THE (ARCHI) TECTONIC IN TECHNOLOGY: ISSUES OF TECHNOLOGY IN FOUNDATION DESIGN STUDIO

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For these qualities which are expressive of a relation of form to force, the tectonic should be reserved... Thus structure, the intangible concept is realized through construction and given expression through tectonics.
Eduard Sekler, "Structure, Construction, Tectonics,"
in *Structure in Art and Science*

To integrate issues of technology into the beginning design studio, this studio methodology forefront's the development of tectonic relationships of commonly accepted building technologies. What is proposed is an understanding of technology that is conceptual, malleable and most significantly, a generative aspect of the design process. The mystery and seeming authority of figuring out "how something is really built" is confronted in the studio through the plethora of information available on standard building practices to forever demystifying this initially elusive yet purely mechanical knowledge of technology. What is revealed and demonstrated through the studio methodology is a conceptual thinking process which identifies structured relations of technology working to broaden and enhance formal, mechanical, and poetic possibilities. It is at this moment that technology, as a process of poetic skillful making, transcends overtly mechanical conditions and becomes an integral component of the student's evolving language of space, form and materiality. This design studio exercise and semester work introduces and supports a practical and poetic understanding of building technologies and materials so as to provide a strong platform from which the investigation, speculation and invention of contemporary architecture and future technologies may spring.

Soul is essential to architecture. Soul lies in attention to detail distilled in space and concretized in the love of construction. This love can take the form of shimmering icicle prisms or perspectives of steel.
Steven Holl

PREMISE

Architecture speaks through a language of space, form and perhaps most significantly, tangible materials which are brought together with purposeful intention. When describing the design process of architecture, no single point of view, simple statement or emerging theory can concisely or adequately be inclusive of the breadth and complexity of the architectural issues to be considered. However, we can be sure that the conception of architecture is inextricably linked to one's knowledge of the history of buildings, their "built form" and the physical act of building. Irrespective of the role of theoretical and "paper" architectural projects, buildings exist in our world as objective material fact and with this in mind, it is argued that the way a building comes into being, the way building form and material are physically assembled is a fundamental aspect of the discipline and practice of architecture.

Historically the architect's roles in the process of building has been multifaceted and shifting: architect as artist, architect as craftsman, architect as master builder, and the design / build architect, are the basis of an extensive, comprehensive job description for the architect. However, in twentieth century contemporary practice, Guiseppe Zambonini in his article "Notes on a Theory of Making" observes a total segregation of the process of design and the process of building which has occurred as an outgrowth of the standardized project delivery system most typical in the United States. Zambonini further expresses regret for the systematic limitation of professional liability where today's architect designs but is isolated from construction, and the contractor builds but is isolated from design. The architect's involvement in construction processes is a legal condition of architectural practice, a role supported in the American Institute of Architects description of contracted architectural services, and to be clear: the architect's role is to perform construction *observation* rather than a former role of construction supervisor.

Architecture and construction must be taught and practiced together: construction is the means; architecture the end result.
Viollet-le-Duc, *Dictionnaire raisonne*

The atelier system of the eighteenth century Ecole des Beaux Arts is the model for the central position of the design studio in professional programs of architecture in the United States today. Although this model has been modified by the German Bauhaus-ian paradigm, the design of form remains firmly as the central focus of an architect's education. In the current education process of undergraduate architects, courses in building technologies and materials have a decidedly practical aura with little or even at times no direct connection to the conceptual and artful practice of the design studio. The subject of building technology and materials does not hold a fundamental or central role in program curricula. In fact, most building technology and materials courses are not taught by studio instructors, but rather by a group of instructors who often hold the role of technology "consultants" to the design studio. Although the integration of support courses in building systems may occasionally find a role in design studio activities, generally, these concerns are relegated to the margins or seen as a secondary to the task of design. Most troubling and very common is the

relationship between issues of building technologies and materials to the schematic design work of the studio where queries are rooted in the practicality of structure and function: *how will I hold this up* or the artful scenographics of style: *what do I want it to look like.* Rarely in a studio design curriculum, are standard building construction systems, technologies and materiality introduced or presented as a systematic set of relationships which are intimately tied to fundamental basic architectural design issues of space, form, occupation, aesthetics and poetic experience.[1]

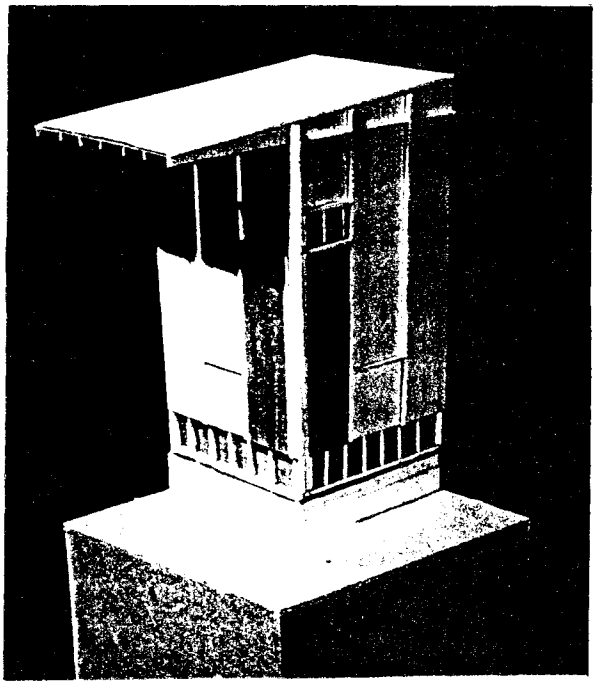
The engineers of today make use of the primary elements and by coordinating them in accordance with the rules, provoke in us architectural emotions and thus make the work of man ring in unison with universal order.
LeCorbusier

Eduard Sekler's discussion of the often misunderstood triad of *Structure, Construction and Tectonics*, reveals the fundamental existence and relevance of the tectonic expression in architecture[2] Sekler's relationship between construction and tectonics alludes not to the mechanical revelation of construction practices, but rather to a potentially poetic manifestation of visible and tangible form which results from the process of construction. Tectonic expression considered by Sekler returns our notions of "structure" to a much broader definition of an organizational concept or idea which gains form and expression through construction. The activity of the tectonic is bound to a poetic manifestation in the original Greek sense of *poesis* as an act of making and revealing toward the expression of both the concept of structure and the practice of assembly or construction. We may also consider the word technology, and notice with curiosity the Greek root form *techne;* a root form which also appears in architecture reminding us of the basic human activity of constructing or fabricating with the intention of giving visible shape. Techne often gives reference to the craft of the carpenter. For the practicing architect and aspiring student of architecture the physical properties and methods of building construction, technologies and materials must not be thought of serving primarily functional and technical concerns, but also recognized for their potential symbolic, cultural and aesthetic content.[3]

STUDIO EXERCISES + TEACHING STRATEGIES

This work was completed in the spring semester of the second year foundation program which follows a first year studio based in what is termed "first principles." The first year studio investigations are primarily in a perceptual grounding for creative making—but remain without any direct architectural reference. In the UNCC curriculum, these students have not yet take courses in structures and materials. The primary focus of this paper are the thematic investigations which become the basis or "touchstone" for the semster long studio. The remainder of the semester is spent demonstrating these issues of tectonic expression, material form, assembly and spatial condition within a larger relational framework of *Structure, Construction and Tectonics.* Student projects work through the development of a modest spatial program and the construction of specific site relationships and conditions.

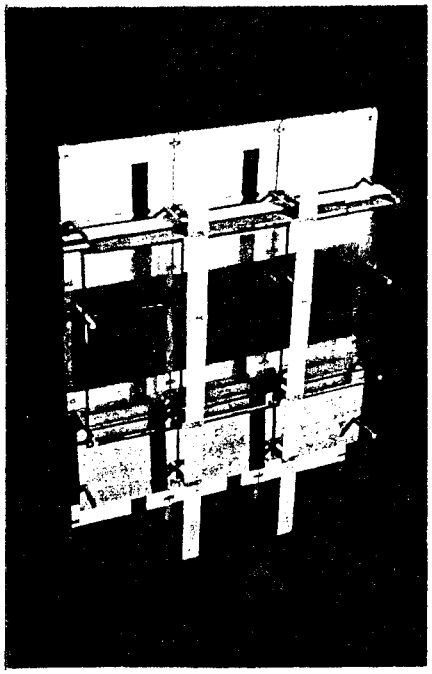
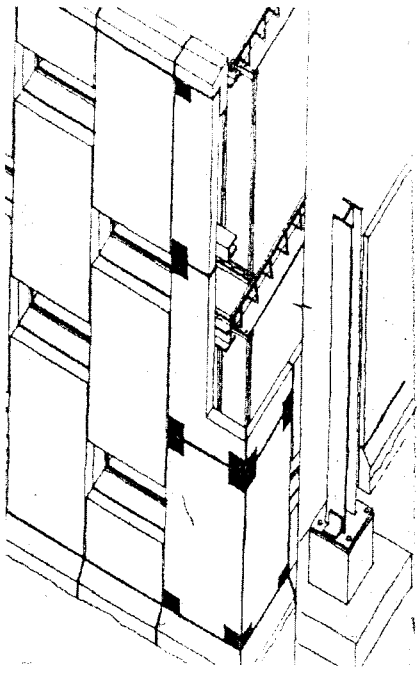
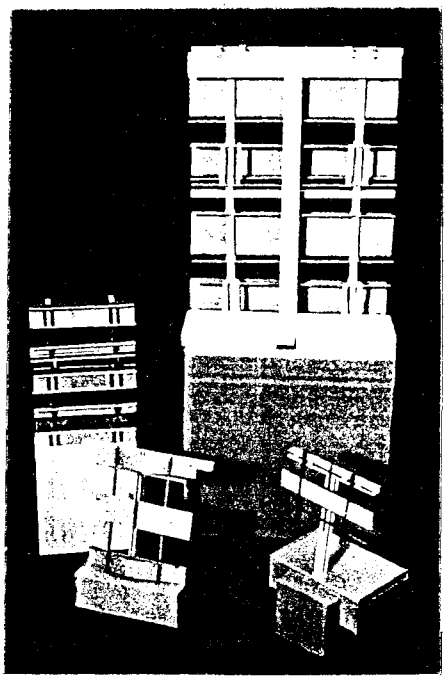
The Wall: this exercise begins by focusing on two words: *structure* as an ordering principle which can be understood as present in a wall assembly and *construction* thought of as the conscious activity or method of putting something together; simply conceived as accepted standard building practices. Although perhaps a simplification, in this exercise the description of Wall is divided into three useful categories of assemblies: a). Mass + piling, b). Frame + Cladding, c). Frame + Infill—with further elaboration of material/operational subdivisions specific to each assembly. Each student is responsible for researching the constituent elements, rules and examples of an assembly type within a classification. A student may be researching Frame + Cladding: *steel frame with a curtain wall* or Mass + piling: *brick cavity wall construction,* and in addition would also include a typical companion roof and floor assembly.



The development of typical 3/4" wall sections, elevations, shadow studies and axonometrics (including an exploded axonometric studies) initially identify and represent a re-assemble of the constituent elements & rules (the structure) of the assemblies.. The most basic of premises and principles are understood: Masonry / mass (anything piled up) is concerned with its innate density and the crafting of openings. Frames are conceptually understood as being able to define / imply large volume(s) with columns and beams and affording various methods of enclosure with Infill or cladding. Built up clad, diaphragm like walls use a system of platforms and walls as a construction method or process of building—such that a platform is crafted to support walls to further support platforms, to further support walls, and on and on..

The details are then the loci where knowledge is of an order...
Marco Frascari, *The Tell-the-tale Detail*

To further extend these basic principles and opportunities of construction systems students focus their investigation on archetypal conditions of juncture: the joint of wall to the earth (foundations), the joint of wall to the sky (roof), the joint of wall to the floor and the joint of wall to wall (corner). The students also consider two elemental construction principles as

related to the form of any specific technology: gravity and binding. These two principles are perceived as material conventions as well as joining operations which influence form and are a basis for understanding hierarchical relationship of parts (in both structure and construction) within the wall assembly. Simply and conceptually understood, the methods of binding (mortar, point connections, nails) inform the nature or method of construction and further that any method of binding (joining) proposes an implied ordering and proportional system rooted in the condition of materials related to method of joint. Consider for a moment the proportional systems of materials, and connection implicit in wood frame construction relative to masonry construction. The studio also considers the condition of joint as a manner and opportunity for explaining the relationship between the things adjoined. Consider the nature of a joint which brings together two dissimilar materials and perhaps two dissimilar structures. With this in mind, the exercise proposes the design of a wall which establishes a joint between inside and outside, a joint which establishes a relationship between material conditions and lastly a joint which established a relationship between material and immaterial conditions.

The objective of this studio work is to define and investigate the (archi) tectonic phenomena in architectural space and form making as a foundation for the further development and application of building technologies and materials. This pedagogy intends to present building technology and materials as a constituent component of the art of architecture and most significantly, places these issues at the core of a foundation design students' exploration of form, space, structure and meaning in architectural production.

The central premises and goals of the studio exercise are further developed as follows:

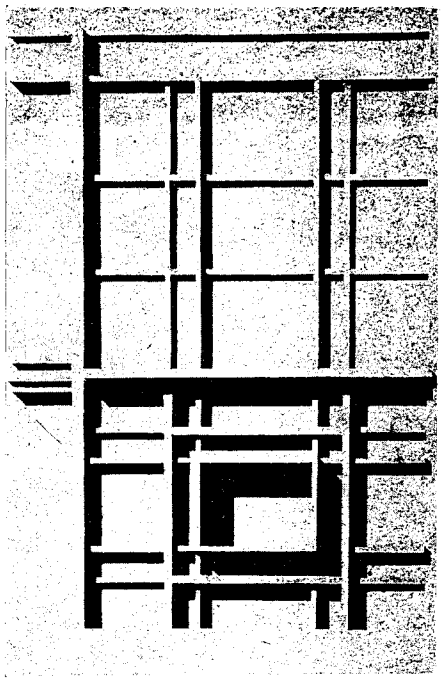
-building technologies understood as a systematic construct related to the language and order of architectural form and space. This is a proposition of and for the necessary simultaneous consideration of form, space and material assemblies in the production of an architecture.

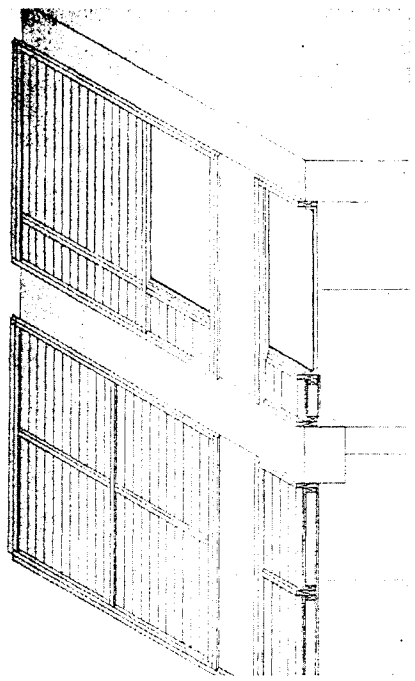
-building technology understood as an organization and classification system of practical applications based on constituent elements and consistent rules which support identifiable aesthetic qualities and specific characters of form and poetic experience.

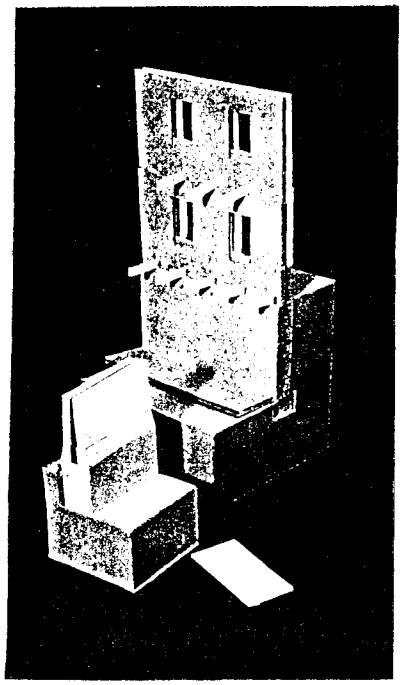
-building technology identified as a system of relationships of forms and practices with the significant capacity to manifest metaphysical, cultural and phenomenological relationships and ideals.

STRUCTURE, CONSTRUCTION AND TECTONICS

For many young students the term structure and construction are all too familiar and beginning a studio project with the reality of materials enthuses some students who sense that we are finally going to "do architecture" and incenses other students who intend to embrace the capricious will of the artful architect. However, placing the issues of tectonic expression in a larger realm of ideas seemed a strategic way to enter the studio. To broaden an understanding of both the architectural quality of the term *structure* as well as its larger principles, we considered and explored this definition relative to: the structure of a conversation, the structure of a film, the structure of a painting and the structure of a wall section. This analysis also helps us understand why we so quickly and off handedly refer to a building as a "wood structure" or become consciously aware of the significant if not profound role of a "building's structure." Structure as an idea in the studio is proposed as conceptual and abstract term referring to a system of constituent relationships; an order of ideas and forms which are the basis for an assemblage of some kind. The term *construction* on the other hand is defined as the process of realization or actualization of a concept or system of relations. The construction process could then be proposed through a variety of possible accepted methods or conventions of realization. The appropriate (expressive) relationship between structure and construction is the architect, artist or designer's skill and ability to judge.







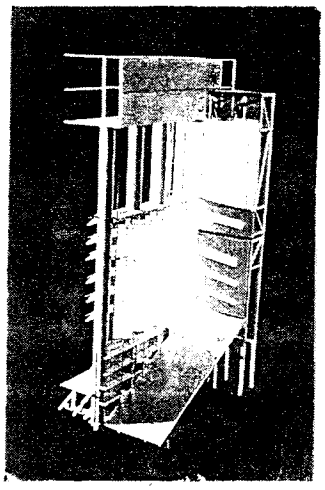
When a structural concept has found its implication through construction, the visual result will affect us through certain expressive qualities...
Eduard Sekler, "Structure, Construction, Tectonics," in *Structure in Art and Science*

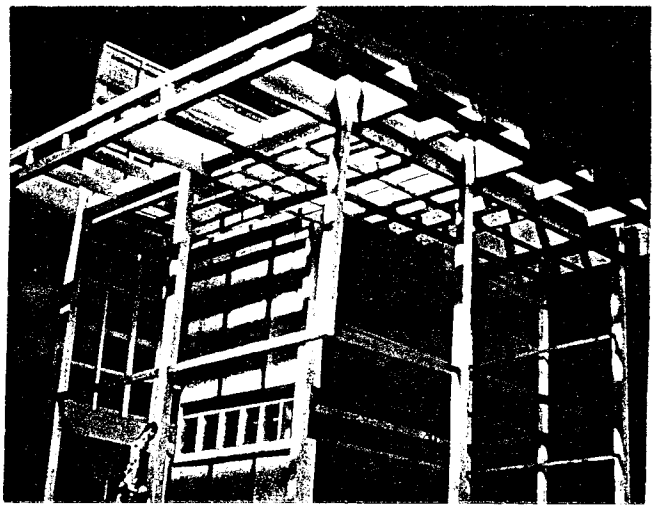
To investigate the role of structure as an intangible concept which requires a manifest expression, the studio studied several non-architectural examples: a selection of Richard Diebenkorn's Ocean Park paintings. The studio work begins by remaking or re-constructing the (visual and phenomenal) structure of the painting. The goal of this exercise is to identify the operative visual structure and order of forms in space and to promote an investigation of the properties and qualities of a material which is distinct from the original materiality of Diebenkorn's paint. The student's materials are varying types of paper which are assembled between two sheets of glass. The papers are translucent, opaque, textured, and are primarily monochromatic to further distance the students from the actuality Diebenkorn's use of color, yet promote a focus on the salient properties or visual results of the use of color. This studio exercise also recalls Paul Klee's universal artistic activity of "making visible" as primarily a tectonic expression: thus structure, the intangible concept is realized through the construction and assembly of the papers and becomes visible not only through a relationship to the original Diebenkorn (a confirmation), but also through presenting a provocative and related structural expression on the other side of the glass. Thus a specific concept of structure is seen to present several (even simultaneous) constructed manifestations. It is on this point that Sekler reminds us that tectonics is most autonomously architectural in that although the architect may not be able to totally control the conditions of structure and type of construction, but the architect is the undisputed master the tectonic expression.[4]

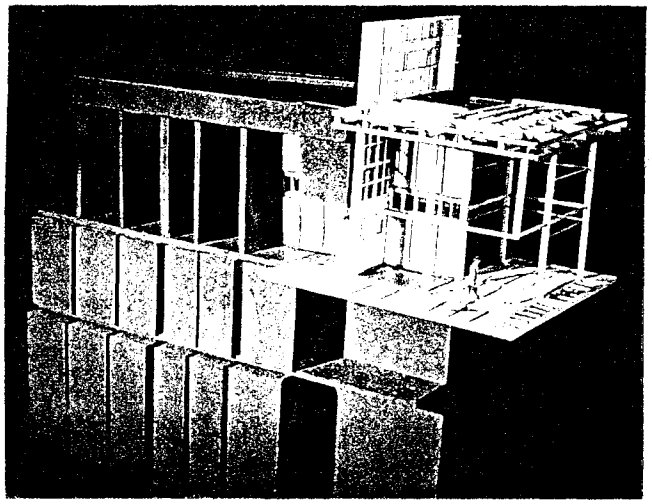
These lines show this whole art lives by its carcass. Now Auguste Perret has told me, hold on to the carcass and you will have the art.
Le Corbusier's annotation in his copy of Viollet-le-Duc's *Dictionary raisonne*, vol. 1 Paris 1854, referring to the "structural" carcass of a building.

THE PRACTICE AND DESIGN OF CONSTRUCTION

At present, professional programs in architecture find it logistically impossible to teach 'actual' construction and do their best to substitute a limited "visit" to the issue of construction through the mock-up of a detail perhaps via a basswood model or a more realistic full scale construction which aspires to more superior materials and levels of craft. With these visits to construction issues, the emphasis and value of the exercises is firmly placed in the student's *experience* of construction. Several prominent schools provide venues for actual construction field work where a shelter or project for *Habitat for Humanity* is physically planned and constructed by a group of students often during a charette or analysis / design charette.[5] Although these are admirable studio options and programs, there is a limited number of students who can participate. Further, due to the time constraints of the semester, the construction techniques and methods employed in these projects are directed toward simple residential framing and other building techniques that, although once part of our shared cultural knowledge, do not approach the vastness of construction systems significant to the production of architecture today. As educators we need to address the profound difference between the knowledge and skills for constructing in the field versus the knowledge and skill required for the design of construction. For the students who participate in field construction, the ability to synthesize this experience to any other construction situation or most importantly, the *design of construction* (architecture) remains the responsibility of the







student and is not generally a significant part of the construction studio experience.

Within most five year Bachelor of Architecture Degree Program, issues of building technologies, construction and materials are typically introduced in the third or fourth year curriculum[6] When considering most core or foundation programs, a student's first two of the three years of foundation design studio work is spent on the design of form without specific consideration of the inevitability of construction. Many architectural programs are structured with material, building technologies and building systems as *support* lecture courses to the *synthetic* studio. The remarkable synthesis and transformation of the practical and functional aspects of building systems and construction, is however primarily the responsibility of the student.

The critical relationship of building and construction to architecture is a territory included in most historic treatises on architecture: Vitruvius' *Ten Books on Architecture,* Palladio's *Four Books on Architecture,* Alberti's *On the Art of Building in Ten Books,* Viollet le Duc, *Dictionaire raissonne,* Gottfried Semper's, *Style in the Technical and Tectonic Arts or Practical Aesthetics,* yet this significant history of the relationship between building, construction and materiality as a constituent element of the language of architecture remains widely ignored in today's educational model. We must re-consider the imaginative content of creative production of technology by going beyond the satisfaction of functional requirements and open the creative and imaginative possibilities of the technical means involved in building construction concurrent with design evolution of architectural space and form. Further, the incorporation of issues of tectonics, technology and construction in design studios lays the a foundation for understanding a broad and comprehensive architectural discipline with its aspects of history and practice, cultural meaning and individual experience poignantly captured in a constructed language of space, form. and material relations.

Ultimately, the flying buttress learned to talk, the rib learned to work, and both learned to proclaim what they were doing in a language more circumstantial, explicit and ornate than was necessary for mere efficiency.
Erwin Panofsky, *Gothic Architecture and Scholasticism*

The evolving pedagogy presented in this paper proposes to introduce in the education of an architect, the knowledge of building technologies and materials as a malleable organization and classification systems of practical applications which are based on constituent elements and consistent rules which support identifiable aesthetic qualities and manifest specific characters of form and poetic experience. What we must clearly understand is that when design concepts and forms are not generated through the guise of construction and making, they cannot hope to allude to an architectural eventuality. When the building of an architecture is approached as an organization system which encompasses aesthetic, formal and practical applications, there is the facility and artistry to transcend the common understanding of building technologies and materials acquired by rote mechanics of lecture and evaluated regurgitation.

Most significant to the educational and professional promise of the next generation of (global) architects is a keen ability to understand both the conceptual and practical, the empirical and rational in order to develop well considered options and alternatives. This type of thinking understands the formulation of an architecture as a concatenation of architectural premises which include the inevitability of construction and materiality. At the root of this process is the ability to think in simple terms, to proceed from generals to particulars, to know how to structure and prioritize relationships between like as well as discordant concepts. Such a process of thinking is fundamental to the leadership role of the architect as master builder.

NOTES AND REFERENCES

1. Based on a curriculum survey of the 20 Southeast Regional Schools of Architecture and a survey of the student body at UNC Charlotte College of Architecture.
2. Eduard Sekler, "Structure, Construction, Tectonics", in *Structure in Art and Science,* Gyrogy Kepes, ed, (New York: 1965)
3. Kenneth Frampton, Rappel a l'orde: the Case for the Tectonic, Architectural Design v. 60, #3-4 (New York: St. Martin's Press, 1990) pp. 20, Sekler, "Structure, Construction, Tectonics", in *Structure in Art and Science,* Gyrogy Kepes, ed, (New York: 1965)
4. Sekler p. 94
5. UNC Charlotte is now beginning to offer a studio each semester with Habitat for Humanity. A design charette produces a schematic design which is constructed over the semester. Yale University 's construction studio was founded by the late Charles Moore offering students a hands-on construction experience. The University of Oregon also has a construction project studio and many graduate and undergraduate programs are beginning to offer a single studio in construction.
6. Based on a curriculum survey of the 20 Southeast Regional Schools of Architecture.

A CONCEPTUAL FRAMEWORK FOR DESIGN

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INTRODUCTION

A theoretical framework is porposed for understanding the ambiguity of architectural design objects. The framework is based on the cognitive science concept of a "semantic network" and on the artificial intelligence concept of "frames."[1] It is linked to a computer graphics rendering program. It presumes that an architect draws objects (e.g., walls) with ambiguity at the beginning of a design process. The objects take on a more specific function and form over time as the design process moves from a schematic to a more detailed sttae. The ambiguity, however, is not merely a vagueness. Rather, the ambiguity has to do with a potentially wide set of potential identities that a schematic design object may have (i.e., an object may simultaneously be identified as a kind of "wall" object, and/or a kind of "skin" object, and/or a kind of "load-bearing" object.) At the end of the deisgn process, the set of potential identities may become fewer. Yet, when the project is finished, some ambiguity may still remain. The framework for describing the ambiguity is called a "conceptual structure." This paper desribes how then conceptual structure functions and gives a few short examples from a larger set of case studies that were undertaken.

Using a computer as a research tool, a knowledge based system and a rendering program were developed. The computer tool is used to describe the material attributes and to render the visual appearance of objects. This project was initially undertaken for the author's Ph.D. dissertation in architecture.[2] The knowledge base which underlies this program is called a *conceptual structure.* The *conceptual structure* represents the architectural objects of a design project. It also represents the properties that the objects may inherit by being classified in certain ways. For example, an object may be classified as a kind of "masonry" object and may inherit some material attributes of marble, or brick, or concrete. An object may also be classified in potentially more than one way, such as an object that is simultaneously a kind of "exterior wall" object, and also a kind of "travertine marble" object, and also a kind of "load bearing" object, etc.. In addition, the *conceptual structure* can be used to describe how schematic objects may be modified in the design process. For example, the *conceptual structure* can be used to describe the transformation of a wall from a schematic massing object into a final and more materially specific object.

Each classification within a *conceptual structure* holds attributes which can be used to describe some aspects of a design object. Some of the classifications may have precedence over other classifications for certain attributes, such as color, or texture, or materiality or size or other qualities (see figure 1). The attributes in turn determine the 3D visual appearance of the object within a computer rendering. The *conceptual structure* allows potentially conflicting classifications for a design object to co-exist within a consistent framework. It suggests a way to

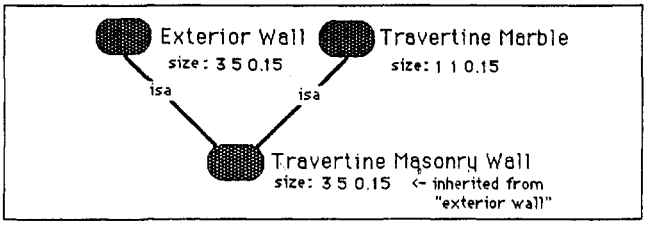

Figure 1: A "Travertine Masonry Wall" is an "Exterior Wall" and a "Travertine Marble" object

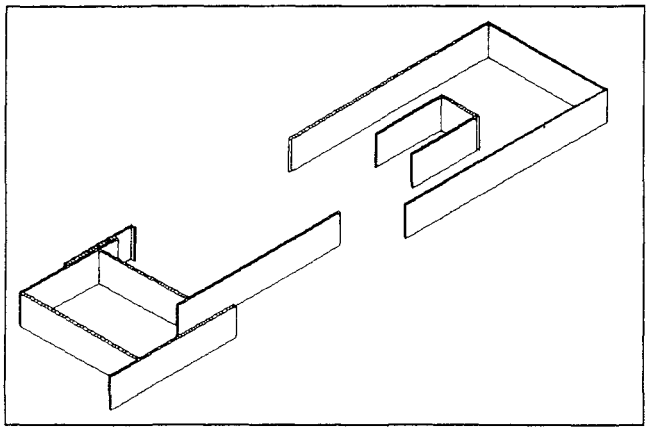

Figure 2: Stage 1 - First Sketch; screens and spaces

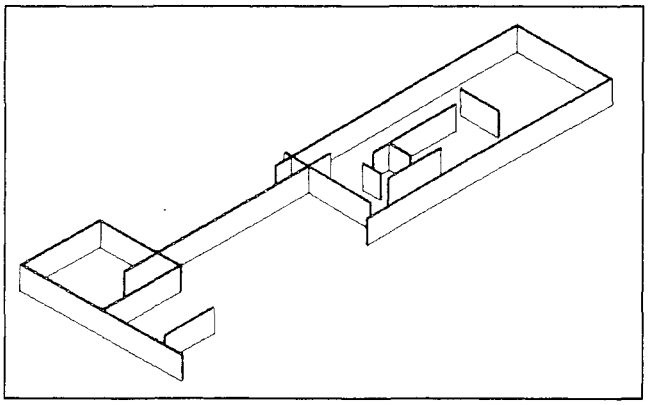

Figure 3: Stage 2 - Second Sketch; screens and spaces redefined