and the best materials available, to the end that every living activity will receive the benefits of our enormous industrial energies. It is through the complete integration of all these forces that we will arrive at the form of the product. Form, then will be the by-product of the end result of our best intellectual and industrial energies rather than a point of departure. [1]
Charles Eames

Charles Eames was truly convinced about the merits of prefabrication - not only for the benefit of new architectural form, but especially as a conceptual means to fulfill essential human needs in a modern, post-war society.

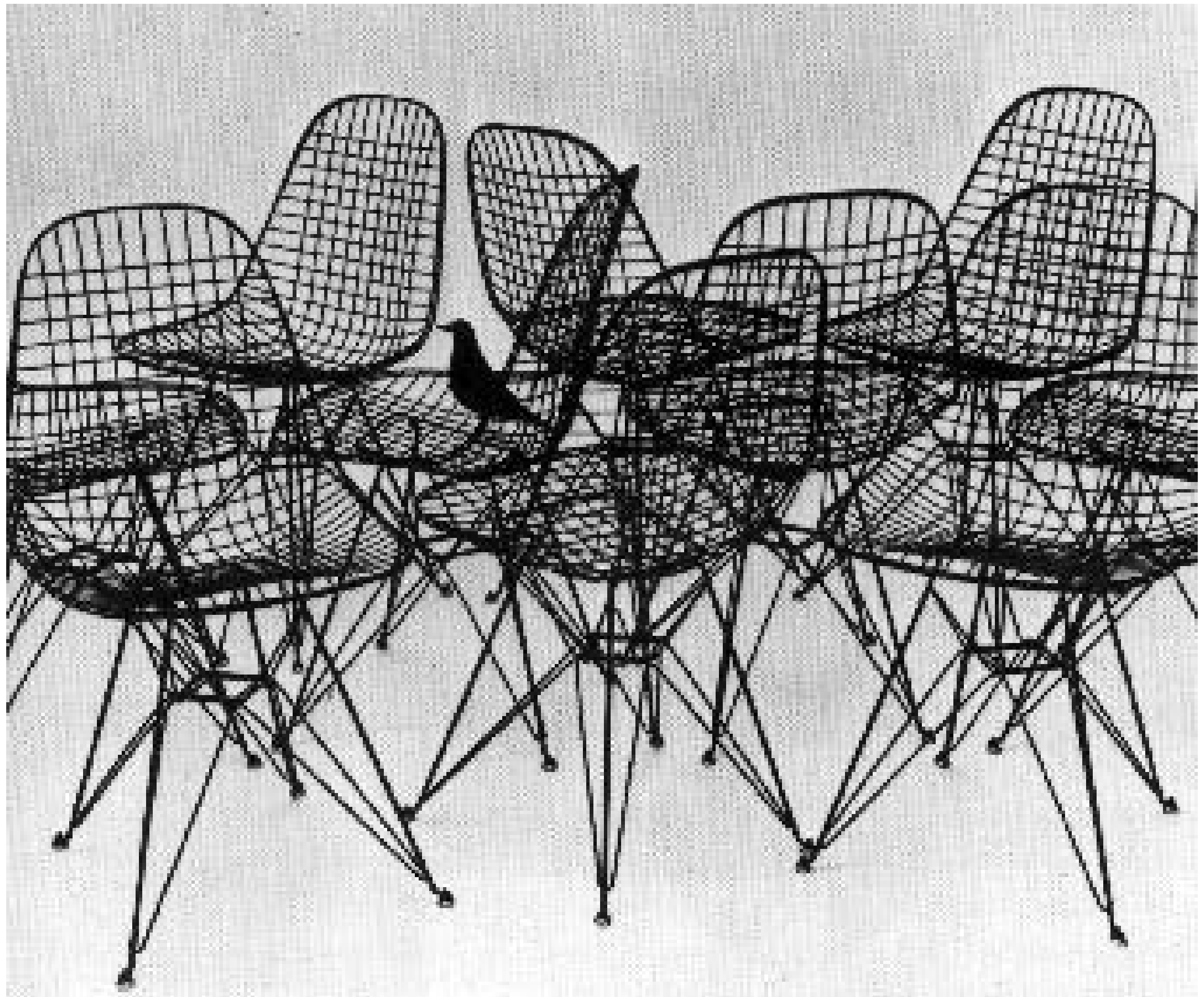
As contributor to the California based magazine Arts & Architecture, Eames co-authored the article, or rather manifesto, "Prefabrication", which thoroughly analyzed the needs of the modern family. The article was much inspired by Taylorism and scientific studies.[2]

The article described how to revolutionize house building through the introduction of new construction technology, studies of modern living, and redefinition of the modern architect as a 'scientific' housing designer:

The laboratory has been put on the production line. […] The application of this new and ready vocabulary to a truly industrialized mass production of good family living machines is the logical, practical, and realistic approach to our housing problem.[3]

Houses were to be regarded as mass-produced products like cars; however, to a much greater degree, offering opportunities for the clients to individualize the 'product' - their environment.[4] The integration of opposites such as industrial production and the human scale defined by individual preference seems to be the essence of Charles Eames's architectural pursuit, both in his furniture design, as well as in his few architectural works.

Case study House # 8 - the Eames House - reflects the same intention and fits the characterization of a true tectonic laboratory where Ray and Charles Eames tested their visionary ideas through architectural experimentation. As Ray summarized, Eames House can be regarded as both an architectural means as well as an end:



This house is an experiment; its aim was to make people open their eyes, to make them see the quality and quantity of materials and systems that were easily available. And I believe we succeeded.[5]

Even though Eames House grew out of a strong idea about industrial possibilities and society, Charles Eames never followed any architectural style or movement, but approached each design problem in his own personal way. According to Marilyn and John Neuhart, his working method followed the principle of - less is more. As for the design problem he needed to solve - he would hone it down to its minimal expression in order to identify the core of the problem, defining the question to get to the answer. Supposedly, he characterized this method of approach as architectural, in spite of also applying it to design projects, films and exhibitions. He would 'build the structure of the project' like the architect would approach the design of a building and then let the material speak for itself 'through this carefully built structure'.[6]

This subtle design strategy forms the basic nature of Eames House, feeding it with transcending qualities. Ideas and materials are simultaneously linked mentally and physically by technology, and Eames lets the material transfer meaning through the building structure. As such, Eames House defines the question: how does one approach the means of prefabrication for house building, not only as a method of rational production, but from a human point of view?

The Notion of Prefabrication

Awaiting peace, the editorial of Arts & Architecture, July 1944 argued for the need to reinterpret the industrial means, which had developed during wartime in the U.S.A. Scientific improvements, as well as new products and manufacturing processes that had been invented for warfare, were to be serving civil needs instead. The editorial advocated new technology in favor of humanism, declaring their viewpoint like this:

Now, at last we know that any standard we have established for ourselves can only be maintained if we associate ourselves in the creation of world standards as they relate to living. And, first, we must concern ourselves with the material facts of living. Among those facts, perhaps the most important, because it is the principal and most intimately connected with environmental conditioning of human beings, is everything we mean when we say "HOUSE." [7]

73
Wire mesh Chair, 1951.
Charles Eames.

In light of this objective, to formulate ideal environmental conditions for the modern family, the architect of a truly successful prefabricated house should

74
"What is a House".
Arts & Architecture, July 1944.
Charles Eames.

be a student of human behavior, a scientist, an economist, and industrial engineer.[8] According to Arts & Architecture, the 'architect-engineer', supplied with these new professional skills, would be able to specify personal needs instead of personal taste with same precision as the scientist. Moreover, he should be able to rationalize the process of construction, in terms of controlling the various phases of industrial production from the assembly line to the site. This way, the architect-engineer would act logically in accordance with the architectural task from an economical point of view.

As a result of this new approach to house building, the prefabricated house would reflect conscious efficiency and adaptability to purpose or change.[9]

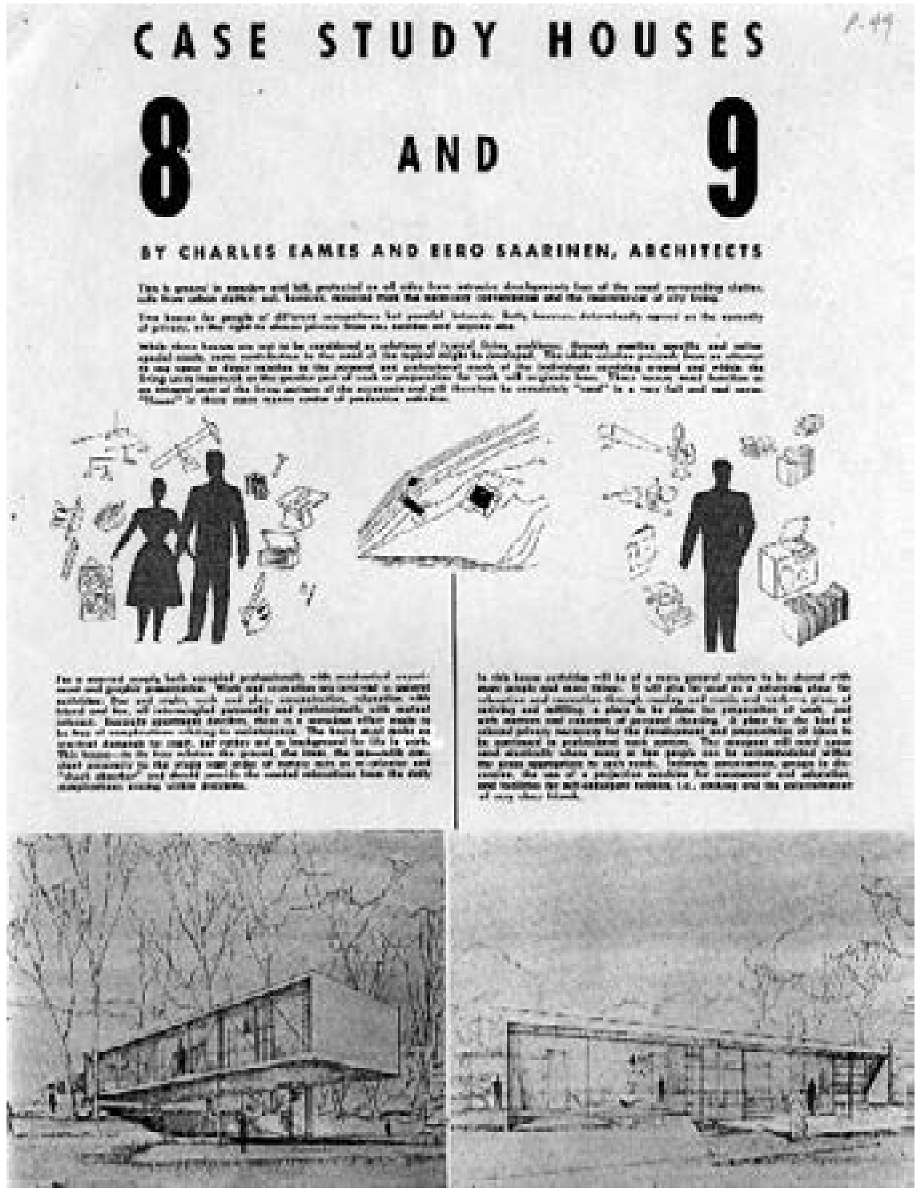
Therefore, it should contain both standardized as well as individualized construction solutions. The article "Prefabrication" suggests that one way to accomplish this aim would be by categorizing the parts of the house into those that are shaped by basic human needs, and those which are adapted to the individual person. The classification is defined like this:

It is the kitchen, the bathroom, the bedroom, the utility and storage units that will profit most by the industrialized system of prefabrication. Here the activities of all men are much the same in the use of these basic household utilities, which properly designed and engineered will accommodate the over-all family function, and offer facilities and conveniences impossible to the individual's most ambitious preferences. [Whereas] it is in the living-recreational areas that variation becomes a matter of valid personal preference where the family desires in terms of differences in activities must be considered.[10]

In continuation of this line of thought, Eames defined prefabrication as a method to create individualized solutions based on standardized production. Thus, he did not pursue any particular construction system or technology, but rather studied all sorts of materials, technologies, and manufacturing processes, unfolding their inherent potentials, refining his methods of approach concurrently. Eames's notion of prefabrication can be characterized as a way to process ideas rather than a pursuit of an architectural idiom.

The Case Study House Program

In 1945 John Entenza conceived the Case Study House program together with Charles Eames. Entenza was owner and editor of the prominent art magazine, Arts and Architecture, which included articles on film, music and book criticism, besides features on modern art and architecture. Even though Entenza was not an architect, he was seriously interested in the Modern Movement and was dedicated to presenting and passing on its precepts within the pages of his magazine.


CASE STUDY HOUSES
8 AND 9
BY CHARLES EAMES AND EERO SAARINEN, ARCHITECTS

75
The Case Study House, Program, December 1945.
Arts & Architecture.
Charles Eames
and John Entenza.

However, the articles often held an underlying tone of social consciousness.[11] Criticizing the general discussions about post-war housing, the magazine had undertaken the unusual commission to build prototype houses designed by eight selected architects, or firms, who were favored due to their reasonableness.[12]

The aim of the program was to shape the course of the post-war building boom through an architectural interpretation of mass-produced houses. As Max Underwood points out in his paper, about "the techné of Charles and Ray Eames" Case Study House #8, the program was based on three motives: "First, to develop houses that addressed the rapidly changing post-war American culture (i.e. family structure, increased mobility due to the car, and new domestic appliances and products such as television and microwave). Second, to develop houses that addressed the overwhelming post-war demand for new, low cost housing through the utilization of recent technological developments and new industrialized materials (i.e. light weight cold rolled steel, aluminum, fiberglass, plywood, silicone, etc.) Third, to develop environmentally responsible houses that were energy conscious and responsive to the landscape of Southern California."[13]

Implementation of new materials and technology was one of the main concerns of the program and several manufacturers had agreed to collaborate with the designing architects in their research on the products they intended to use. Furthermore, the program demanded the architects to be faithful to the notion of industrialization, in the sense that the house should be 'capable of duplication' and by no means an 'individual performance'.[14]

The building projects were perceived as genuine case studies, based on diligent and systematic inquiry into current technologies and practices of construction. Communication of facts and results to the public also formed part of the program. The design process and execution of each project would be reported in the magazine Arts & Architecture, commented by the architect, and the final results, the houses, would be open to the public for a period of time. After the period, tenancy studies would be carried out and final conclusions would be made, completing the program.[15]

The resulting Case Study Houses #1 through #7 fulfilled the intention of this program. Eames House, however, moved way beyond the industrialized objective and continued to act as a framework for endless architectural experimentation and investigation for Charles and Ray Eames. Ray has described the continuing exploration this way:

We used to bring home a piece of furniture we were working on home to look at it because in the office everything was out of scale.[16]

76
The Eames House.

77
Site plan.
1. Eames House
4. Entenza House.

Ceaseless questioning into the connection between everyday life and technology characterizes Charles and Ray Eames's personal reading of the Case Study House Program.

Eames House

The Eames House lies discretely behind a group of tall eucalyptus trees, halfway dug into the sloping hill of the site. The residence consists of two pavilions placed in continuation of one another with a small paved courtyard, separating living and working areas. The rectilinear building complex runs close to the north/south axis, with its longest visible facade towards the east.

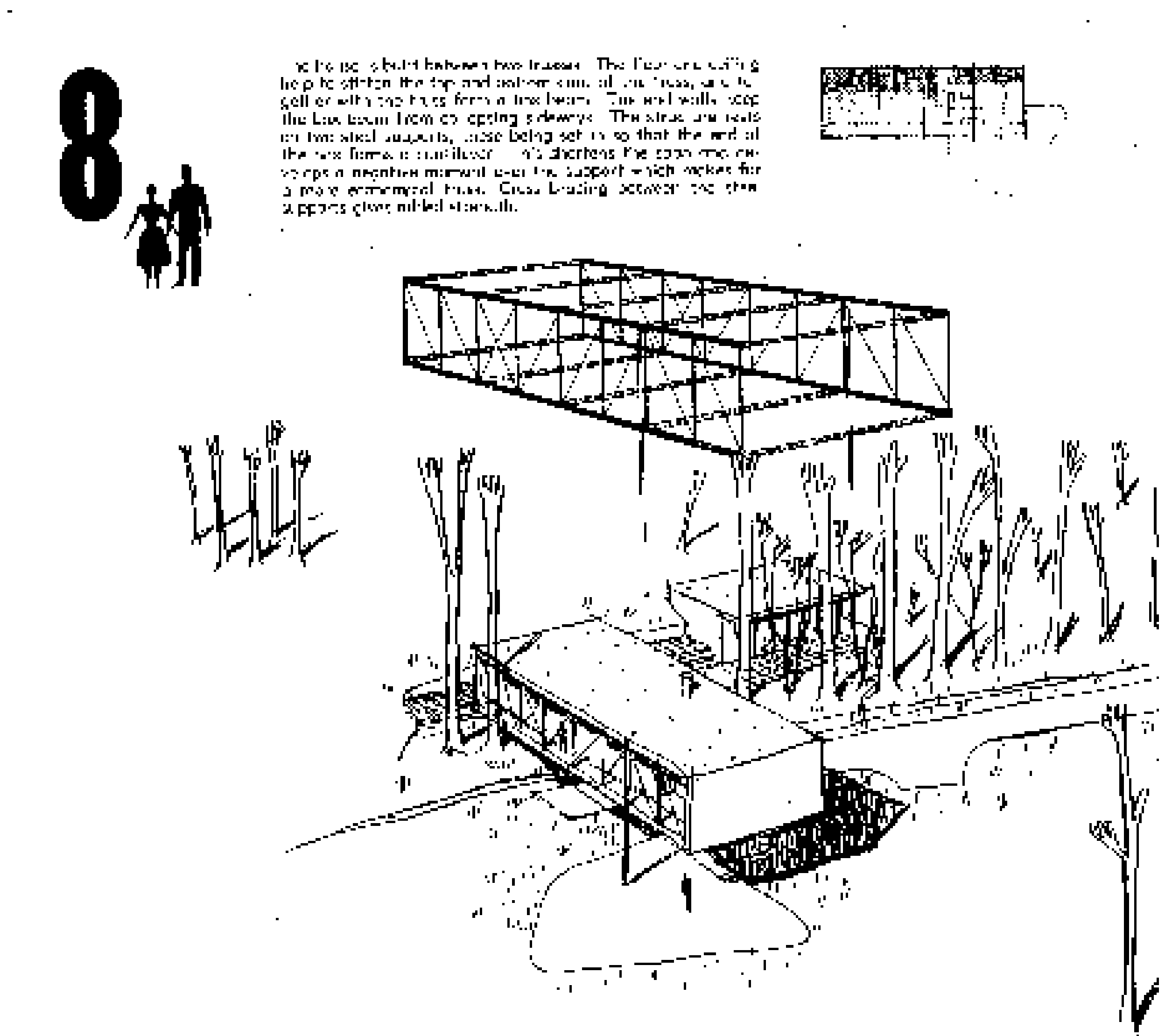
The exposed steel structure of the building complex makes up a three-dimensional mesh that is filled out by different materials. Different textures reflect light in various ways and the physical appearance of the house leaves one with an illusory experience. Moreover, the composition of the black-colored steel frame and the use of primary colors for the infill panels make the facades appear as giant abstract images, similar to paintings of Mondrian.

Eames House shares the beautiful site with Entenza House, Case Study House #9. Both projects were initially planned together, in collaboration with Eero Saarinen. However, as the projects proceeded Saarinen withdrew from the design team of Eames House, and ended up having most influence on the final design for the Entenza House.

The specific programs for the houses were worked out on the behalf of their future owners and with their particular living conditions in mind. Eames House should form the framework for a married couple - their work and recreation, and Entenza House should be the pleasurable environment for a single man, a place where he could relax and entertain his visitors. The program announced further:

[…] these houses are not to be considered as solutions of typical living problems. […] "House" in this case means center of productive activities.[17]

Since the two Case Study Houses were to be built in accordance with the very special needs of their occupants, they could not be easily duplicated, as recommended in the Case Study Program. However, their architectural integrity seemed to legitimize this deviation from the original program.
The initial design for Eames House was illustrated as a suspended object, free of any relation to the ground, the trees and the sea, planned to act as a 're-orientor' in constant proximity of the order of nature.[18]



78
Sketches for the Bridge Horse, december 1945.
Arts & Architecture.
Charles Eames.

The house, often referred to as the Bridge House, was situated perpendicular to the embankment, turning its back on the Entenza house, which allowed for a full view of the Pacific Ocean. The Bridge House was conceived as a house built between two trusses, where the floor and ceiling constructions helped to stiffen the lightweight frame structure.

The box beam rested on the ground at one end and on two steel supports at the other end, with the box cantilevering out beyond them.
The Entenza House rested on the ground, incorporating the meadow into the living scheme. The one-story building is designed as a large, flat box, its primary facade totally glazed, facing the sea.[19]

The aim of this project was to enclose a large amount of space within a fairly simple frame. According to Edgardo Contini, structural engineer of the two houses, they were: " Two exercises in contrasts, two kinds of shelter. In the cantilever bridge house the emphasis was on structure, and it was designed for structure to be exposed; the intention of the Entenza house is to eliminate structure - to be anti-structural, to be as anonymous as possible […]".[20]

Due to various circumstances, the Bridge House project was never completed, but changed at the last minute into the existing building project. Supposedly, Eames did not like the fact that he was using a great amount of steel to enclose a very small amount of space (2,500 square ft. versus 3000 in the final project). According to the story of the construction process, Eames should have used the same amount of steel components for the new project because the steel members were already waiting at the stockyard.[21] However, this incident seems hardly probable, as the American scholar Edward R. Ford, has pointed out in his construction analysis of the two projects.[22]

That Eames changed his mind about the design of the construction did not really affect the essential discussions, which made up the Case Study House #8. According to an article reviewing the building project in Architectural Forum, Sep.1950, Eames stated three questions that generated the design of the house: How cheap is space? - How industrial is our building industry? - How light is steel? [23]

The house provided an ambiguous answer concerning the questions about price of the space and efficiency of industrialized building. The intention was to create an open and well-braced frame structure, similar to lightweight factory constructions, based on prefabricated parts from a steel fabricator's catalogue. Like a gigantic Meccano set, the elements: small WF sections, open-truss joists, roof and floor decks, steel sash and doorframe were detailed to be bolted together. The frame was to be filled out with different kinds of new, industrial materials, panels of plywood, asbestos, plaster and glass.

About light steel constructions, Eames was surprised to discover the properties of the material when the house went up and found it being very different from heavy steel members. Features like delicate tracery of thin rods 12 inches deep was able to span more than 20 ft.; carefully bent sheets could bridge more than 7 ft. and still carry the usual roof load, 4 inch columns could rise 17 ft. without wavering etc. He found the material fascinating, generating new ideas about building-construction along the same lines as the daring structures conceived by aviation engineers.[24]

The new materials used in Eames House were well known at the time for airplane and car construction, but not utilized for house construction. Thus, the materials and standard components were relatively cheap to produce, but expensive to rework and fit for specific use. Eames summarized the pros and cons of this new type of construction a year after its erection:

PRO: 1. Steel could easily be designed to very close tolerances;

2. Labor costs could be drastically cut: Entire structural steel was erected by 5 men in 16 hours. Three days, one man had finished the roof deck. After that, all other trades could work continuously under cover;

3. Skeleton frame could be filled with an endless variety of interchangeable sheet materials, […]

4. Space sensation was greatly enhanced by lightness of steel;

5. Poor carpenter workmanship was a worry of the past;

6. There was no condensation in any part of the house during the past year. Layers of warm air under the ceiling did the trick.

CON: 1. Steel costs more than wood, especially if transported far;

2. Steel must be protected well against weather;

3. Residential wiring and plumbing are still hard to integrate with factory-type structure;

4. Carpenters are easier found than steel workers.[25]

Even though the structure of the Eames House is claimed to be inspired by the modern building technology used in aviation and factory constructions, it is just as closely linked to the concept and physical appearance of the traditional American balloon-frame. As a true industrial structure, the balloon-frame substituted traditional carpentry constructions with simple joining that required no craftsmanship, providing rational and time saving procedures.[26] Similar to the balloon-frame, the structure of Eames House was designed in order to achieve rational and simple construction solutions. Standard steel members were joined and welded together like industrial steel constructions. Nothing was invented for this special occasion. As noted in the review of Architectural Forum: " The

79
Eames House, under construction. Light gauge steel joists made rapid construction possible. 1949.
Charles Eames.

80
Eames House, view from the Studio.

complicated connections between steel members were handled in the most direct manner possible: A welded plate joins the open truss joists to its column; a window frame butts against a corner post; a wall panel is set precisely into an angle frame. Nothing is concealed; nothing is elaborately designed."[27]

The notion of the Eames House as an off-the-shelf, prefabricated industrial construction, translated into residential housing, only applies to the basic steel structure. The fitting of window frames and other components had to be handcrafted on a piece-by-piece basis. According to Don Albison, a staff member of the Eames office at the time, he performed two hundred separate welding operations on the factory sash and additional work on other parts of the connections between the frame and other elements.[28]

The Structural Screen

During the building process, Eames turned his attention from the question of industrial and rational construction procedures to the actual experience of the structure - the final house. Eames claimed that:

Case study wise, it is interesting to consider how the rigidity of the system was responsible for the free use of space and to see how most matter-of-fact structure resulted in pattern and texture.[29]

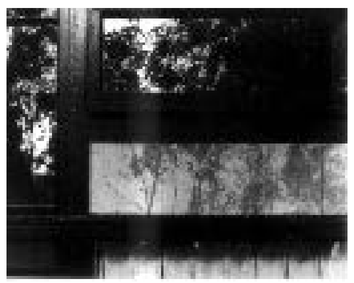
In that sense, he did not assume that the construction system had its own logical order that could determine the design of the building. He translated its rigid nature and made a personal rendering of industrial architecture -making his own standard. Edward R. Ford also refers to this issue in his analysis of the structural details and geometry of the facades. He explains that Eames wanted to harmonize the facade by making the two-story walls identical to the one-story walls instead of showing the consequence of their 'true' construction. Ford notes that, "Like many examples of 'honest' building, Eames house goes to considerable effort to hide certain aspects of its construction in order to glorify others."[30]

Eames may have manipulated the construction details in order to get the right architectural sensation. Whereas, if he had followed logical rules of construction, the house might not have ended up with such a strong and bold architectural expression as a final result. Continuing this discussion, one is tempted to ask if honest construction is a matter of following regular patterns of thought, or of being true to the objective of the project?

There can be no doubt that Eames found the composition of the building envelope in relation to the spatial sensation, both interior and exterior, as the most critical aspect of constructing the house. During completion of the facades, he continued testing different materials; glass, wire glass, asbestos, plywood, and plaster in various colors in the frame of the structure - composing different experiences of texture, transparency, reflection and translucency. He let the materials form the architectural answers:

Most of the qualities that proved satisfying were inherent in the materials themselves - the texture of the ceiling, the metal joists, the repetition of the standard sash, the change of glazing from transparent to translucent - the surprise of seeing the plane in space by the wire glass in the studio. [...] Glass and reflections restore transparency and add double images that become characteristic of the building.[31]

Similar to sliding wooden shutters in traditional Japanese architecture, the facades provide a layered transitional sensation of space. Eames transformed a rigid industrial construction into constantly changing experiences and variation, formulated on the basis of human needs and activities.



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2 Ibid., p. 37
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4 Ibid., p. 34
5 "Case Study Houses", Domus, February 1981, No. 614, pp. 14-15
6 Neuhart, Marilyn & John, Eames House, Ernst & Sohn, Berlin, 1994, pp.10-11
7 Eames, Charles, "Notes in passing", Arts & Architecture, July 1944, p. 3
8 Ibid., p. 33
9 This notion was also supported by Buckminster Fuller. Ibid., p. 35
10 Eames, Charles, "Prefabrication", Arts & Architecture, p. 35
11 John Entenza was an extraordinary person with a broad range of interests. He was extremely important to Charles Eames in is first years in Los Angeles - as a friend, advisor, patron and benefactor, and occasionally as collaborator. He introduced the Eameses to the local community of artists, architects, designers, filmmakers, and writers. Neuhart, Marilyn & John, Eames House, Ernst & Sohn, Berlin, 1994, pp. 16-17
12 The chosen architects were, in alphabetical order: Hornton Abell, J. R. Davidson, Charles Eames & Eero Saarinen, Richard Neutra, Ralph Rapson, Whitney Smith, Spaulding & Rex, and Wurster & Bernardi. The program was expanded to include 34 houses, of which 23 were completed before it ceased, when Entenza sold the magazine in 1966. Steele, James, Eames House: Charles and Ray Eames, Phaidon, London, 1994, p. 8
13 Underwood, Max, "Revealing Connections: The Techne of Charles and Ray Eames' Case Study House #8 and Rem Koolhaas - O.M.A.'s Villa dall'Ava", Essays in Technology, 82nd ACSA Annual Meeting, Montreal Quebec, 1994, p. 232
14 Entenza, John, "Announcing the Case study House Program", Arts & Architecture, January 1945, p. 38
15 Ibid.
16 Underwood, p. 234
17 Arts & Architecture, December 1945, p. 44
18 Ibid.
19 Ibid., p. 45
20 McCoy, Esther, Case Study Houses 1945-52, Los Angeles, 1977, pp. 54-55
21 Different versions of this story exist, each of them adding yet another layer of theory to the real event. Supposedly, Charles Eames has never revealed his true motives for changing the project, but the amount of steel in relation to the space seemed out of proportion. For additional information: McCoy, Case Study Houses 1945-52, p. 57, Ford, The Details of Modern Architecture, vol. 2: 1928 to 1988, pp. 230-231, Steele, Eames House: Charles and Ray Eames, pp. 8-9
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25 Ibid.
26 Giedion, Sigfried, Time, Space and Architecture, Harvard University Press, Cambridge, Massachusetts, 1941/1982, pp. 344-350
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28 Neuhart, Marilyn & John, Eames House, p. 38
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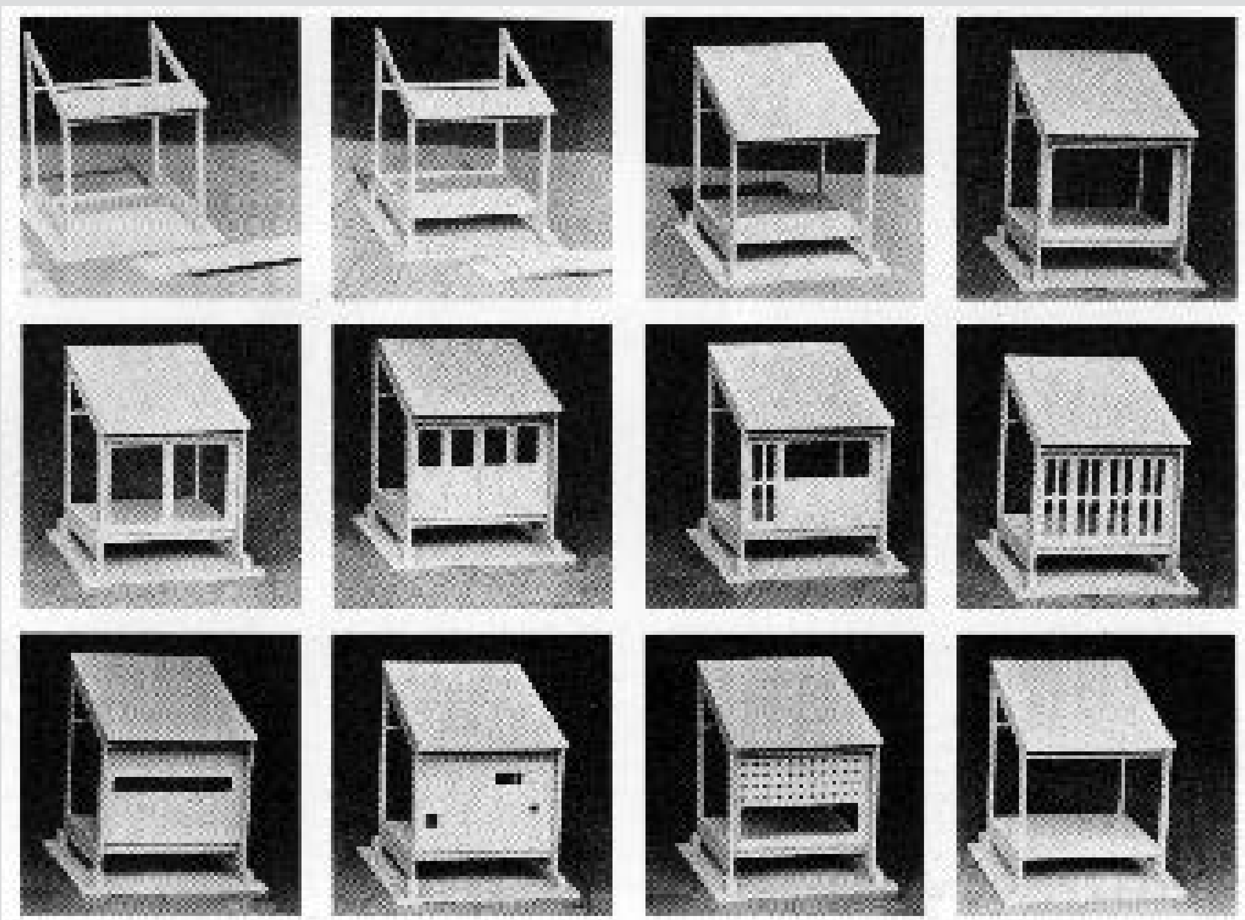
81
Eames House, a limited palette of materials, including steel and glass, shows the restrained approach to detailing.
Charles Eames.

Standards of Ideal Construction Elements

Espansiva
Built: Hellebæk, Denmark (1969-70)
Architect: Jørn Utzon



82
Espansiva, 1970.
One unit shown as a model during assembly, and enclsed with different facade uints.
Jørn Utzon.

My ideal of industrial prefabrication in house building is a building system similar to the log-house system, in which neutral, uniform, identical components can give shape to a variety of buildings. [1]

Utzon

Utzon's visionary statement stems from an interview with the Finnish architect, Markku Komonen – concerning his faith in the potentials of serial production. Throughout his career Utzon has pursued the problem of defining ideal design systems for prefabricated building components. In each project, he has examined the same theme, yet come up with quite different architectural answers.

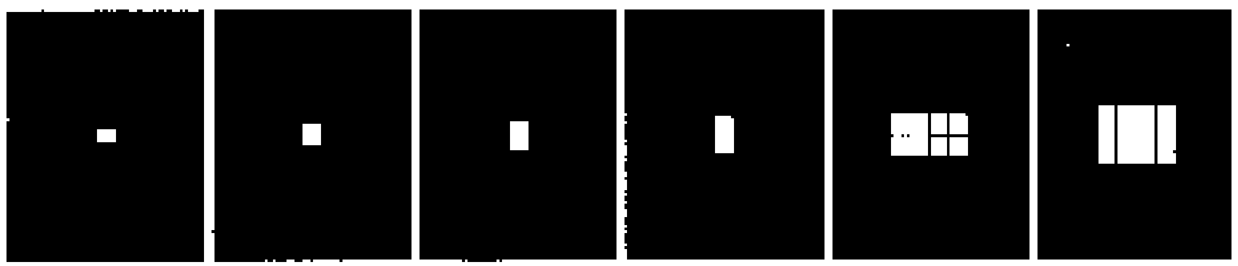
The Espansiva building system represents one of his most thorough investigations into the issues of system building, reflecting a genuine understanding of the prefabricated construction unit as an essential parameter for architectural design. In comparison to the construction system of the Sydney Opera House, the Espansiva system has often been characterized as crude and simple, without any importance when it comes to aesthetic appearance. However, in the Espansiva project, Utzon tested contemporary industrial building industry, studied its limits and potentials, and wanted to define an ideal system of standards, which also referred to an aesthetic ideal for architecture. As such, it represents a profound study of tectonics in architecture.

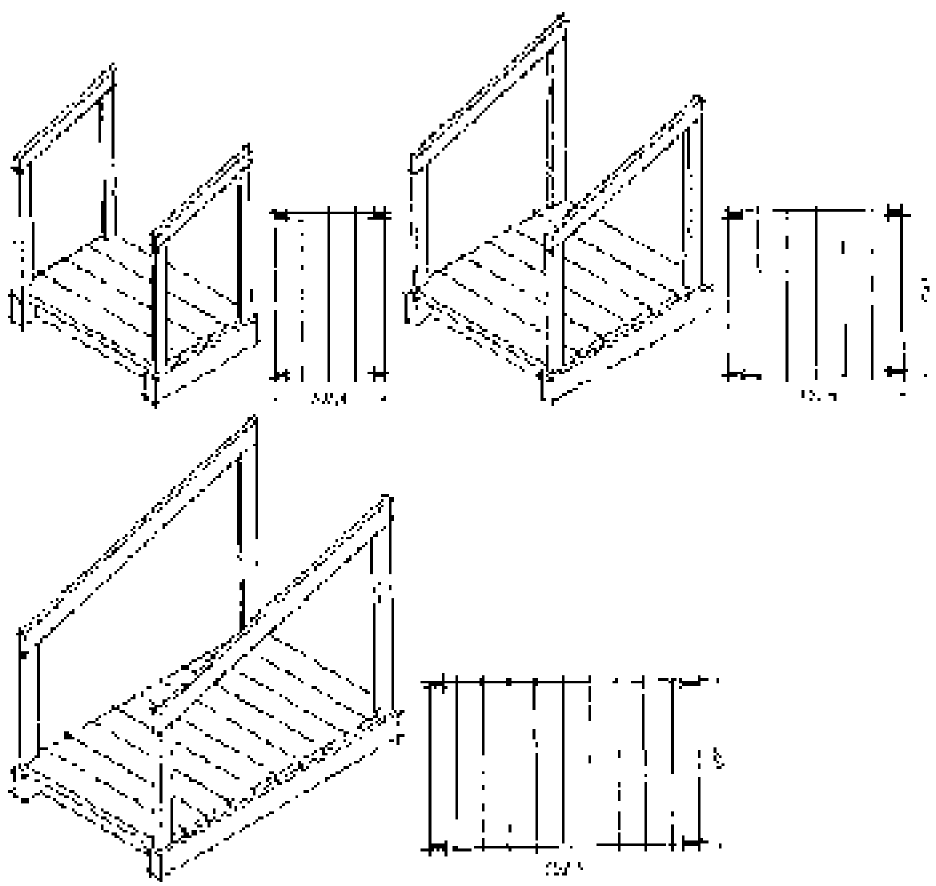
In the interview, Komonen suggests a parallel between Utzon's early projects under the heading, additive architecture, and Aalto's notion of flexible standardization. Both ideas concern the fusion of structural rationalism and richness in variation, similar to structures in the world of nature. As an example of flexible standardization, Komonen refers to Aalto's design for a unit-built staircase (1942). The proportions between riser and tread provide a design system that leaves freedom in fitting the staircase to different spatial circumstances. Unfortunately, the staircase system was never launched commercially. The lack of success of Aalto's staircase system illustrates the problem of defining a flexible standard of high aesthetic quality that meets rational industrial manufacturing processes. One is therefore tempted to ask if the connection of two essentially different concepts, such as, rationalism (which implies uniformity), and flexibility (which implies variation), at all is feasible?

The Additive Principle

Utzon has been able to tie these opposite ends together in his architectural design, and one of his keys to the problem encountered by Aalto, has been the concept, additive architecture.

As Giedion has pointed out, "Jørn Utzon, […] posses the double gift: he is able





83
Espansiva, 1970.
The first four panels of the black frieze show the four units comprised in the system.
Jørn Utzon.

84
Espansiva, 1970.
Sketches showing the three pavillion units. All the pavillions are 3 m. wide, whereas the lenght variate.
Jørn Utzon.

to have direct contact with the cosmic elements of nature and the past and also complete control of contemporary methods of industrialized production - especially prefabrication. As a result he is able to detach prefabrication from its purely mechanistic attributes and bring it nearer to the organic."[2]

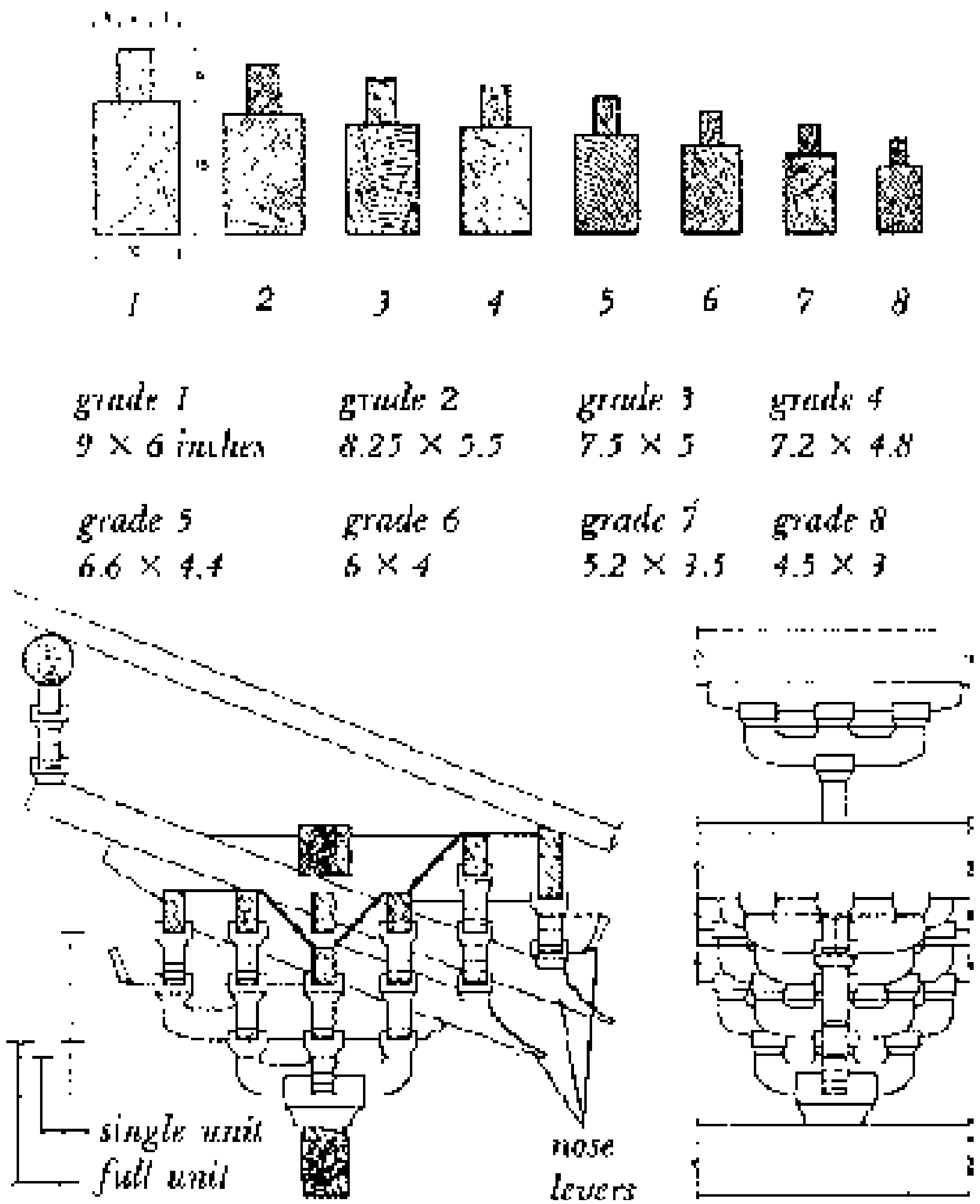
The French architect Françoise Fromonot has summarized Utzon's additive principle in her latest book on Utzon's Sydney Opera House. She says that,"[It] follows the method: definition of a basic unit reflecting the functional nature of the programme, perfection of the variations, assembly of these functional elements in reference to the site and the construction schedule."[3]

Fromonot's characterization could easily be applied to Utzon's architectural approach in general, however, his design solutions seem to carry subtle variations in the definition of units (standards) and method of approach. In Utzon's terms, additive architecture is not only a sheer matter of adding structural elements that share common standards to one another.

Building components are to be regarded as autonomous, whole, and equally significant elements, not only in theory and on the drawing board, but particularly during the construction process. In the short article, Additive Architecture, he unfolds the concept as such:

> A consistent utilization of industrially produced building components can only be achieved if these components can be added to the buildings without having to be cut to measure or adapted in any way. Such a pure addition principle results in a new architectural form, a new architectural expression with the same attributes and the same effects as are obtained, e.g., from adding more trees to a forest, more deer to a herd, more stones to a beach, more wagons to a marshaling yard – or more morsels to the Danish Frokost Board; it all depends on how many different components are added in this game. […] When working with the additive principle, one is able without difficulty, to respect and honour all the demands made of design and layout as well as the requirements for extensions and modifications. This is just because the architecture – or perhaps rather the character – of the building is that of the sum of total of the components, and not that of a composition or that dictated by the [design of] facades. Again, when working with the additive principle, one is able to avoid sinning against the right of existence of the individual components. They all manage to find expression.[4]

In theory, Utzon's argument works fine. However, building components that are not to be cut to measure or adapted in any way surely challenges the (technical) design of the building components and in particular the very process of construction. Usually, most building components have to be fitted or adapted during the building process. They are tied together as structural joints to transfer



85
Yingzao Fashi, standard dimension according to the Building Standards.
Song Dynasty (960-1279).

forces - or woven together as overlays to protect against the weather: e.g. when a beam meets a pillar, it must be shaped so the beam can rest firmly and stay fixed. Building constructions, featuring whole and perfect building components throughout the entire building construction thus require thoroughly planned technical details with an extremely high finish of the products.

Construction principles based on similar ideas can be found in Yingzao Fashi, a twelfth-century Chinese building manual.[5] Although Utzon hardly refers to any construction system as his source of inspiration, except of maybe traditional Scandinavian timber frame constructions, he was at the time very intrigued by the philosophy of traditional Chinese building construction, as described in the Yingzao Fashi. Supposedly, he became acquainted with traditional Chinese building methods while traveling in China in the late fifties; furthermore, these issues were of general interest at the time when he attended the School of Architecture, at the Royal Danish Academy of Fine Arts.[6]

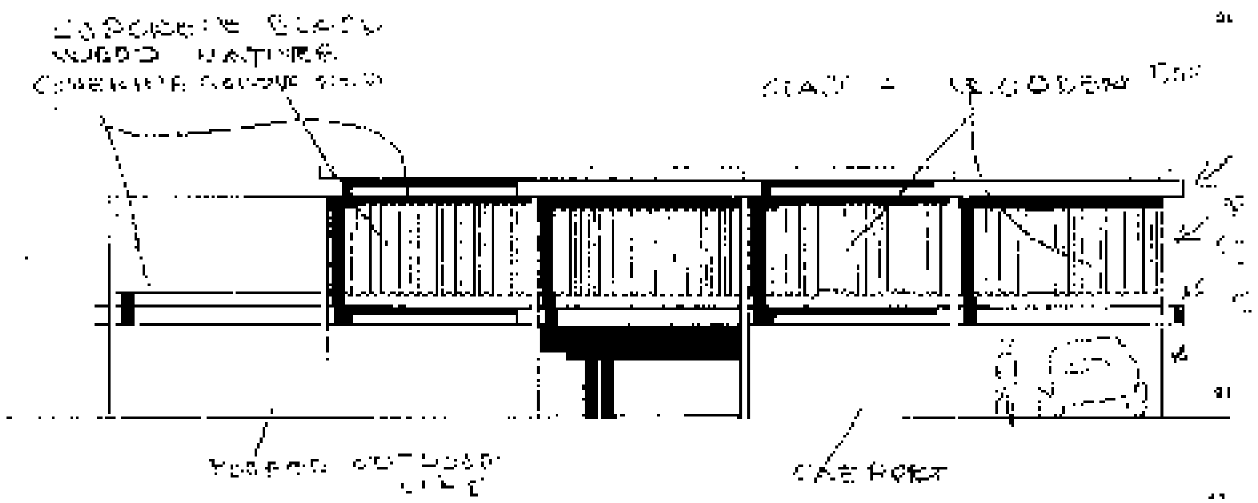
Yingzao Fashi illustrates a range of building types based on a simple timber syntax. As such, Utzon found the book interesting in relation to industrial construction technology. The additive system hold similar ideas as Yingzao Fashi that the same kit of parts could be used to assemble quite different structures, roof-forms in particular.[7]

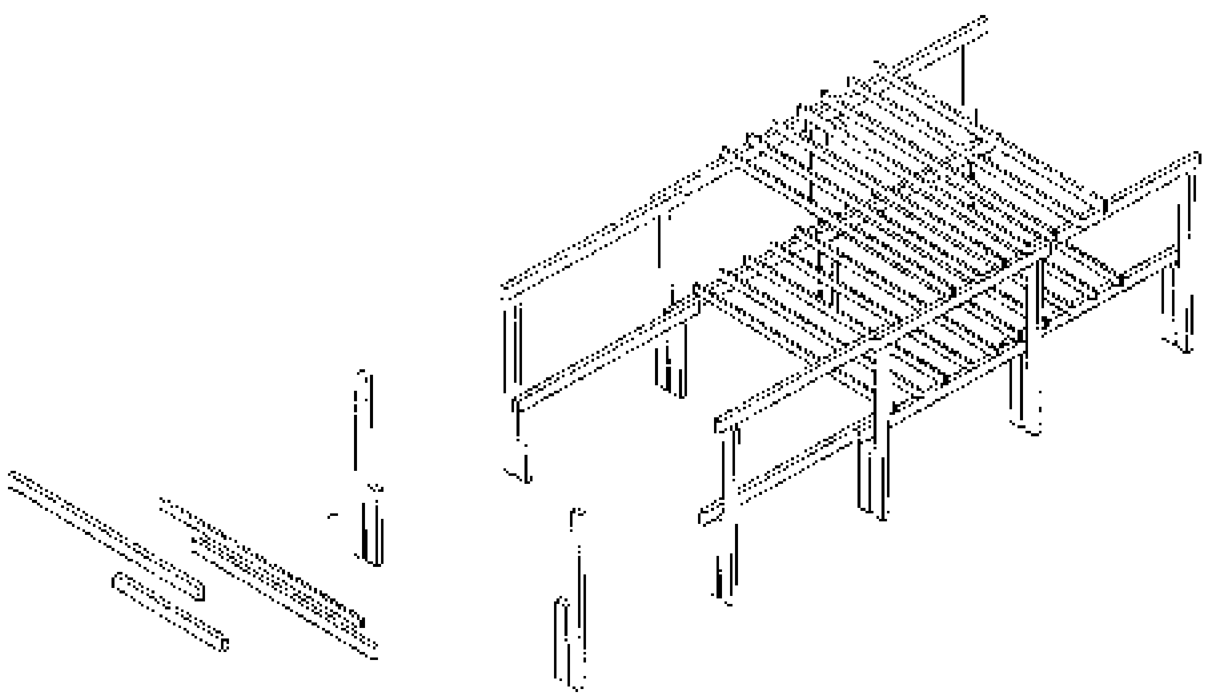
An interesting aspect of Yingzao Fashi is the definition of standards, where the unit acts as basis. The measures are given in units and sections, not in feet and inches. The Danish art historian, Else Glahn, has described the nature of the system like this: "The Chinese system has the cross section of a construction member as its unit, while the Western has space, the length or span, or a smaller opening as its unit. The aim of both systems is a rationalization of the building process, […]."[8]

According to Glahn, the unit was derived from the cross section of the bracket arm, and various buildings used different sizes of units according to the building's relative importance. Once the size of the unit was established, the carpenters would use a unit rule instead of a foot rule. Another important aspect of the system was that the ratio between the depth and width of each unit referred to the same rules of proportion as for the Golden Section.

Analogous to Yingzao Fashi, Utzon's additive principle is based on the unit as measure. Therefore, he treats the various construction components as whole and perfect members.

Utzon tried applying the additive principle for the first time in the Furesø House (1952-53), which also represents his first use of prefabricated elements. The Furesø House is situated on the edge of a large lake, where the damp environment determined the design of the house. It was formed as a frame structure of pre-cast concrete columns and beams that elevated the living area off the





86
The Furesø House, 1952-53.
Elevation.
Jørn Utzon.

87
The Furesø House, 1952-53.
Concrete construction.
Jørn Utzon.

ground. The dwelling was contained in a wooden box.[9]

Separation of supporting and supported elements was the main feature of the construction, which shows in the lack of structural connection between the concrete structure and the wooden box. The columns were designed as double structures, separated into a short column that supported the beam of the floor construction and a tall column supporting the beams of the roof. Each element was defined in accordance with its structural purpose; however, the concrete elements appear quite heavy and a little oversized, considering that they carried a simple, lightweight construction.

The beams, running along the facades, were placed on the top of each column, and secondary beams were laid on top of these, stretching crosswise between the facades and supporting the secondary structure of the wooden box, similar to a plain matchstick structure. By overlapping or weaving the columns and beams together like this, in a fusion similar to the cantilevered bracket arms illustrated in the Yingzao Fashi, the vertical and horizontal forces were translated from pure structural joints into an architectural narrative.

The Furesø House illustrates Utzon's tectonic approach, which relates to simplified and purified forms and constructions. By reducing the structural elements to their very essence, he defines and exposes their inherent meaning. He described this viewpoint as such:

> One must understand that the simpler the form or composition, the easier it is to understand and the stronger is its influence on us. We must understand that all the elements in a composition in a house or in nature mean something and can both enrich, and enlighten the whole, or further stress the main form or character.[10]

The Furesø House may seem to simplify the building methods of Yingzao Fashi; nevertheless, it formed a point of departure for Utzon's further investigations into issues of prefabricated units, joinery, and systems of standardization, and his dream to invent, new architectural forms and new architectural expressions.

The Repetitive Principle

Since the Espansiva system is exemplified in few built prototypes consequently exploring the additive principle, it seems appropriate to examine how it deviates in thought from Utzon's major opus: the Sydney Opera House.[11]

The projects share many similar properties, reflecting the basic nature of prefabrication. Still, there is no comparison, the Sydney Opera House holds the most elegant features and idiom.

The Sydney Opera House - Utzon's prominent answer of transforming prefab-

ricated components into artistic means of construction - tends more towards the notion of repetition than addition. Because of the initial difficulties of the project in designing construction systems in accordance with the architectural intention, many of the construction details were conceived together with different manufacturers, during realization of the project. In order to make this extraordinary project economically feasible, the construction had to be based on systems of standards, which allowed for both repetition and variety.

As an illustration of this process, the tile-lids that covered the different vaults is a perfect example. The tile-lids were fabricated on site, like the vault segments. Their spherical geometry that was similar to the vaults made serial production possible. Despite the complexity of the double curved forms of the building, there were only 18 types of lids, out of 4.253 tile-lids.[12]

According to Fromonot, Utzon made a virtue of standardized products designed by the architect. By moving from the idea of traditional tile cladding to the principle of a cover of tile-lids he provided a system that permitted ease of fabrication and construction, and last but not least, ensured a perfect cover.[13]

Within the building industry, the notion of repetition belongs to the realm of economy, due to its rational and reductive attributes. However, Utzon defines the repetitive principle as a creative tool for design, by drawing out the aesthetic qualities from technical constraints, e.g. as in the tile-lids. In Utzon's terms, the repetitive principle is based on identical construction elements that are repeated in accordance with a logical system and aesthetic intention. It is thus a matter of defining a closed system that is based on few components that, when they are repeated, they make up a unique architectural design. The additive principle is slightly different. It is rather a matter of defining an open system that holds a multitude of construction elements that can be added to one another in many different ways, providing a scope of architectural solutions. The construction elements are conceived from a more objective point of view in order to obtain a high degree of flexibility.

Espansiva

Espansiva was conceived as an open system, that held flexible potentials in regard of, the client, the site and program - and the market. As for the architectural expression, it reflected the tenet of functionalism, which Utzon believed, was an essential of true architecture.[14]

The Espansiva project was planned in collaboration with a group of Danish timber merchants, who formed a small company named Espansiva Byg A/S. Their intention was to develop, produce and market wooden components as a prefabricated building system for single-family houses. As such, Espansiva was a catalogue house, that was meant to be built in accordance with the demands

88
Sydney Opera House, 1954-66. Prefabrication of tile-lids (photo: Max Dupain).
Jørn Utzon.

89
Sydney Opera House, 1954-66. Details of arch ribs and precast lid-elements.
Jørn Utzon.

of the client, on a site of choice, and planned by any architect.

The structural principles of the Espansiva system grew out of Utzon's great interest in the building construction of the traditional Danish half-timbered house and bole house construction. He reinterpreted these historical precedents and conceived a basic unit, consisting of a laminated timber structure. This was elevated from the ground placed on two concrete beams that were bolted to foundation pillars, one in each corner. The roof was made of prefabricated, stress-skin, plywood elements, sloping one way at a 17°-degree angle. The floor construction consisted of cellular concrete foundation slabs. The structure left the roof and floor planes as solid and uninterrupted slabs and, furthermore, it made the non-bearing outer walls and the partitions between the columns totally flexible. In certain ways, this structural principle reflected his idea of roofs and plateaus, which liberated the space in-between the planes.[15]

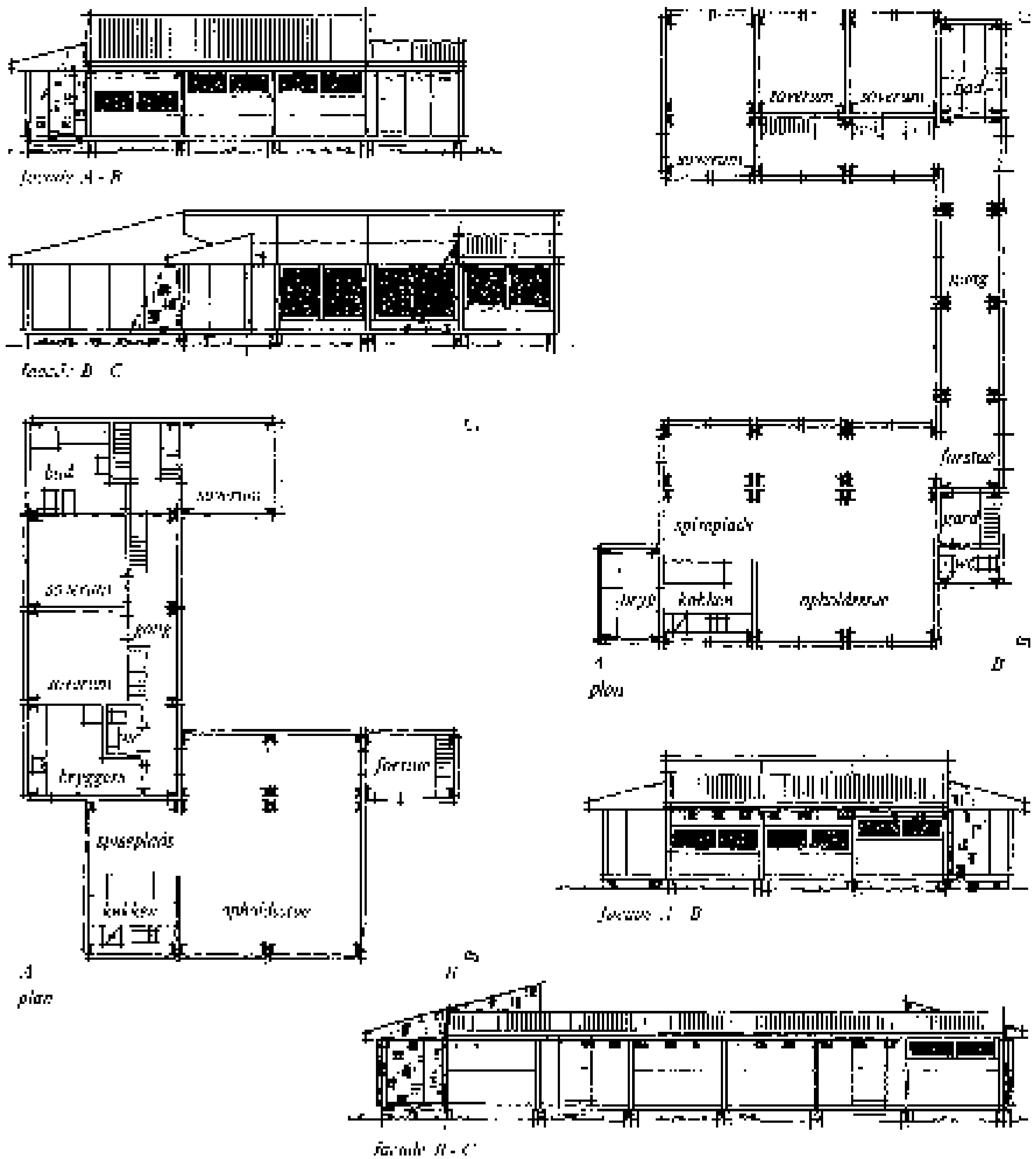
The units were of three different sizes, defined according to the functions of the rooms. The measurements of the unit plans corresponded with the geometrical principles of the Golden Section, as in the Yingzao Fashi. Joining the units without partitions would make it possible to lay out rooms of any size desired. The only limitation would be the span between the posts, which governed the depth of the module.

The same richness in variation was envisioned for the cladding materials. Different kinds of products were considered for the roof and outer walls. For the roof: tiles, cement boards, metal sheets and tarpaper. Similar strategy was used for the cladding materials of the exterior walls. They would be made of plywood, cement boards, glazed or metal clad panels. Utzon designed standard types of doors and windows for the system.

Utzon did not contrive a new construction technology as for the Sydney Opera House; Espansiva was an investigation into existing industrial materials and construction practices. Nevertheless, the unit system gave a complete freedom in the composition of various housing types and other one-story buildings, such as schools, motels, etc.

With himself as one of the first and only clients, Utzon built a prototype in order to test out the various possibilities and limitations of the components. He chose a rather narrow site in the woods of Hellebæk, not too far from his first brick house and the northern coast of Zealand.

A closed brick wall with no openings defines the exterior appearance of the housing complex. The pavilions are laid out creating an atrium and the few 'open' facades are oriented towards the woods and towards the inner courtyard. Since the house was built as a demonstration of the system, all the recommended roof and facade materials were used. Utzon mainly used heavy materials for the walls of the periphery of the building complex and lightweight materials



90
Espansiva, 1970. Examples of plantypes and facades. Court yard Houses and Angled Houses. Drawings from the brochure material of the Espansiva. Jørn Utzon.

or glazing for the interior facades. This distinction is also seen in the roofing principles where tiles are used for the pavilions facing the road and aluminum sheeting for the atrium pavilions. He also distinguished between large and small units, placing the smallest units towards the atrium, leaning the lowest part of the roof profile towards the center. The Espansiva house can be characterized as the most consistent illustration of Utzon's additive design principle, but the formality of the system makes some of the actual construction solutions irrational and ambiguous.

Utzon's idea of standardized, yet flexible, units for construction that could provide him with a multitude of design options was the keynote of the Espansiva system. Besides his interest in the Yingzao Fashi, this notion seemed to originate from his fascination with natural structures. Already, in his first article, Tendencies of Contemporary Architecture (1947), he described how this particular quality of nature could inspire architectural form:

If one […] passes on to nature one will see that the elements of nature are created out of a multitude of small identical elements of very different nature and characteristics, which multiplied or combined with other sorts create an infinite richness and grandeur - in terms of space, matter, form and color [16]

Various images showing natural forms of accretion and growth, side by side with illustrations of vernacular and 'organic' architecture illustrated the article, suggesting which form systems acted as model for his theory of additive assemblies.[17]

Utzon seem to have studied these additive principles of nature very closely, since he came up with this particular interpretation of addition, that could be applied as an architectural design strategy. One of the most interesting detail of the Espansiva system is the signification of the interstitial space between the unit elements. Utzon perceived this leftover spacing as a construction element and, depending on the design of the house, it could be filled out or left open.

The spacing measured 12cm, similar to the standard dimensions of all the components of the system. This standard module was derived from the measurement of the Danish brick.[18] This particular feature of the interstitial space made the construction system feasible as a true additive structure. Utzon described it like this in comparison to the common linear module system:

Throughout the system, a standard spacing of 12 cm has been adopted between the components, irrespective of the way in which they are combined. This spacing was chosen after a close study of the additive principle. In contrast to the linear module system, where the thickness of the partitions need not to be taken into account, the partition itself here becomes a module, a unit, a component (whatever ones like to

call it) which is added to the pavilions or inserted between them.[19]

Utzon points out a critical aspect of the difference between the two systems: the wall thickness can be perceived as part of the module system; or the module system made of 'independent' components each being a module/unit.
As Utzon found out while working with these issues, the linear module system - conceived as a rational tool for control of industrial building construction - was not suitable for variation of architectural form due to its conceptual basis.[20]

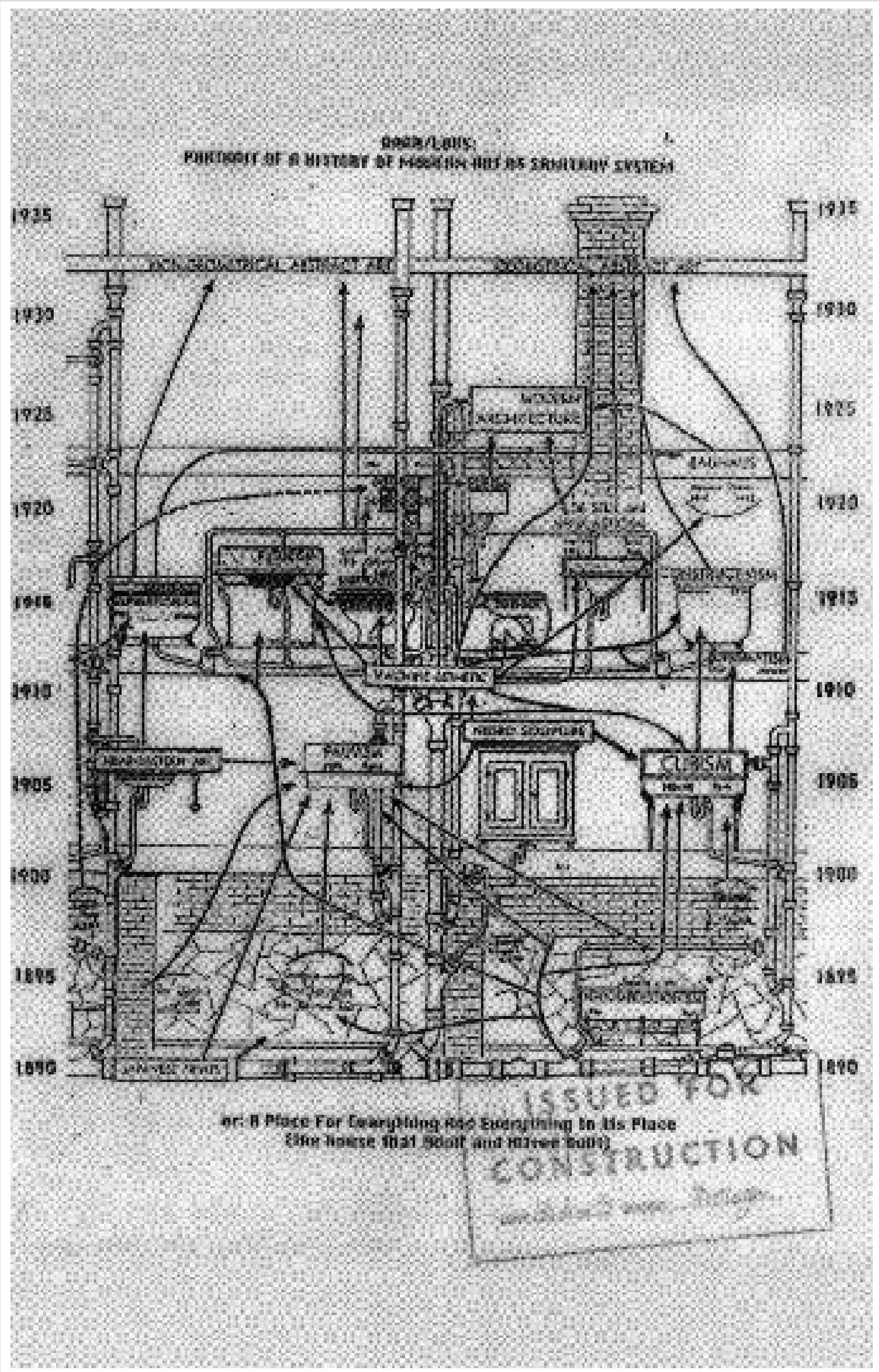
The linear module system was most of all a theoretical model based on economical values, in contrary to Utzon's that was based on 'infinite richness' and 'grandeur'. Utzon's version considered the very nature of the regulating module system as just as important as all the other architectural ingredients.
It was equally furnished with meaning, which he characterized like this:

The drawings are not a thing per se with meaningless and dimensionless module lines: - the module lines represent wall thickness, and the lines on the paper form the contours of the finished thing.[21]

By thinking this, Utzon could liberate the whole idea of modular system building, as Giedion said, from its 'purely mechanistic attributes' and bring it into 'direct contact with the cosmic elements of nature', this way providing an alternative answer to the common methods of industrial construction.

1 Interview with Markku Komonen, Arkkitehtii, 2/83, p. 46
2 Giedion, Siegfried, Space, Time and Architecture, Harvard University Press, Cambridge Massachusetts, 5th edition, 1982, p. 678
3 Fromonot, Françoise, Jørn Utzon: The Sidney Opera House, Electa/Gingko Press Inc., Milan, 1998, p. 196-197
4 Utzon, Jørn, "Additive Architecture", Arkitektur DK, no.1, 1970, p.1
5 Yingzao Fashi, Building Standards, was a manuscript copy of a book from the Song dynasty (960-1279) found in 1918. The book describes building technology, preliminary calculations, foundations, carpentry, joinery, and manufacture of a number of materials. Glahn, Else, "Yingzao Fashi: Chinese Building Standards in the Song Dynasty", VIA, no. 7, 1984
6 At the time, the New Carlsberg Fund had donated a true model copy of a Chinese temple to the School of Architecture. Furthermore, the same year as Utzon enrolled at the Royal Academy of Fine Arts in Copenhagen, Arkitekten M, 1937,issued an extensive article on the subject, "The Art of Building in China" pp. 41-54
7 Frampton, Kenneth, , Studies in Tectonic Culture: The Poetics of Construction in the Nineteenth and Twentieth Century Architecture, MIT Press, Cambridge Massachusetts, 1995, p. 257
8 Glahn, VIA, p. 91
9 Helmer-Petersen, Keld, "A New Personality: Jørn Utzon", Zodiac/5, 1961, p. 78
10 Utzon, Jørn, Tobias Faber, "Tendenser i Nutidens Arkitektur", (Tendencies in Contemporary Architecture) Transl.; H. Thomsen, Arkitekten M, 1947, p. 64
11 The other building project based on the additive principle is Herning Skoleby Project. Only few of the units were built as a prototype. For many years it has been a private residence; today, it is part of Herning Kunstmuseum.
12 Fromonot, Françoise, Jørn Utzon: The Sidney Opera House, p. 119
13 Fromonot states: "… the use of a traditional method to seal the cladding on the double curved forms would have required specialist tilers who would have to make countless specific adjustments to ensure a perfect cover", Fromonot, Françoise, Jørn Utzon: The Sidney Opera House, pp. 122-123
14 Utzon, Jørn, "Additive Architecture", p. 1
15 Utzon, Jørn, "Platforms and Plateaus: ideas of a Danish architect", Zodiac, no. 10, 1962, pp. 112-139
16 Utzon, Jørn and Tobias Faber, "Tendenser i Nutidens Arkitektur", p. 66
17 Frampton, Kenneth, Studies in Tectonic Culture, p. 253
18 Utzon used a similar unit principle in his first house in Hellebæk (1952), where the brick determined the module, and worked as a standard for the rest of the construction elements. The lightweight partitions and cabinets were measured by the standard of 12 cm, (4 1/2 inches) e.g.: 48, 60, 72, 84 cm. Utzon Jørn, "Eget hus i Hellebæk", Arkitekten M, no.1, Jan., 1953, pp. 8-9
19 Utzon, Jørn, "Additive Architecture", p. 3
20 As a result of the economical expansion and social welfare a serious need for housing developed during the 50' and 60' in Denmark. This led to numerous rationalization programs for building construction. Nissen, Henrik, Modul og Montagebyggeri, Polyteknisk Forlag, 1970
21 Utzon, Jørn, "Additive Architecture", p. 1

91
Espansiva, 1970. Interior photo showing the four columns joining four units.
The triangular elements stabilize the structure and is placed in between the units.
Jørn Utzon.



92
Baar/Loos.
Portrait of a History of Modern Art as sanitary System or:
A place for Everything and Everything in its place.
(The House that Adolf and Alfred built).
Margaret Morgan,
Collage 1997.

The spatial organization of a building, its construction and the physical design of the building envelope are essential to the sensation of its environment and for its use. Due to modern construction technology and various new building materials, architectural structures have become increasingly complex. Extreme environmental conditions provided by larger building volumes, glazed facades, and the use of materials with little diffusibility, such as concrete and sealing mastics, necessitate a great number of mechanical systems and a highly developed environmental technology in order to control the indoor climate and provide comfort for the users.

Today more than ever, mechanical systems and environmental technology are decisive parameters in building constructions making up a notable part of the building budget. Despite these circumstances, mechanical systems and environmental control are rarely generators to new perceptions of space and aesthetics in contemporary architectural discussions.

In The Architecture of the Well-tempered Environment, Reyner Banham explains that the reason for this condition is because the architectural profession for the past two and a half centuries primarily has been occupied with the aesthetic dimension of the plan and of space in architecture.[1] Thus, the responsibility for maintaining decent environmental conditions fell to another group of men; everybody from plumbers to consulting engineers. Banham claims that "to most architects this field represented an alien culture that they held beneath contempt, and still do."[2]

One may wonder why architects have left this task to the experts and abandoned the responsibility and aesthetic challenge of this art praised by Muthesius in 1904, when he saw the wonders of the English bathroom for the first time:

We have here an entirely new art that requires no propaganda to win its acceptance, an art based on actual modern achievements that perhaps one day, when all the fashions that parade as modern movements in art have passed away, will be regarded as the most eloquent expression of our age.[3]

As expressions of our age, mechanical systems and environmental technology do take up a lot of space, money and energy in building construction; however, only few architects have pursued the essence of these issues and explored its generating power for architecture.

Richards Medical Research Building & Alexandria Library

Richards Medical Research Building (1957-65) by Louis I. Kahn & Alexandria Library (1989-90) by Alison and Peter Smithson represent two of the most profound architectural answers to the issue of designing with mechanical systems

and solving exceptional environmental problems.
Even though the programs of the two cases are of different natures, the one being a medical laboratory and the other fulfilling a library function, they illustrate the critical aspect of how to perceive the body of a building. Defining it either as a machine made of the sum of its individual parts, or as an organism, consisting of interdependent parts comprising a whole.

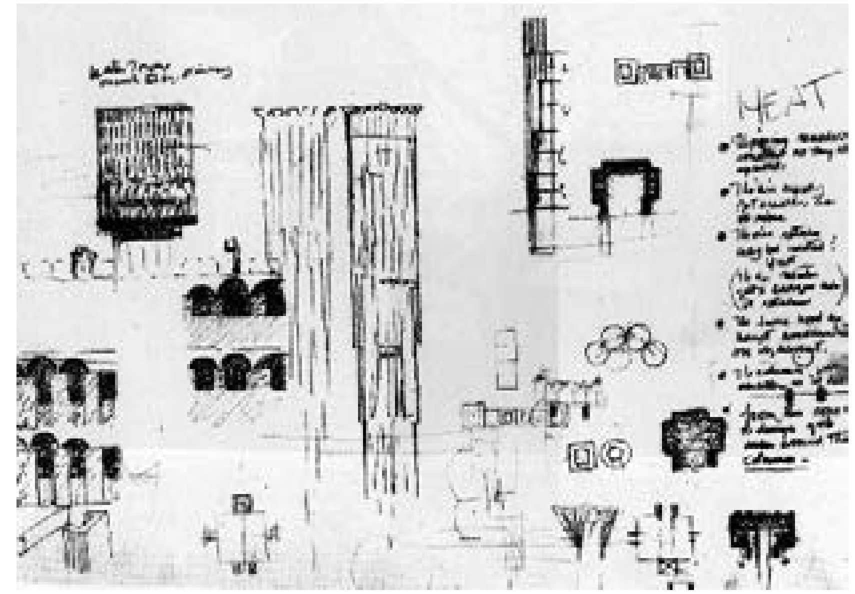
As ways to approach the physical organization of buildings and its construction design, one could claim that in the Richards Building, Kahn pursued the machine analogy, through his theory of served and servant spaces. He provided a conceptual and physical hierarchy of spaces and elements that helped him to define an architectural order for laboratory buildings, - a system of thought he also applied in his succeeding design for the Salk Institute.

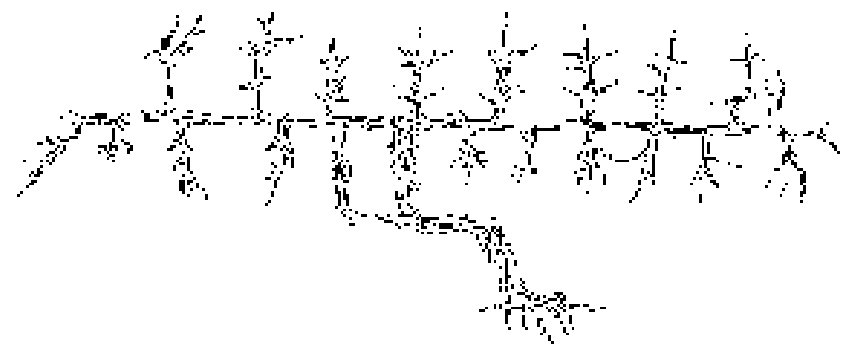
The Smithsons on the other hand tended towards the metaphor of the (human) organism in their library scheme, regarding the structure as a physical entity. Through critical analyses of the severe climate in northern Egypt and traditional building culture, they generated a design growing out of context and place more than from the actual library function.

Nevertheless, these definitions may be too absolute, since Kahn spoke about the importance of correlation between building organization, construction solutions and materials parallel to 'the order of things'. Also, the Smithsons identified environmental problems as separate elements, making systems for organizing and using mechanical technology.

Despite these overlapping ideas and construction solutions the projects can be studied as different architectural interpretations, affected of course by the specific use of the buildings, which determined part of the lay-out and design. Kahn would not have been able to solve the problem of separating polluted and fresh air by natural ventilation, and the Smithsons could not have used heavy mechanical systems due to the local standards of technology, that is, low-tech resulting in regular power failures in the city of Alexandria.

[1] See Giedion's and Banham's contributions to the history of mechanization and architecture: Giedion, Siegfried, Mechanization Takes Command: a contribution to anonymous history, W.W. Norton





93
Richards Medical Research Building. Plan and elevation sketches, 1957 showing exhaust ducts growing larger at each floor.
The notes on the right read:
- The piping remains constant as it rises unwards.
- The air supply get(s) smaller as it rises.
- The air return may be wasted ? If not (the air return gets larger as it returns).
- The fume hood exhaust accumulates on its ascent.
- The column gets smaller as it rises.
- From this comes the design of the area around the column.

Louis I. Kahn.

94
Alexandria Library, 1989.
Library access diagram.

& Co., New York, NY, 1948/1975; Banham, Reyner, The Architecture of the Well-tempered Environment, (second edition) University of Chicago Press, 1984. This book represents the first thorough inquiry into 'those services in buildings that provide comfort and well being of humans'.

The greatest promoter of 'the house as a machine' in this century is probably Le Corbusier. In his Vers une Architecture (1923), he announced: "A house is machine for living in. Baths, sun, hot-water, cold-water, warmth at will, conservation of food, hygiene, beauty in the sense of good proportion. An armchair is a machine for sitting in and so on". Towards a New Architecture, Butterworth Architecture, Oxford, 1989, p. 95

[2] Banham, Reyner, The Architecture of the Well-tempered Environment, (second edition) University of Chicago Press, 1984. p.11

[3] In the chapter, "The Bathroom" Muthesius praises the Modern English Bathroom. Muthesius, Hermann, The English House, (Das Englische Haus, Wasmuth, Berlin, 1904), Crosby Lockwood Staples, London, 1979, pp. 235-237

Served and Servant Spaces

Richards Medical Research Building
Built: Philadelphia (1957-65)
Architect: Louis I. Kahn (1901-1974)

Every space must have its own definition for what it does, and from that will grow the exterior, the interior, the feeling of spaces, the feeling of arrival.
All these things indicate themselves once we think of them as being a realm of spaces – a hierarchy of spaces - and not just simply a feeling. It is just not enough to say: " I feel this should be larger here and bulge out here" and so forth. This you can also do - it is absolutely right to do it - but it must have an internal kind of structure which permits you to do it, […] spaces must be distinguished. The serving areas of a space and the spaces which are served, are two different things. […]
The architect must find a way in which the serving areas of a space can be there, and still not destroy the his spaces. He must find a new column, he must find a new way of making those things work, and still not loose his building on a podium. But you cannot think of it as being one problem and the other things as being another problem. […]
In the very fabric of making it must already be the servants that serve the very things I've talked about – its timbre, its light, and its temperature-control; the fabric of the construction must already be the container of these servants.[1]

Louis I. Kahn

The notion of servant and served spaces is the central organizing principle in Louis Kahn's architectural designs. He began to develop and refine the themes of differentiated space and separation of elements in the mid-fifties, inspired by Anne Tyng, an associate architect in his office.[2] However, these ideas are traceable in nearly all of his projects at any scale, from his early single-family houses and public buildings to his city planning of Philadelphia.

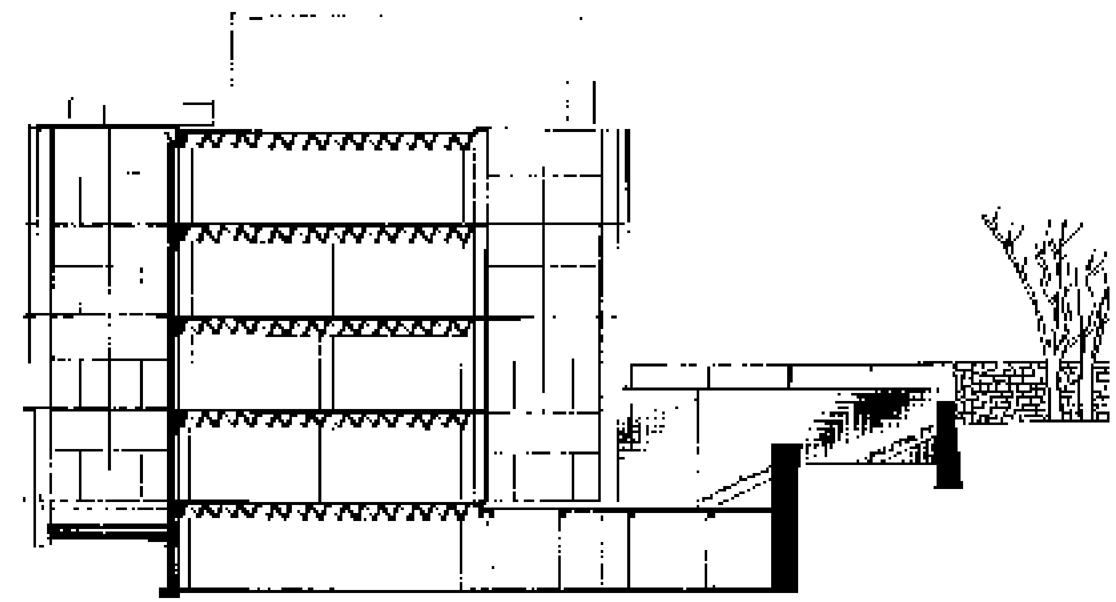
When Kahn was asked to build Richards Medical Research Building in 1957, he had never before designed a laboratory or worked on a major project of equal importance, with the possible exception of the New Haven Art Gallery (1951-53). His affiliation with the University of Pennsylvania led to the commission and it represented an important step for his future career as a teacher, as well as for his career as practicing architect.

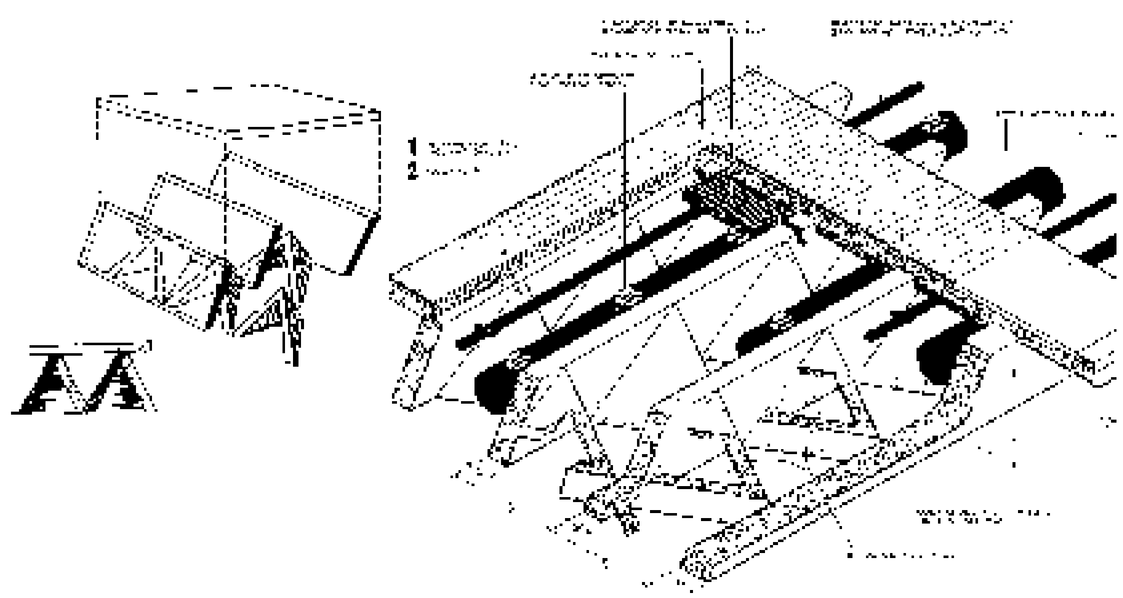
Critics have claimed that the Richards Building, more than any of Kahn's previous designs, embodies his growing sense of differentiated space shaped by visible, rational, and signified structure. Also the "clear articulation of separate components and emphatic distinction between served and servant spaces has been considered to be his strongest departure from accepted norms."[3]

95
Perspective sketch showing the study of building masses.
Richards Medical Research Building, 1957.
Louis I. Kahn.

Differentiation of Space

According to Anne Tyng, Louis Kahn always strove for a distinction between architectural elements as well as concepts. Although she primarily referred to his detailing, he had the same attitude at a larger scale.[4]
His traffic analyses for the city of Philadelphia from 1951-53, and the construction





96
Yale Art Gallery, 1952.
Section.
Louis I. Khan and Anne Tyng.

97
Yale Art Gallery, 1952.
Isometric drawing of the ceiling structure and the air-distribution system.
Louis I. Khan and Anne Tyng.

of Yale Art Gallery in the same period anticipate the notion of separation. In his traffic diagrams, Kahn differentiated the various elements, first analyzing the problem by identifying its component parts, in this case pedestrians and vehicles, each illustrated by arrows of different size or color intensity to indicate relative speed and scale.[5]

Kahn also refined his theories of spatial differentiation through his pursuit for an idealized geometrical order. This interest was stimulated by Anne Tyng's ideas about ordered geometry and they developed this design principle during their collaboration on the designs for the Yale Art Gallery and the City Tower project for Philadelphia (1952-53). Buckminster Fuller went so far to define Anne Tyng as Louis Kahn's geometrical strategist.[6]

The geometric principles of these two projects were derived from organic structures and the City Tower was, furthermore, based on highly evolved space frame technology. Much in line with the structural ideas advocated by the French engineer Robert Le Ricolais and Buckminster Fuller, the City Tower was developed as a triangular space frame.[7]

However, Kahn envisioned spatial as well as homogeneous structures already in 1944 in his essay, "Monumentality". This article, with its misleading title, describes the notion of monumentality from a tectonic point of view. Kahn states, that it is now possible more than ever to build new monumental structures made of new materials and construction technology. Kahn especially recommended tubular steel members and welding procedures as convincing construction solutions for redefinition of conventional architectural structures:

Joint construction in common practice treats every joint as a hinge which makes connections to columns and other members complex and ugly. To attain greater strength with economy, a finer expression in structural solution of the principle of concentrating the area of cross section away from the center of gravity is the tubular form since the greater the inertia the greater the strength. […] The engineer and architect must then go back to basic principles, must keep abreast with and consult the scientist for new knowledge, redevelop his judgement of the behavior of structures and acquire a new sense of form derived from design rather than piece together parts of convenient fabrication.[8]

Not only did Kahn think of the very construction member, as a spatial element and forming element with an inherent nature, he actually spoke for an ontological approach to new materials and technology. As noted by Kenneth Frampton, these early ideas represent the basic thematic of Kahn's work.[9]
Kahn's interest into space-frame technology died soon after the City Tower project, but according to Brownlee and De Long: "he continued to explore the

interstitial spaces that he discovered within other structural systems. This became means of defining relationships between spaces according to visible, rational pattern, and a way of invigorating traditional, wall-bearing structure in a manner suitable to his own time. Ultimately, he achieved the organic interrelatedness of parts that marks great architecture."[10]

Besides structural rationalism, Kahn's spatial perception was also informed by his interest of historic architecture. Especially, medieval castles in Scotland fascinated him because the structure itself, the thick, load bearing stone walls, contained utility spaces and other sorts of small secret rooms for the occupants. He wrote:

The Scottish Castle. Thick, thick walls. Little openings to the enemy. Splayed inwardly to the occupant. A place to read, a place to sew…. Places for the bed, for the stair…. Sunlight. Fairy tale.[11]

Kahn's studies of historic architecture and formulation of differentiated spaces also led to a distinction between the notions: ideal form and design - or what a building 'wants to be and what actually emerges as result of specific circumstance. To identify the two he initially used the terms order and design, but later he redefined order into form. Kahn explained the meaning of the terms like this:

Form encompasses a harmony of systems, a sense of Order and that which characterizes one existence from another. Form has no shape or dimension. For example, in the differentiation of a spoon from spoon, spoon characterizes a form having two inseparable parts, the handle and the bowl. A spoon implies a specific design made of silver or wood, big or little, shallow or deep.
Form is 'what'. Design is 'how'.[12]

As Brownlee and De Long point out, Kahn did not refer to "order in the usual sense of superimposed geometric pattern, but rather as a preexisting Platonic ideal. The measure of his designs depended therefore on the degree to which they anticipated in that discovered ideal."[13]

Served and Servant Elements - or the Order of Things

Even though Kahn never determined an ideal order for architecture, his recognition of order implied a hierarchy. Within his own architectural works, one also finds personal preferences; however, he varied the basic principle for each project. This attitude is also reflected by his concept of served and servant elements. In his legendary writing, "On Things Disliked" he claimed:

98
Plans, Comlogan Castle, Dumphiesshire, Scotland.

99
Indian Institute of Management, Ahmedabad, 1963.
Scematic plan considering the structural system of bearing walls and vaults.
"Type 5, possible vaulting system bearing to bearing wall no prestressed beams".
Louis I. Khan.

I do not like ducts; I do not like pipes. I hate them really thoroughly, but because I hate them so thoroughly, I feel they have to be given their place. If I just hated them and took no care, I think they would invade the building and completely destroy it. I want to correct any notion that you may have that I am in love with that kind of thing.[14]

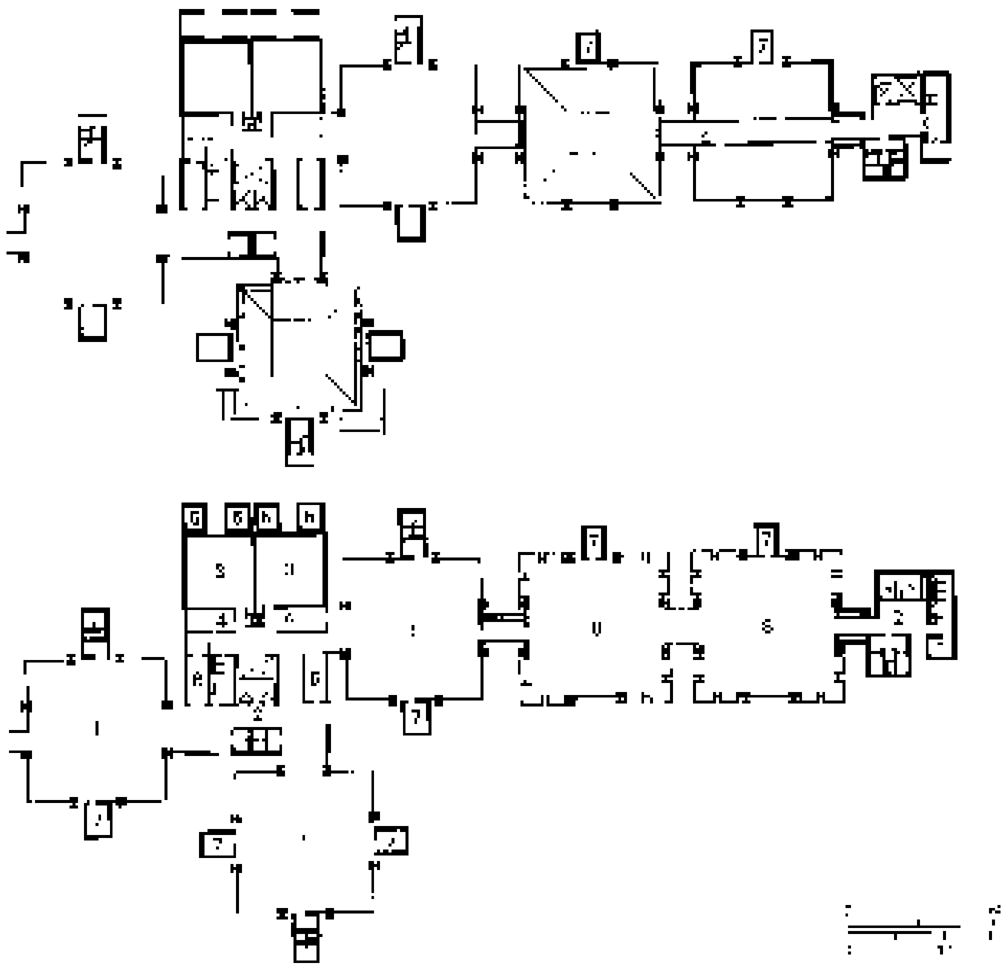
Kahn makes it clear that he wanted to control their invasion by defining their place. That way he kept the primary spaces, in the case of the Richards Building the actual laboratory function, free of disturbing elements. As such, his sense of defining an order can be regarded as a way to purify the architectural elements, to pursue their very essence. This approach also led to ordered integration of structural and mechanical systems, a design principle he applied in the design of the Salk Institute in La Jolla.[15] He described the interstitial mechanical spaces of the structure with this self-referential metaphor:

One serves the body and one is the body itself.[16]

Even though Kahn talked about the serving element being the very element, each of them were still perceived as single entities. They were just related or joined within a system of order. That could be an order of autonomous elements or composite order. The latter ordering principle he used for the Indian Institute of Management in Ahmedabad. He based the relation between the concrete structures and the brick constructions on a composite order:

A beam needs a column; a column needs a beam. There is no such thing as a beam on a wall. And if you make the decision which I made, saying that the beam of brick is an arch, therefore, since I did not want to use any concrete beams, and since I was not going to use any columns, it became so natural to use an arch, because it was only part of the wall construction which is characteristic of brick …[I] invented many things about arches, like big arches which stretch as much as twenty feet, let us say, with a very low thing using restraining members in concrete to take the thrust away…I made a composite order in which the concrete and the brick work together. This is a composite order. A sort of sense of the structure, a sense of the order of brick, sense of the order of structure which made this possible.

The design goes on and on…because you recognize that structure has an order; that the material has an order; that the construction has an order, the space has an order in the way of the servant spaces and the spaces served; that the light has an order because it has an order in the sense that it is given by structure, and that



100
Richards Medical Research Building, 1957-61.
Typical floor plan (above) and first-floor plan (below).
1. Studio towers
2. elevators and stairways
3. animal quarters
4. animal service room
5. fresh air intake stacks
6. air distribution shafts
7. fume and exhaust stacks
8. biology building towers.
Louis I. Khan.

101
Richards Medical Research Building.
The entrance and the plateau.

the consciousness of the orders felt.[17]

As such, Kahn's notion of served and servant elements can be read as an ordering principle, not only pertaining to architectural space, but architectural problems at any scale.

Richards Medical Research Building

Richards Medical Research Building is located along a narrow campus walk, partly framed by large grown trees of the Botanical Garden right behind the building complex. Red-brown brick towers rises straight from the ground with out any foundation, which let the building rest firmly on the site.

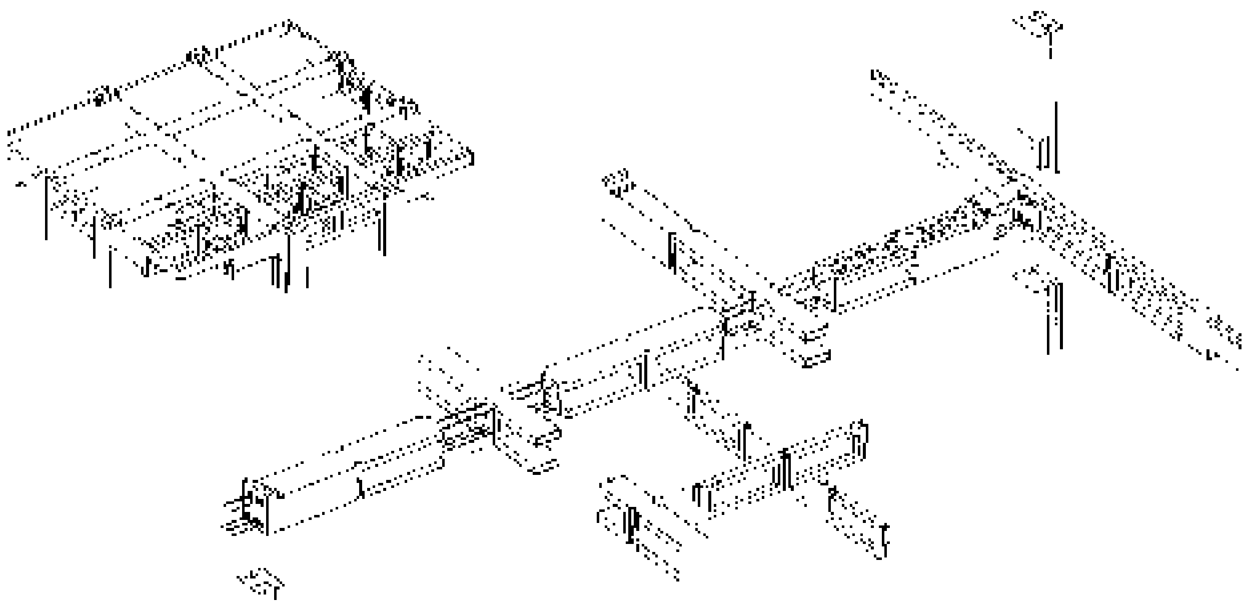
In order to enter the building complex, one has to ascend diagonally up steps onto an open plateau under the main laboratory tower. The entrance is towards the back of the portico, concealed in the darkness of the cantilivered deck. This sense of concealment and the monumentality of the structures leaves one with a sacred feeling, yet the human scale is present in proportions and detailing.

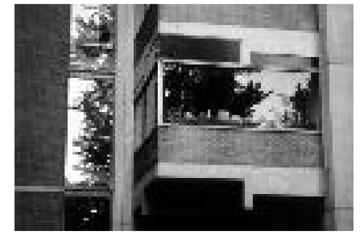
Due to the restricted size of the site, the building complex had to take a vertical form. However, Kahn's particular reading of the program added another conceptual dimension to the sense of verticality of the laboratory towers. Kahn made two observations that determined the final form of the building. First, that scientists work alone or in small groups, but may need mental and physical contact with other groups. Second, that dangerous working operations necessitate that the service facilities are separated from the work spaces and that infected fumes must be immediately removed.[18] He described the design like this:

I designed three studio towers for the University where a man may work in his bailiwick and each studio has its own escape stairway sub tower and exhaust sub tower for isotope air, germ infected air and noxious gas.[19]

The differentiated spaces of the studio towers - the served and servant concept - Kahn also used for the overall layout of the building complex. Richards Medical Research Building consists of three towers with vertically stacked 'studio' laboratories, placed adjacent to a fourth enclosed service tower. (Each tower: 45 square ft.; the total building complex: 75.000 square ft.). The service tower contains common utilities such as access halls, stairs, elevators, vents for airconditioning, and animal rooms, connecting at each level with the studio and office towers. Kahn described the design like this:

This design, an outcome of the consideration of the unique use of its spaces and how they are served, characterizes what it is for.[20]





102
Isometric drawings, showing assembly of precast concrete members of the floor system. Louis I. Khan.

103
Richards Medical Research Building.
Detail of the Facade.

In that sense, the final design of the building complex, its organization, and constituent parts reflect the essence of its function, each part referring to the whole and the basic architectural idea. Thus, Kahn's analogy to the human organism also seems appropiate. Referring to the service tower, he said:

This central building has nostrils for intake of fresh air away from exhaust sub towers if vitiated air. [21]

In light of his notion of order, one may conclude that his anthropomorphic interpretation may allude to a body made of interrelated, but autonomous parts.

Due to the limited budget of the building project, Kahn wanted the structure to be rational and economical. Therefore, he conceived the structural system as a precast-pre-stressed concrete construction from the very beginning. However, the central service tower was not suitable for prefabrication and had to be designed as an in-situ concrete construction.[22]

The laboratory towers are supported by eight columns of precast concrete, placed at the third points of each facade. The brick-veneered towers containing exhaust stacks and exit stairways are placed between the columns, but independantly.[23]

An elegant feature of the structural system is the Vierendeel trusses used for the cantilivered spans of the studio towers. This way, loads could be concentrated near the center and the facades and windows could be designed in any desirable way. The spatial frame of the trusses would form the framework of the horizontal service ducts. The building skin consists of only three materials: brick, glass, and the visible concrete structure. Brick spandrels are carried on concrete beams and the blue-tinted glass is set above, flush with the outside plane of the structure.

Kahn generated his design from the program and use of the building, but he also wanted to change the conception of laboratory functions through the architecture. Even though laboratory buildings had been divided into modular, adaptable work spaces and services spaces for decades when Kahn conceived the Richards building, he criticized that they did not make this distinction clear enough. He meant this lack of clarity affected the work of the scientists and jeopardized the separation of polluted and clean air:

The normal plan for laboratories which places the work areas off one side of a public corridor and the other side provided with stairs, elevators, animal quarters, ducts and other services. This corridor is the vehicle of the exhaust of dangerous air and also the supply of the air you breathe, all next to each other. The only distinction between one man's spaces of work from the other is the difference of the numbers on the doors.[24]

The laboratory spaces are conceived as architectural studios, without any partitions. Each floor of the laboratory towers was planned as one large room in which the researchers were to define his own space according to personal needs. Kahn envisioned the working situation like this:

I thought what they should have was a corner for thought, in a word, a studio instead of slices of space. A studio wants to be a place free for every man to decide for himself. There should be no circulation through it. It should be more like a table on which you work.[25]

However, this idealized environment has been criticized by the researchers working in the laboratory. From the very beinning, they claimed the need for individual work spaces and have gradually put up partitions and room dividing furnitures such as bookshelfs and racks. Furthermore, they have criticized the window arrangement, claiming that glare disturbs their working process, and despite the open-plan, equipment installation and different arrangements also have been difficult - not flexible as intended.[26]

In light of this critique, Kahn's design strategy, pursuing the essence and order of things, almost seems to have carried him away. Reading the program on his own terms made the Richards Building tend towards rigid formalism. Nevertheless, by sticking to his design priciples so consistently and proving that mechanical systems, pipes and duct are equally significant as other architectural elements, he created an architectural monument.

104
Richards Medical Research Building.
Looking up at the ducts and studio towers.
Louis I. Khan.

[1] Kahn, Louis I., "Louis I. Khan, Philadelphia – Pennsylvania/USA – Talk at the conclusion of the Otterloo Congress", CIAM '59 in Otterloo, ed. Newman, Oscar, Karl Krämer Verlag, Stuttgart, 1961, p. 211

[2] Anne Tyng first worked with Kahn in 1945 in the office Stonorov and Kahn, later in Kahn's own practice. She clearly had a major influence on Kahn's development, introducing him to D'Arcy Thompson's On Growth and Form.
Frampton, Kenneth, Studies in Tectonic Culture: The Poetics of Construction in the Nineteenth and Twentieth Century Architecture, MIT Press, Cambridge Massachusetts, 1995, p. 216

[3] Brownlee, David B. and David G. De Long, Louis I. Kahn, In the Realm of Architecture, Rizzoli, New York, NY, 1991, p. 63

[4] Interview with Anne Tyng. Latour, Alessandra, Louis I. Kahn: Writings Lectures, Interviews, Rizzoli, New York, NY, 1991, p. 52

[5] Brownlee and De Long, Louis I. Kahn, In the Realm of Architecture, pp. 55-56

[6] Ibid., pp. 52-53

[7] Ricolais conducted research and taught at University of Pennsylvania, and knew Kahn as a colleague.

[8] Zucker, Paul, New Architecture and City Planning, Philosophical Library, Inc., New York, NY, 1944, p. 580

[9] Frampton, Kenneth, Studies in Tectonic Culture, p. 209

[10] Brownlee, David B. and David G. De Long, Louis I. Kahn, In the Realm of Architecture, p. 71

[11] Ibid., p. 107

[12] Kahn, Louis I., "Form and Design", Architectural Design, April/4 1961, p. 148

[13] Brownlee, David B. and David G. De Long, Louis I. Kahn, In the Realm of Architecture, p. 56

[14] Kahn, Louis I., "Not for the Faint-hearted", AIA Journal, June, 1971, p.31

[15] Together with Arthur Komendant, Kahn developped the initial structural system of folded plates for the Salk Institute. "Giant folded plates were arranged in pairs that created interlocking hollows; pipes and ducts were to be housed in the longitude 'folds' of the ceiling structure and then fed transversely through the five girders into vertical service towers placed along the outer wall of each lab."
Brownlee, David B. and David G. De Long, Louis I. Kahn, In the Realm of Architecture, p. 332

[16] Kahn, in a conversation with Peter Blake, July 20, 1971, What will be has always been: The Words of Louis I. Kahn, ed. Richard S. Wurman, Rizzoli, New York, 1986, p. 130

[17] Kahn, Louis I., "Silence and Light - Louis I. Kahn at ETH", Ronner, Heinz, Sharad Jhaveri, Louis I. Kahn: Complete work 1935 -74, second ed., Birkhaüser Verlag, Basel, 1987/1994, p. 9

[18] Drexler, Arthur, Ed., "Louis I. Kahn, Architect: Richards Medical Research Building", Museum of Modern Art Bulletin, Vol. 28, no. 1, New York, NY, 1961, p. 4

[19] Kahn, Louis I., "Form and Design", Architectural Design, p. 151

[20] Ibid.

[21] Ibid.

[22] Komendant, Arthur, 18 years with architect Louis I. Kahn, Aloray, Englewood, N.J., pp. 8-17

[23] Drexler, Arthur, Ed.,"Louis I. Kahn, Architect: Richards Medical Research Building", Museum of Modern Art Bulletin, p. 4

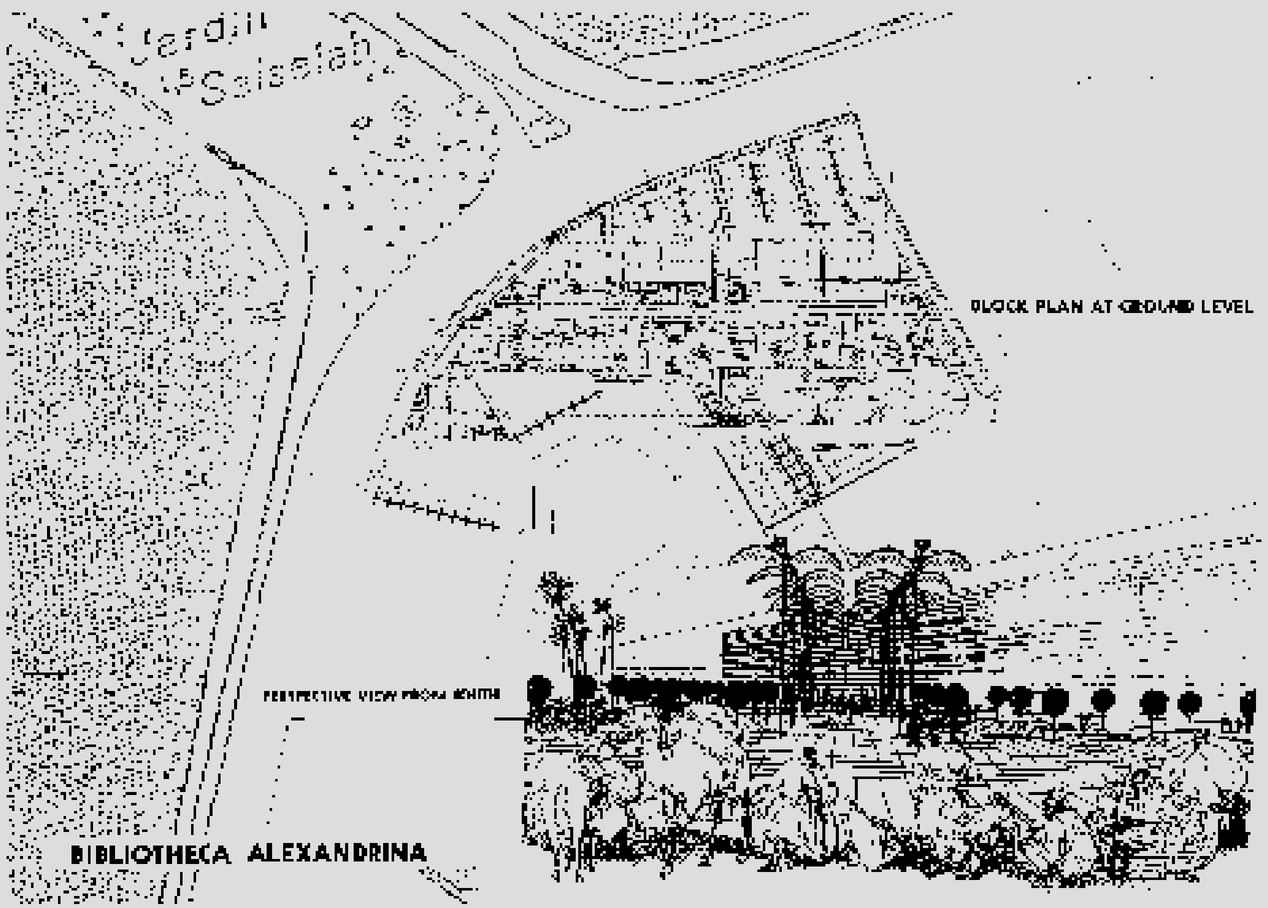
[24] Kahn, Louis I., "Form and Design", Architectural Design, p. 151

[25] Ronner, Heinz and Sharad Jhaveri, Louis I. Kahn: Complete work 1935 -74, p. 108

[26] Komendant, 18 years with Architect Louis I. Kahn, pp. 19-20

Sensing the Environment

The Alexandria Library
Competition scheme: (1989-90)
Architects: Alison & Peter Smithson



105
Alexandria Library, 1989.
Ground plan with perspective from the south.
Alison & Peter Smithson.

... Ambient light, ambient air, no fuss about detail - awareness in a quiet way of the sweet functioning: that is architecture; and in a large building, its achievement involves us now with the organizing of the mechanisms and services with a clear formal objective in mind...In a real building the light and the space and the air are one...sniff the air...sense the space...know how to act. How to keep this sense of what is going on…where the light and heat and air are coming from...how to get in and out...and where the lifts are...these are the questions...[1]

Alison and Peter Smithson

The sensitive attitude of Alison and Peter Smithson refers to a different realm of environmental technology and mechanical systems than the common instrumental perception of today. It hints at a silent realm of architecture that seems to require a particular awareness and attention.

An interesting aspect of their approach is the linking between the physical sense of the building and the senses of the human body. Given this premise, the human body as physical organism and figure becomes an essential parameter for the design of the building as well as its use.

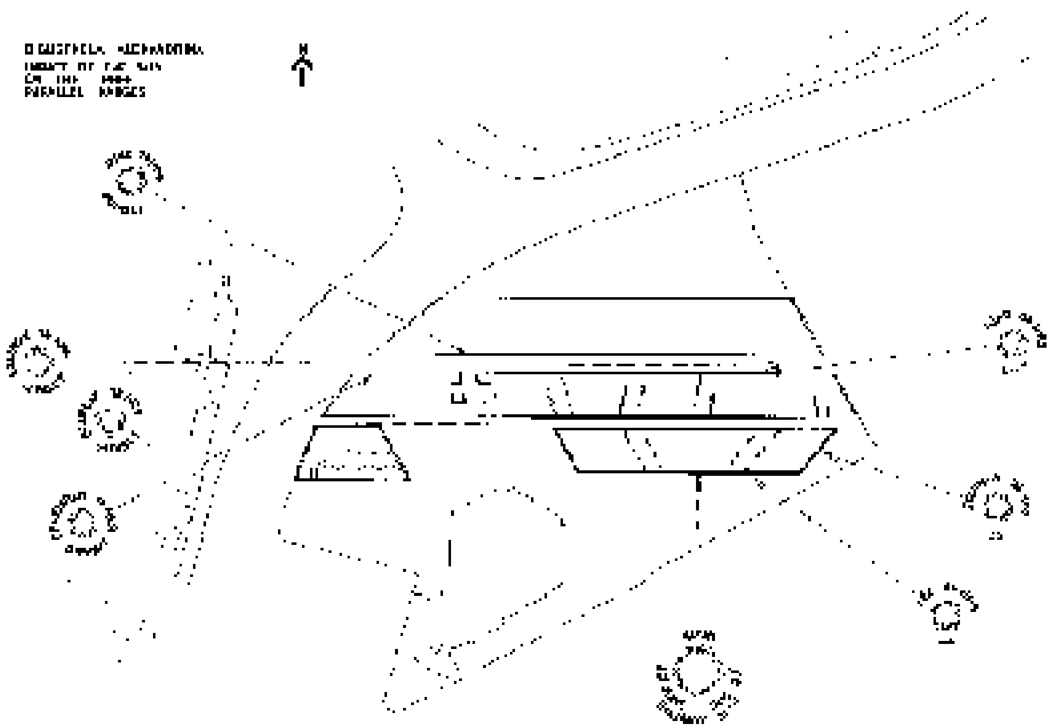
This idea is an on-going theme in Alison and Peter Smithsons work - in their writings as well as buildings, and for this reason it is interesting to study their competition brief for a new library in Alexandria. This proposal characterizes the epitome of their profound investigations.[2]

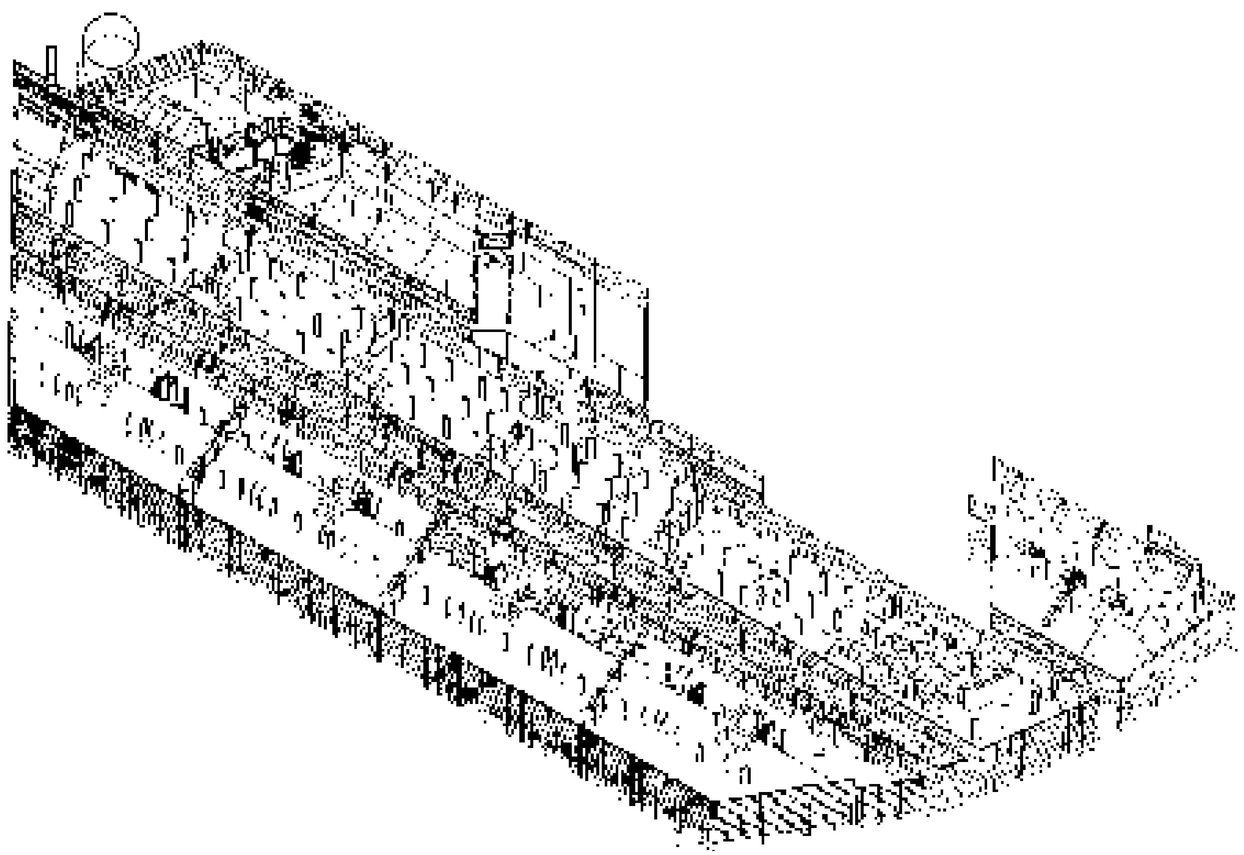
In the fall of 1988, UNESCO, UNDP, and the government of Egypt launched an international competition for a new library in Alexandria, in memory of the city's once great library. The program demanded a library with a floor space of 50.000 m^2 and in order to get by the zoning regulations the building had to be relatively low.

It was to be located next to the University at the Corniche of Alexandria - on a site close to the wetlands of the Nile Delta and the shore of the Mediterranean.[3]

Building Organization

The plan of the library shows three, long, parallel building volumes whose axes run east to west. The most northerly of these volumes, the 'B' range, which contains the principal libraries overlooks the sea. The middle range is developed locally without any hierarchy of spaces and with patches of libraries in-between enclosed spaces for services and administration. The southern range, also called the Port Said range, contains the Ptolemy library with historical material. Internal streets form interstitial spaces between the building volumes, providing shaded public streets similar to the mutually protecting walls of Souks in the Middle East. The internal streets divide the library into strips of territory, which relate to





106
Alexandria Library, 1989.
Impact of the sun on the three parallel ranges.
Alison & Peter Smithson.

107
Alexandria Library, 1989.
Composit axonometric, shaded version, 1989-90.
Alison & Peter Smithson.

particular collections of literary material from different periods of history.[4]

The notion of strips also responds to the severe climatic conditions and reflect the idea of a passive environmental shield. As protection from critical sun angles and on-shore winds, they work like means of shelter belts similar to the shelter belts for strip farming in the flood plains of the Nile.[5] But also the stair towers and wind collection ducts that characterize the strip of the Corniche range provide passive air circulation to all parts of the library.

To access the building, the visitor has to move across its various layers, and to use the library one has to move via the interstitial streets along the building strips, or has to circulate vertically through the stair towers. The building layout relates to sun angles and renders the course of the day, and the Smithsons envisioned this detail as follows:

Because of the configuration of the shore-line, these internal streets at this location on the Corniche of Alexandria acquire a magical characteristics in that the sun setting in the sea at the equinox will run for a few minutes horizontally along their length: this very romantic western notion is raised on the Islamic foundation of filtered light from within' that the shaded public street gives to the accommodation it serves.[6]

Notions of light, time, and movement intertwine in the architectural design of the Library and form a physical dialogue between the users/visitors and the building.

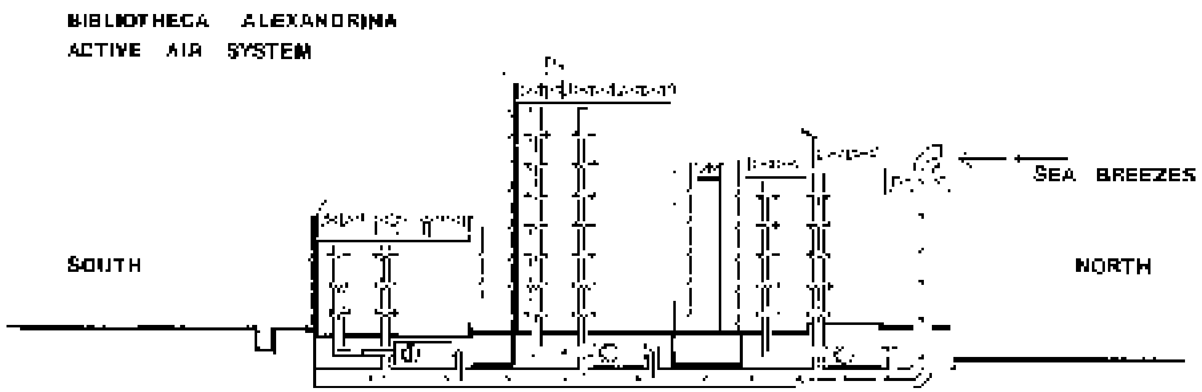
Structural Integration

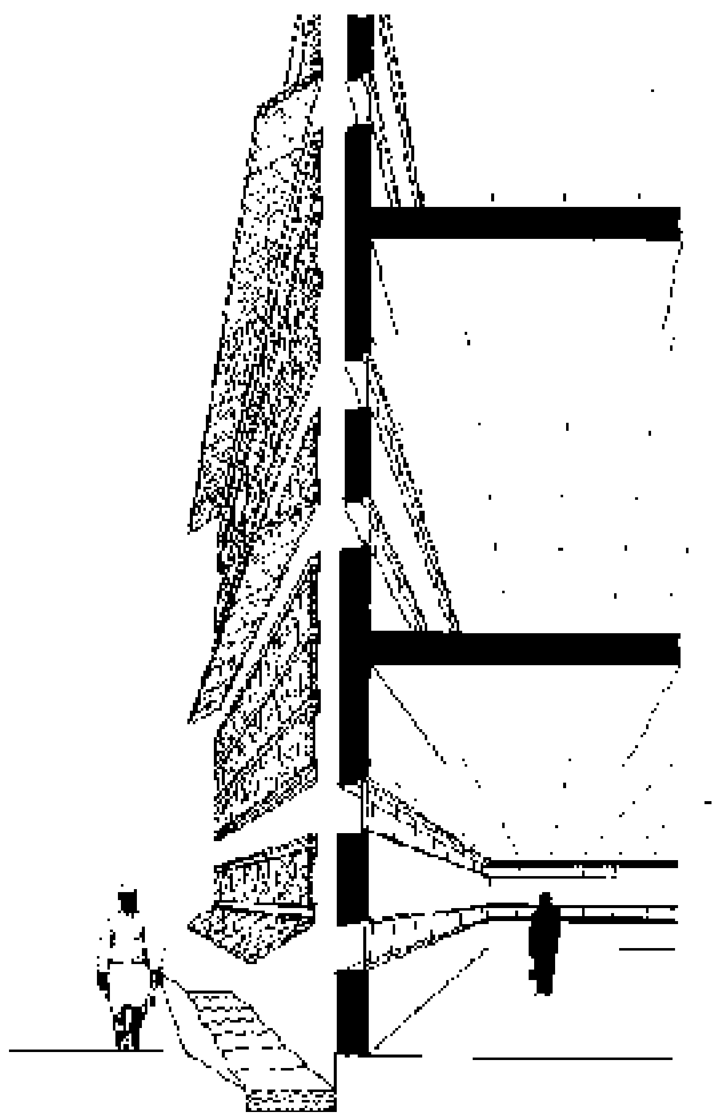
According to Peter Smithson, the qualities of natural light inside the library, together with the idea of self shading, minimum energy use and most importantly, the building's ability to operate during power-cuts, were the major concerns that generated the design of the building. The complexity of these problems is dealt with in the structural principles of the building, as well as in the constructions of the facades.

One of the central ideas concerning the load bearing structure was to suit it to the construction environment of Alexandria where it is normal for buildings to be relatively simple and maintenance free. Thus, the library was to be constructed with a load bearing structure developed to enable the use of relatively low stressed, generously proportioned reinforced concrete beams and columns.

Moreover, the structure was to be strengthened, whenever possible, by massive masonry load bearing walls.

The exterior of the building was to be clad with marble stone and glass. These ideas provided the basis for a construction system that would minimize the cost and permit concentration of scarce resources on finishes and installation systems.





108
Alexandria Library, 1989.
Diagram showing the active air system.
Peter Smithson.

109
Alexandria Library, 1990.
'Double perspective showing the air-gap between the inner supporting skin and the outer sun-reflecting skin.
Peter Smithson.

As for the question of ventilation, the interior spaces are supplied with both natural and mechanical air movements. The Smithsons describe the environmental engineering systems as a synthesis of two systems of thought:

The active systems of air movement rely upon wind towers collecting sea breezes on the North side and the air being drawn down to basement level where mechanical plant 'plugs' into the fresh air shafts and then delivers the treated air up the building in vertical shafts. At night the mechanical plant can be by-passed and vertical shafts will allow the air in them to rise naturally to zenith, cooling the inner structural masses.

In case of a total failure of power supplies this by-pass 'free-cooling' can be used together with the opening of high-level windows on the North and South elevation to encourage air movement across the building, removing the built up heat from occupants. The stack effect of the rising airshafts on the southern elevations will encourage the draw-through of air.[7]

Different ventilation systems are defined as integrated elements of a unified whole, and low-tech solutions make the Alexandria Library a sustainable organism, sensibly responding to the environmental setting.

The Skin

The most significant construction feature of the scheme is the integration of environmental issues in the design of the facades. Peter Smithson describes the facade construction in accordance with this concept:

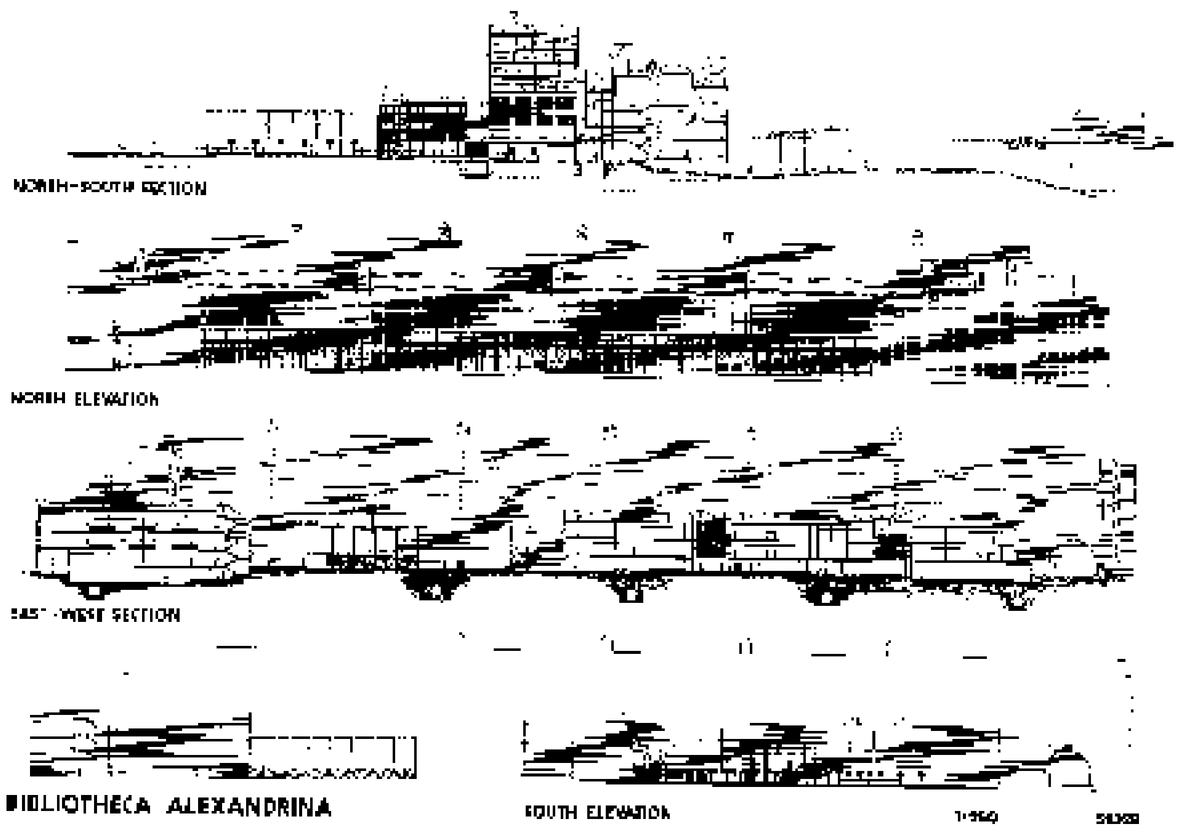
For the south elevations, which potentially are areas of the greatest solar gain, we have developed a twin skin system which totally shades the inner wall and encourages vertical air movement between the skins thereby 'cooling' the inner skin: an analogy can drawn to blowing across the palms of ones hands.

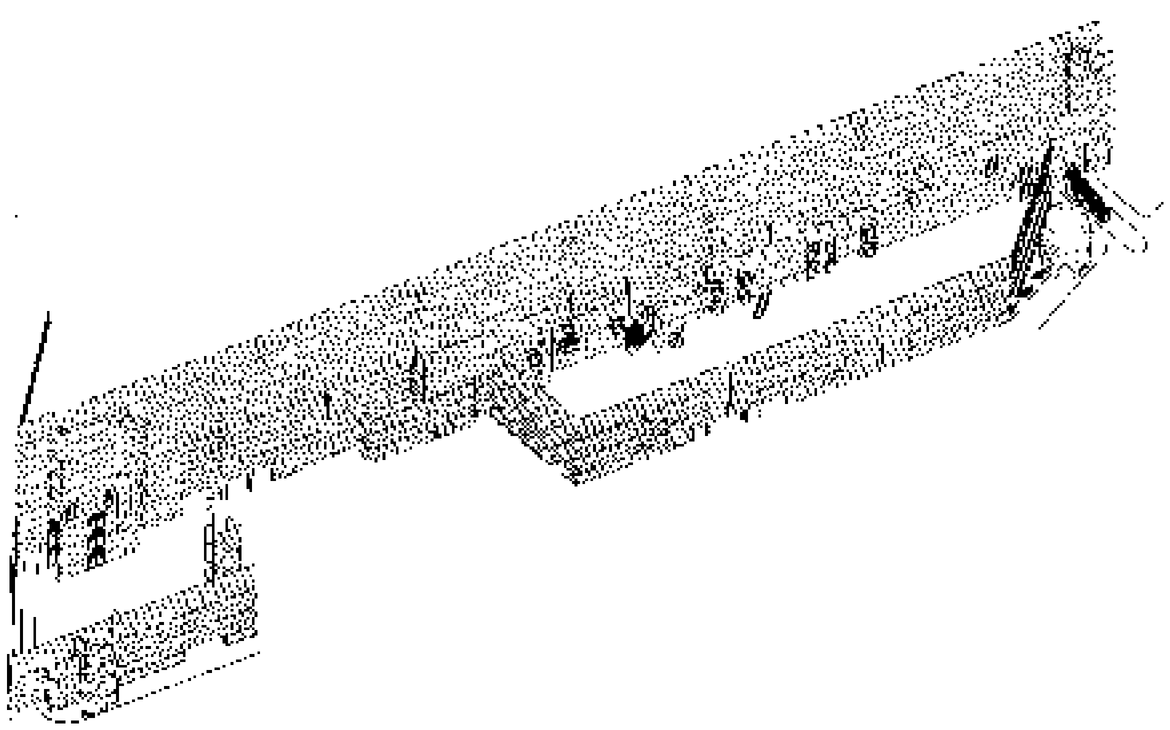
The roof is similarly shaded to encourage air movement and will be of the right colour to maximize short wave radiation to the night sky.

Theoretically the thermal gains into the interior spaces during the day will be minimal and at night the rising cool air will 'draw' the heat from the inner skin.

During the time of the year when heat is needed, the top of the void between the inner and the outer skin can be closed to trap the solar gain reducing the heat loss of the building.[8]

Peter Smithson perceives the building envelope as a "breathing skin" that works as a self-sufficient physical entity. However, the building envelope still reflects the tectonic vision of the overall building complex - that consists of layered constructions combined with layers of meaning.





110
Alexandria Library, 1989.
Cross and long sections.
South and north elevations.

111
Alexandria Library, 1989.
Diagram of connection north range to inner range.
Peter Smithson.

Peter Salter, a former staff member of the Smithsons's office, who worked on the project, unfolds this condition of how the plan of the building complex is reflected by the construction and detailing of the facades in an almost Albertian manner:[9]

The strategy of strips, the layering of the building as a series of shelter belts providing shadow of varying widths and heights, is also reflected in the detail skins of protection. … Each facade uses a common detail of secondary structure, but changes its cladding material and formation depending on its aspect to the sun. The north-facing facade of the internal street system overshadowed and sheltered by the Middle range 'C' libraries, is clad with glass, whereas the south-facing facade is clad with white marble. The facade of the Corniche range facing the sea has alternate stripes of green and white marble. These cladding materials anticipate different levels of translucency and different qualities of shadow in the building, and consequently provide a particular light by which to read.[10]

Conceiving the outer skin of the building as a layered construction makes it easily adaptable to the various climatic conditions provided by different orientation of the facades. It works as a flexible structural frame for different cladding materials, yet a certain degree of homogeneity is attained by the formality of the system.

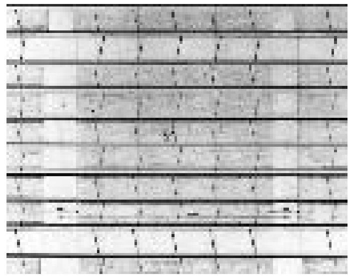
Like the skin of the human organism, the skin of the library registers the climate. Its very construction design adjusts and balances the thermal environment of the exterior to the interior. To consider the building skin as a climate register in architectural design offers a different point of departure instead of the dominating course where spaces are perceived primarily through vision.[11]

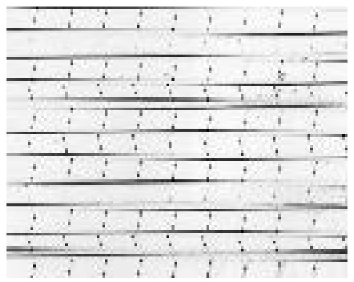
Second to the eye, the skin is the most predominant sensory organ and the method to measure its sensitivity is by pressure of touch. However, most people probably do not recognize pressure as the most significant sensory experience of the skin.[12]

The skin also registers temperature, humidity, atmospheric pressure, and most often, it responds to several of these environmental issues at once. The skin represents an intelligent envelope, responding to sun-exposure and wind by tanning and weathering. It slowly changes throughout life, and if damaged or cut, it heals itself, storing time and events in its wrinkles and marks.

Analogous to the skin of the human body, the 'skin' of the Alexandria Library serves and protects its 'flesh and bone' and, last but not least, shows particular care for the comfort and experience of the users of the building.

The different facades correspond to the varied use of the interior spaces during the day. To permit views for the readers in the libraries facing south and





give a sense of the day for those deep in the building, slabs of the marble skin are lifted up to form shades like an eyelid, or simply omitted near ceiling level. On the libraries facing the north, glass is substituted for the marble in order to give a full view of the sea and sky.

Moreover, these two types of horizontal slit windows are designed in accordance with different light condition of the year. Through the high level slit windows, narrow beams of low winter sunlight will enter. The lower slit windows are at right angles to the sun's direction at noon; at the equinox, these windows are at reader's eye-level providing light for the desk.[13]

The skin of the library is comparable to the tents of the North African nomads, working as an ideal protection against the severe sun and high temperatures. The texture and color of the traditional tent canvas protects by shading and cooling. The fabric allows enough light to penetrate in order to see and its particular texture intensifies air circulation and supports natural ventilation.

It is quite difficult to translate and integrate similar physical properties of North African tent structures, as well as the human skin, into contemporary building envelopes of large building structures like the Alexandria Library. Therefore, the Smithsons's architectural answer to such complicated problems is remarkable, not only for its highly developed climate control, but in particular for the simplicity and straight-forwardness of the design.

According to Peter Salter, the design strategy of the Smithsons for the Alexandria Library Competition anticipates a responsive architecture. Through invention and the development of a sensibility towards materials and construction, it carries resonnances of the process of its making in relation to the demands of site.[14]

As such, the proposal for the Alexandria Library Competition adds yet another layer of meaning to the art of designing environmental control systems.

[1] Smithson, Alison & Peter, <u>Without Rhetoric: An Architectural Aesthetic 1955 -1972</u>, Latimer New Dimensions Limited, London, 1973, p. 48

[2] To mention a few building projects which include different versions of these aspects in their design: Climate Houses, Paisley and Hampstead, 1957-60, The Economist 1959-64, The Kuwait Mat-Building, 1969-70.

[3] The Norwegian firm, Snøhetta, won the first prize. They designed a large circular building volume, partly slanted and dug into the ground. It is presently under completion. Smithson's scheme was neither honored nor mentioned.

[4] Salter, Peter, <u>Climate Register: Four Works of Alison and Peter Smithson</u>, Architectural Association, London, 1994, p. 30

[5] Ibid.

[6] Notes from visiting Peter Smithson in London, May 1998. Text material from The Alexandria Library Competition Scheme 1989

[7] Ibid.

[8] Ibid.

[9] Alberti, Leon Battista, <u>On the Art of Building in Ten Books</u>, translated by Joseph Rykwert, Neil Leach and Robert Tavernor, MIT Press, Cambridge Massachusetts, 1988/92, p. 421. Alberti defines the notion of compartition as: "[…] the process of dividing the site into yet smaller units, so that the building may be considered as being made up of close-fitting smaller buildings, joined together like members of the whole body".

[10] Salter, Peter, <u>Climate Register: Four Works of Alison and Peter Smithson</u>, p. 30

[11] Peter Salter has borrowed the term from the short text, Climate Register by Alison and Peter Smithson (1986), for the exhibition catalogue concerning four works by the Smithsons. Salter defines the term as: "Climate register allows the putting together of seemingly disparate fragments of observation and ideas. It accommodates the uneasy relationship between the unequivocal physical and technical demands of site and programme and the 'first-thought', the intuitive reading of context".
Salter, Peter, <u>Climate Register: Four Works of Alison and Peter Smithson</u>, pp. 8-9

[12] The skin informs the brain by 1 mill. bits per second. (The eye: 10 mill. bits per sec., the ear: 100.000 bits per sec). These numbers are calculated by; counting receptors of the sensory organs, the number of light cells in the eye, spots sensitive to pressure on the skin, gustatory nerves etc. Nørretranders, Tor, <u>Mærk Verden: En beretning om bevidsthed</u>, Gyldendal, Copenhagen, 1991, p. 164

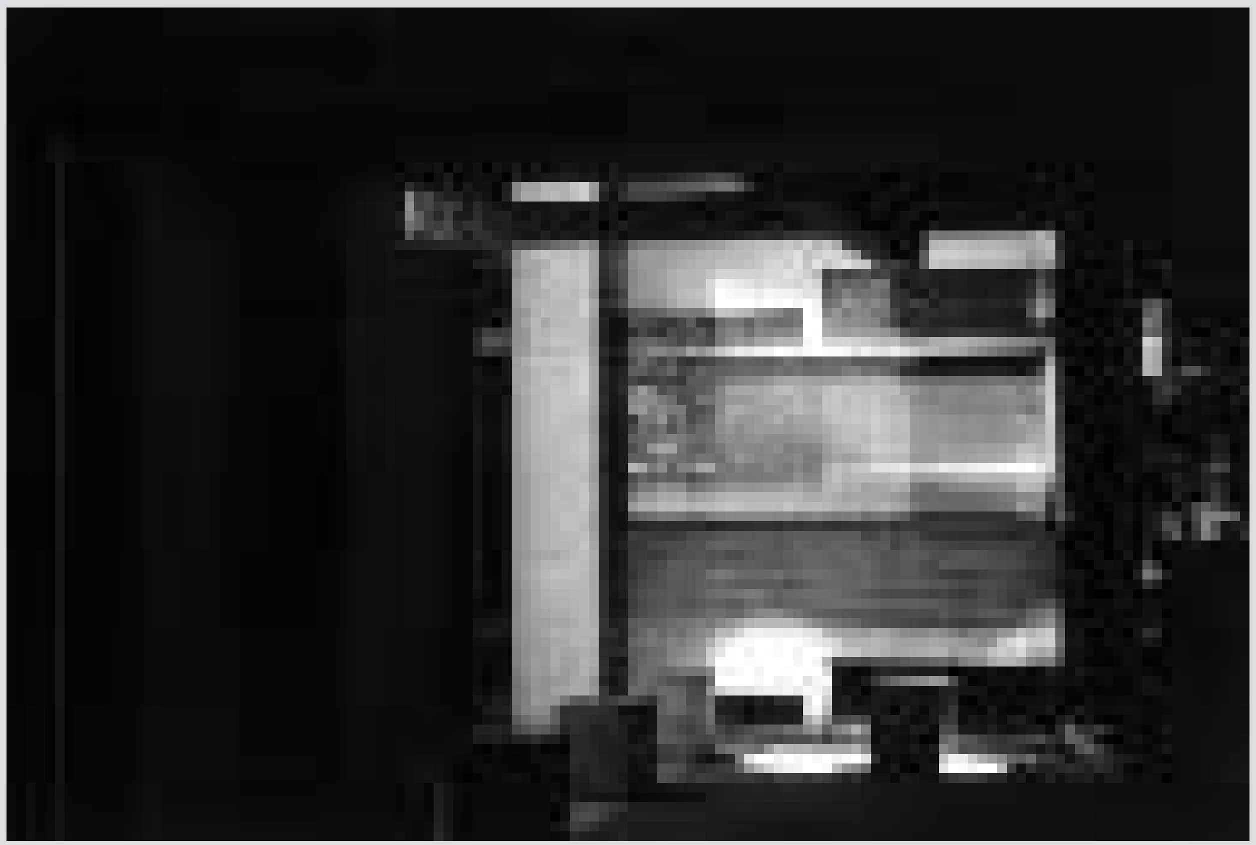
[13] Notes from visiting Peter Smithson in London, May, 1998

[14] Salter, Peter, <u>Climate Register: Four Works of Alison and Peter Smithson</u>, p. 11

112
Alexandria Library, 1989.
Study for the north elevation.
Peter Smithson.

113
Alexandria Library, 1989.
Study of south elevation.
Peter Smithson.

Conclusion



114
Richards Medical Research Building. Looking through the entrance space.
Louis I. Khan.

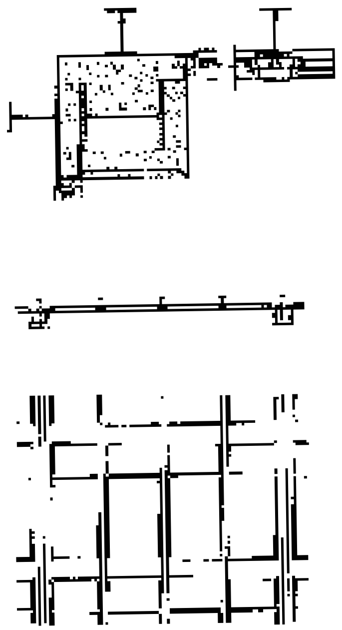
A young architect came to ask a question: I dream of spaces full of wonder. Spaces that rise and envelop flowingly without end, of a jointless material white and gold. When I place the first line on the paper to capture the dream, the dream becomes less.' […] This is a good question of the unmeasurable and the measurable. Nature, physical nature, is measurable. Feeling and dream has no measure, has no language, and everyone's dream is singular.
Everything that is made however obeys the laws of nature. The man is always greater than his works because he can never fully express his aspirations. For to express oneself in music or architecture is by the measurable means of composition or design. The first line on paper is already a measure of what cannot be expressed fully. The first line on paper is less.[1]

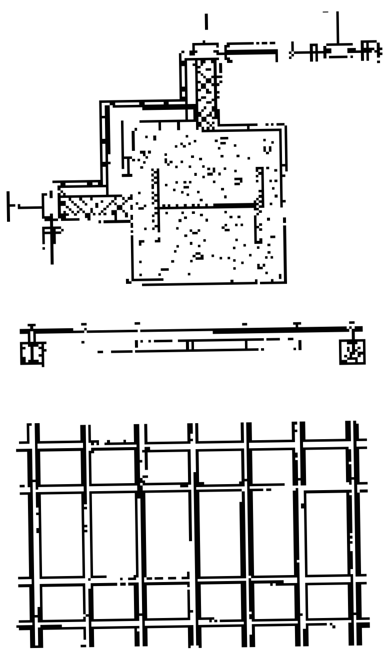
Louis I. Kahn

Louis Kahn's Parable depicts the dilemma in all architectural design processes. As soon as you touch the paper, the initial vision assumes a form that seems less than the potentials of the utopian dream world. However, this dialogue between visionary intention and the extension of reality provides the basis for the making of architecture. In this context, the architectural design process can be regarded as a way to identify the immeasurable, or as a method to pursue something that is even greater than the ethereal dream, in order to supply architecture with a poetic dimension.

Tectonic visions in architecture depend on these processes and the architect's subjective reading of present construction technology, as well as on ideal visions. This way, the individual definition of the architectural ideal or utopia seems to form part of the theoretical basis for the design process. To illustrate this assumption, one could draw a parallel between Mies van der Rohe's understanding of the steel structure of 860-880 Lake Shore Drive and Benjamin's reading of utopia. Mies saw the steel structure as something that was 'rooted in the past, dominating the present and tending into the future'. It represented a formal 'unfolding of its time', similar to Benjamin's utopia, which is also linked to the presence of immediate reality and historical movements. This attitude is different from the design process followed by Utzon and the utopia described by Vesely. In the Espansiva project, Utzon isolates the architectural problems as pure abstract questions, e.g. the additive system of special designed units, similar to Vesely's description of the methods of modern science, where nature is transformed into idealized models.

As such, each of the selected case studies must be perceived as products of various circumstances of their time, as well as an individual will to form, which explains why some of the architects seem to have fulfilled their architectural intentions, whereas others appear to have failed. This sort of paradoxical cir-





cumstance is analyzed by Robert Maxwell in his essay The Dialectics of Positions, in which he states that even though utopia is regarded as a means to criticize the status quo, it may hold aspects that both are innovative and others that are reactionary.[2]

However, the objective of this study is not to decide which architects were right or wrong, or if they succeeded as technological innovators or architectural geniuses, but rather to show how different approaches to visions in architecture also affect the conceptual basis for the understanding of technology and vice versa. This way, the different case studies are perceived as parallel readings of their immediate reality, each of them providing critical answers to how one defines questions of construction within the reality of modern industrialized building practices.

In order to explain this further, the tectonic visions of the various case studies are briefly reexamined according to the thematic structure. Where the first chapter, Process and Technology, questioned how architects approach new materials and implementation of industrial construction methods, exemplified by works of Mies van der Rohe and Le Corbusier, the second chapter, Component and Composition, was an inquiry into component design and rational standards of prefabrication, illustrated by designs of Charles and Ray Eames, and Jørn Utzon. Finally, the third chapter, Separation and Integration examined various building morphologies defined as different physical entities, through the work of Louis I. Kahn, and Alison and Peter Smithson.

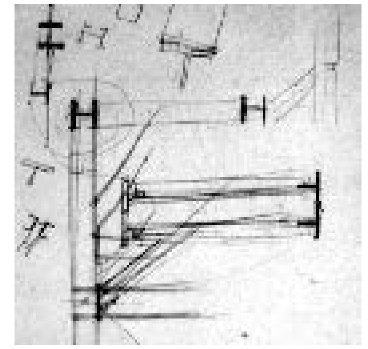
Architecture and Industrialized Construction - Process and Technology

The tectonic vision of Mies van der Rohe described in the case 860-880 Lake Shore Drive, concerns how he signifies industrial steel construction and the rational product, the I-beam. By exposing a distilled image of the steel structure in the facades of the towers, Mies supplies the steel structure with new meaning, elevating it from a rational construction system to a system of thought.

He translates the steel structure into a new conceptual form through his architectural universe. That is, by studying the nature of its material qualities, refining it as a detail of construction, and using it as a method to 'frame' the architectural space of the towers, he interprets the essential questions of architecture and industrialization as two separate, but parallel movements.

In Mies's terms, industrialized processes and products are regarded as facts of his time and therefore as means to question the essence of things, in order to find the true architectural expression. He summarized these ideas this way:

Architectural development depends upon how seriously these questions are stated and how clearly they are answered. Therefore, we hope that these questions will



115 - 116
860-880 Lake Shore Drive and Seagram Building, New York, 1958: curtain wall details.
Mies van der Rohe.

117
860-880 Lake Shore Drive, 1951. Sketches for the detailing of the I-beam.
Mies van der Rohe.

probe deeper and deeper and will be directed more towards the essence of things. We must get at the kernel of truth. Questions concerning the essence of things are the only significant questions; the answers a generation finds to these questions will be its contribution to architectural development![3]

Mies's contribution to the architectural development of skyscraper constructions is probably one of the most significant ideas changing the aesthetics of tower building in the U.S.A. The expressive articulation of the steel structure as part of the building envelope was elaborated, not only in his own succeeding tower designs, but also refined by architects like Skidmore, Owings & Merrill.

Le Corbusier follows a different path, interpreting reinforced concrete as the materialization of L'Esprit Nouveau, the new spirit. He defines the Dom·ino system as a means to provide housing for the masses and as a way to create a new architectural idiom. By conceiving the Dom·ino system as an 'object-type', he reduced the pillotis and the suspended slabs into figurative representations of purified structural elements. This way, construction is converted into abstract artistic means, and the architectural problem is approached as though it is a canvas and the architect, an artist, who composes abstract architecture by means of collage and montage.[4]

This attitude also reflects his conception of the building site as the actual place of manufacturing construction elements, where the flowing concrete can be molded into any form desired, determined by the architect. He seems to believe that architecture as an idealized figurative art of his time finds its true expression through the pure and rational nature of industrialization.

Unique Design and the Problem of Standardization - Component and Composition

Alan Colquhoun has noted in his essay, Symbolic and Literal Aspects of Technology, that the dilemma of the modern movement and therefore also the established perception of modern construction (and which is still present today) is rooted in the question:

If buildings are to retain their quality of uniqueness as symbols, how can they also be the end products of an industrial system whose purpose is to find general solutions? [5]

Colquhoun's question perfectly illustrates the core of the problems which both the Eameses and Utzon meet in their quest for ideal components for system building. The Eameses wished to test the architectural possibilities of using mass-produced

118
Eames House.
View into the living room.
Charles & Ray Eames,

119
Espansiva, 1970.
Foundation detail.
Jørn Utzon.

building components for house building. They believed, that they could find a method of approach by which they could convert simple catalogue products into individual architectural designs.

However, during the process of construction, they realized that most of the steel members had to be adapted in order to fulfill their particular architectural intention. Because of this, the Eames House turned out to be a unique architectural design with a tailored construction, with none of the economical advantages as initially presumed.

Utzon faces another problem in that he formulates his additive system too dogmatically. He seems totally carried away by the notion of designing the ideal building components that he does not see the pitfall of his rigid system. Also, the various construction elements seem to be too crude and out of scale, considering that they are going to be used for delicate constructions and detailing of single-family housing. Part of this problem may be due to the fact that Utzon came from the building project of the Sydney Opera, in which the use of large structural elements seemed very appropriate.

Furthermore, in his showcase, the Espansiva House, he includes all the various materials of the building system, which makes the exterior of the housing complex appear confusing and lacking of the simplicity his original idea was based on. This sort of overstatement also is reflected in his design of the load-bearing structure, which consists of heavy articulated laminated wooden frames that are doubled every time the units are joined. Through this, Utzon deceives the rational and economical nature of prefabricated system building, but creates a very clear statement concerning system building.

Colquhoun has described the inherent problem of combining rational system building with the symbolic nature of architecture in modern industrial construction very well:

It is true that a building which is an agglomeration of units can achieve great intensity and unity, but this can only be achieved if the design of each unit anticipates the complex as a whole. This will require modifications which are neither economical nor logical from the point of view of the simple operation of joining one unit to another in additive series. We have here a confusion between technology as a means to construction and technology as the content of the building form itself. Such systems render a building incapable of symbolizing plastically the Utopian Ideals, which undoubtedly inspire them.[6]

Corporeal Reading of Construction - Separation and Integration

As mentioned earlier, this theme is concerned with the question of how to perceive the body of a building: as a sum of its parts - an idealized machine, or consisting of interrelating parts - treated like a living organism.

Even though Kahn is not completely orthodox in his approach to the question of how to define the physical properties of a building, he represents an advocate of the first definition. In Richards Medical Research Building he provides a hierarchy of served and servant spaces (or architectural elements), which fulfills his principles of order. However, he seems so busy defining the different spatial elements of the building complex and the nature of the structure as autonomous entities that he overlooks fundamental environmental issues. This shows, for example, in the similar design pattern of the facades, which neglected the environmental comfort of the working places in the labs. Kahn's axiom of the nature of things, in this case the nature of a laboratory, seems too literally translated into built form. One might even claim that the laboratory of the Richards Building illustrates an theoretical interpretation, thought from the inside and out.

Even though the Alexandria Library of the Smithsons contains similar design principles as described in the Richards building, such as the distinguishing between served and servant spaces, it still shows another attitude to the question of environmental issues. The various architectural elements seem to be regarded as equally important; therefore, the ordering principle can be characterized as more democratic, respecting the environmental context, the site, and the building program. The overall complexity provided by the severe climate is incorporated into the design of the building from the very beginning. As such, the body of the building is conceived within the environmental context, but also created through imagination of the experience and sensation of the interior space.

120
Richards Medical Research Building.
Facades of the studio towers.
Louis I. Khan.

Construction and the Question of Ethics

This study of tectonic visions in architecture has aimed to identify the intentions that architects bring into the design process and the meaning they translate into physical form with their projects. The architectural projects selected for this study have pursued different thematic questions about construction and provided each their definition of how to approach these questions. Regarded as architectural answers responding to critical problems existing within the individual building programs or prevailing at the time, the building projects contain ethical dimensions that are important to recognize when studying the poetics of construction. As for the critical relationship between the question of ethics and architecture, the editors of VIA no.10 have said:

Ethics is the study of moral problems and judgements, which forms the bases for conduct in society. A consistent set of moral judgments enables us to determine a purpose, and thus to act intentionally. Ethics questions what is appropriate and more importantly, how we determine what is appropriate.

Ethical knowledge, the understanding of these values, is gained by practice and action in culture…. While architecture depends on technical and aesthetical knowledge in order to take form, facts alone cannot make it useful, and beauty alone cannot give it meaning. Because architecture aims to be understood and used by its society, it cannot be autonomous and still maintain its relevance. Architecture in this sense can never be value-free.[7]

Understood this way, the ethical dimension of architecture then relates to its physical representation and concerns the questions that shape the outcome of architectural processes. In other words, architectural ethics are identified through the dialogue between visions (ideality) and technology (reality). Therefore, architectural ethics also include the potentials of visionary intentions that seem to hold a poetic dimension. Regarded as such, the nature of ethics seem closely related to the essence of technology, identified as techné or ogos of making, the process of bringing forth art in accordance to a certain mode of 'language'.[8] Martin Heidegger has provided one of the most profound definitions of technology n the essay, The Origin of the Work of Art, which follows this line of thought:

… techné denotes…a mode of knowing. To know means to have seen, in the widest sense of seeing, which means to apprehend what is present as such.[9]

He continues this line of thought in the essay, The Question Concerning Technology, saying that technology is a way of revealing, since it belongs to techné, and he unfolds the meaning of the term like this:

We must observe two things…One is that techné is the name not only for the activities and skills of the craftsman but also for the arts of the mind and the fine arts. Techné belongs to bringing-forth, to poiésis; it is something poetic. The other thing that one should observe with regard to techné is even more important. From the earliest times until Plato the word techné is linked with the word epistémé. Both words are terms for knowing in the widest sense. They mean to be entirely at home in something, to understand and be an expert in it. Such knowing provides an opening up. As an opening up it is a revealing.[10]

Heidegger identifies technology primarily as a theoretical construct, however, in architecture the physical aspects, or the actual means of 'bringing forth', cannot be ignored. Therefore, the already mentioned definition of technology by Frascari supplements Heidegger's interpretation and brings it into an architectural realm. Identified as double-faced, as construing and construction, technology reflects both an abstract definition of the world as well as it constitutes the world. It is

121
Richards Medical Research Building. Entrance plateau. Louis I. Khan.

both a physical and poetic force that expresses the ideals and spirit of man in architecture.

Therefore, one might conclude that if architectural visions do not hold ethical dimensions and moreover result in poetic revealings - then the true potentials of technology have not been unfolded. Its essence has not been realized.

[1] Kahn, Louis I., "Form and Design", Architectural Design, No. 4, April 1961, p. 145
[2] Maxwell, Robert, "The Dialectics of Positions", The Two Way stretch: Modernism, Tradition and Innovation, Polemics, Academy Editions, London, 1996, p. 14
[3] Carter, Peter, "Mies van der Rohe", Architectural Design, March 1961, p. 95
[4] Hartoonian anticipates the fact that Corbusier's architectural system did not have any relation with Vitruvian architecture defined as the "art of building". Hartoonian, Gevork, "Poetics of Technology and the New Objectivity", JAE, Fall 1986, 40/1, 17-18
[5] Colquhoun, Alan, "Symbolic and literal aspects of technology", Architectural Design, November, 1962, p. 508
[6] Ibid., p. 509
[7] "Postscript", Ethics and Architecture, VIA, No. 10., 1990, p. 164
[8] The notion of logos is difficult to define, but it relates to language and thinking. logos, Gk.; a word, saying, speech, discourse, thought, proportion, ration, akin to légein G., to choose, gather, recount or tell over.
[9] Heidegger, Martin, "The Origin of the Work of Art", Basic Writings, Harper Collins, San Francisco, 1993, p. 184
[10] Ibid., "The Question Concerning Technology", p. 318-319

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