Recognizing a *(fertile)* Gap: Issues of Materials, Construction and Building Assembly in the 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.
>
> 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

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", the physical act of building and the laws of applied science. 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 relative to inherent structural forces, 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 master builder, architect as artist, architect as craftsman, and the design / build architect, are all roles that are the basis of an extensive, comprehensive job description for the architect. However, in twentieth century contemporary practice, Guiseppe Zambonini in his essay "Notes on a Theory of Making" observes a total segregation of the process of design and the process of building. He proposes that this gap is an outgrowth of the standardized project delivery system most typical in the United States.[1] Zambonini further expresses regret for the systematic limitation of professional liability where today's architect designs but is isolated from construction, and as well, today's contractor builds but is often isolated from design. The architect's involvement in construction processes is now specified as a legal condition of architectural practice. This limited role is supported by 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.[2]

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

The history of architectural education reveals that 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, it is the design of form that remains as the central focus of an architect's education.[3] The current education of undergraduate architects provides courses in building technologies and materials which have a decidedly practical aura. These courses have little or even at times no direct connection to the conceptual and artful methodology for the generation of form which takes place in the design studio. The subject of building technology, material properties, and structural assemblies should hold a fundamental role in any program curricula. However, most building technology courses are usually not taught by studio instructors, but rather by a group of instructors who often hold the role of (as needed) technology consultants to the design studio. And, 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 the issues of building technologies and the schematic design work of the studio when a student's queries are rooted in either 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 issues of 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.[4]

> Every material possess its own language of forms and none may lay claim for itself to the forms of another material. For the forms have been constructed out of the applicability and methods of production of materials. They have come into being with and through materials.
>
> - Adolf Loos,
> Principles of Cladding in *Spoken into the Void*

Eduard Sekler's 1965 discussion of the often misunderstood triad of *Structure, Construction and Tectonics*, proposes a fundamental existence and relevance of the tectonic expression in architecture.[5] 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 its form and expression through a specific structural system and construction method. With this in mind, the activity of the tectonic can then be bound to the original Greek sense of *poesis* as a reciprocally informed act of *making and revealing.*[6] Thus as a truly poetic act, the tectonic expression promotes the artful manifestation of the concept of structure within or through a codified practice of assembly and construction. We may also consider the specific word *technology*, and notice 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 and form. Definitions of the root *techne* often give reference to the craft of the carpenter, further supporting our consideration of the crafting of a form.[7] 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 as serving primarily functional and technical concerns to be worked out later, but rather considered as fundamental components of any architectural form and recognized for their utility, but also for their potential symbolic, cultural and aesthetic content.[8]

STUDIO EXERCISES + TEACHING STRATEGIES

This studio work was completed within a second year foundation design studio and represents the refinement of pedagogic issues which evolved over several years of teaching in the second year with the critical appraisal and collaborative efforts of collegues.[9] In this five year Bachelor of Architecture curriculum, the second year follows first year studio investigations that are rooted in the development of a perceptual awareness as the fundamental grounding for creative making. This first year design work investigates the generation and morphology of form and employs a broad range of drawing and modeling tools, but without any direct architectural reference in the work. Historically, the second year students in the fall semester study and explore the issues of a formal architectural language and space making. In the spring semester, seminal exercises that research and investigate constructional assemblies and structural systems provide a "base architectural language" to be further developed and employed in the design studio. Working in this specific manner intends to confront the (fertile) gap between the abstract and formal ideas of *design* and the actuality of building in order to promote these issues as an integral and productive part of design studio practice. The unfolding semester's exercises are vehicles for reiterating and demonstrating these issues as related to tectonic expression, material form, assembly and spatial conditions. In 1994, when these exercises researching constructional assemblies were first given, the studio pursued the design and development of an exterior wall and interior wall and acknowledged that both of these walls functioned to simultaneously cut and separate spaces as well as to join and connect them. The degree of connection and the function of the connection (literal or virtual, technical or symbolic, ontological or representational) were considered as an integral part of the evolving vocabulary of the structure, form and order of the wall. These walls and spaces were intended to be the foil for the activities of two twin brothers, one a poet and the other a prosaic rationalist who will co-author a novel.[10] During 1994, the sequence of initial exercises expanded and lead into the semester's work that focused on the development of spatial conditions within the totality of the structural system of the wall assembly. The profound issues of joints and connections remained an integral part of the design work and in addition, the process of construction and methods of assembly were forefronted and design began with the foundations. This studio worked through the design of a modest volumetric spatial program that required the students to author a narrative of occupation and the development of a "constructed" site condition.

The first introductory exercise, albeit naively titled "The Wall," focuses on what is often given, by young students, the cursory consideration of either a ubiquitous surface acting as an enclosing wrapper or the role of a decorated billboard.[11] Pedagogically, the exercise and the student's work is directed to explore two often misunderstood and even preconceived concepts. The first concept, *structure* is reconsidered as a primary ordering principle which can be understood as latently present in any wall assembly. The second concept, *construction* is then thought of as the conscious activity or method of putting something together; most simply conceived as accepted standard building practices. These two

concepts are intended to assist in the understanding of building technologies as an organization and classification system based on the existence of constituent elements and the use of consistent rules and procedures. Although perhaps an oversimplification, in this exercise the broad description of wall or enclosure is divided into three useful categories of assemblies: a). Mass + Piling, b). Frame + Skin, c). Frame + Infill. These categories are further elaborated with material and operational subdivisions that are specific to each assembly. In the studio work, each student is responsible for researching the constituent elements of their wall, which is an activity usually informed by understanding the process and specific rules and methods for assembly. Each student is also responsible for providing a variety of examples of the wall assembly type within the assigned classification. For example, a student may be researching a wall under the category of Frame + Skin, and therefore working on a steel frame with a curtain wall or with the classification of Mass + Piling, perhaps the student will investigate brick cavity wall construction. In all cases, the students also investigate and present what would be considered a typical companion roof and floor assembly for their wall assembly.

In the studio, the student's development of typical 3/4" wall sections with a bay of resulting elevations, shadow studies and axonometrics, including exploded axonometric studies, assist the students to identify and ultimately to present to the class, a "re-assembly" of the constituent elements, and the order and rules (the *structure*) of their specific wall enclosure. The most basic of premises and principles begin to emerge: masonry / mass (anything that is piled up) is concerned with its innate density and the crafting of voids as openings. Frames, on the other hand, are conceptually understood as being able to define or imply the boundary of a much larger volume(s) through a system of columns and beams with the inclusion of various methods of enclosures, Infill or cladding and skinning. To continue, the assembly of a built up and clad / skin or diaphragm on a frame acts as a massive and planar structural element, much like a load bearing wall rather than a structural frame.[12] To this end, some of the Frame + Skin assemblies often use a limited system of platforms and walls as a construction method for building—such that a platform is crafted to support walls which in turn support the addition of platforms which will further support walls, and so forth and so on.

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

To extend these emerging concepts and the knowledge of the basic principles and potential *design* opportunities within the construction systems, the students next focus their investigations on archetypal conditions of juncture along the wall: 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 next studio exercise proposes an inspection of these joint conditions and their attendant

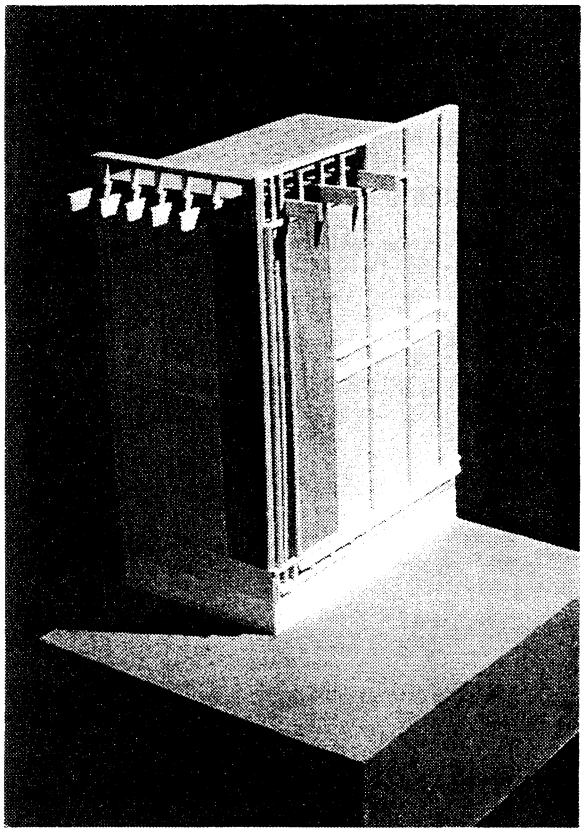

Fig. 1. The Wall exercise 1995: model.

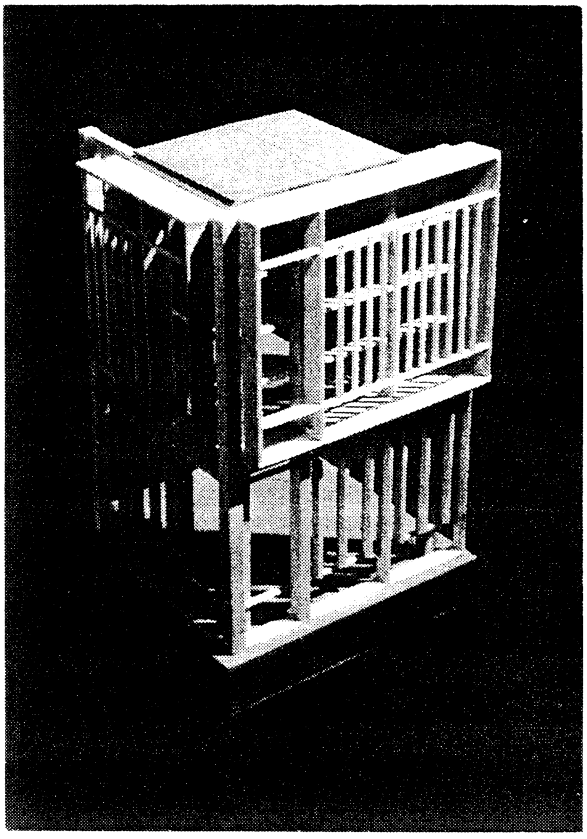

Fig. 2. The Wall exercise 1995: model.

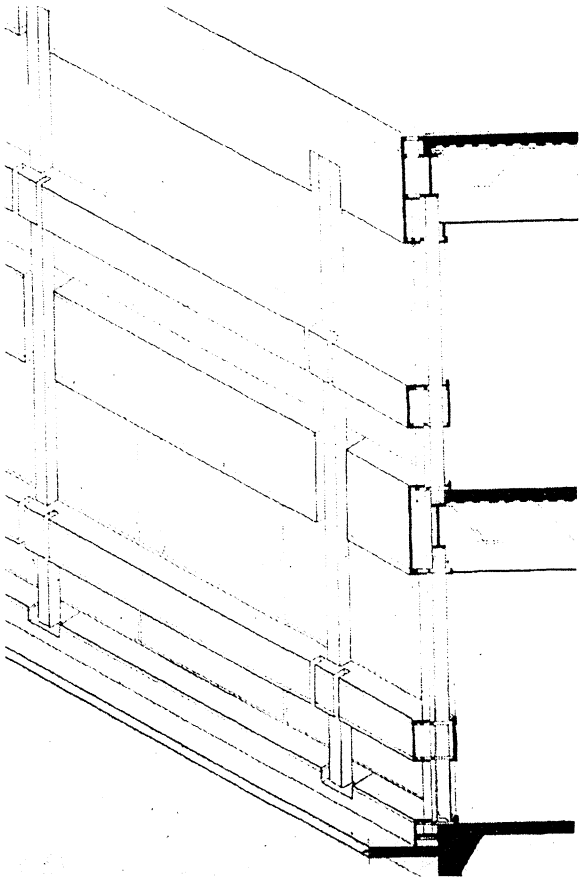

Fig. 3. The Wall exercise 1994: axonometric study.

details to reveal specific formal, material, and significant spatial associations which are related to each condition and constructional assembly.[13] For example, when considering the juncture at the earth, it is a masonry wall that grows from a deeply embedded condition within the earth and in contrast the structural frame wall intends to rest lightly upon the earth with only a puncture to deliver the frame's foundation into the earth. With this in mind, the student's can begin to identify through the relatively simple form and organization of the foundation, the resulting structural elements and characteristics of the enclosure systems as well as the premises of spatial character. The students revisit and reconsider the foundation later on in the studio exercises to understand its potency as an earth work and site construction in an effort to knit together the condition of earth and site with the building structure and construction. When considering joints, the students also confront two elemental construction principles as related to the form of any specific technology: *gravity and binding*.[14] These two principles are perceived as material conventions as well as joining operations which influence form and space and have significant material and formal conditions. Issues of gravity and binding are also 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 and nails are integral to the nature or method of any construction system. In addition, any method of binding (joining) proposes an implied ordering and proportional system rooted in the condition of materials related to the method of joining. Consider for a moment the correlation between the material proportional systems of steel and masonry construction, and the connections implicit in steel frame construction relative to the connections in masonry construction. The studio exercises also consider the condition of a joint as an opportunity for explaining the relationship between the things adjoined when discussing for example, the conception and role of a joint which brings together two dissimilar materials or perhaps even two dissimilar structures. With this in mind, in a short design exercise the student proposes and develops the design of several walls (often the wall assembly researched, but not always the case) in order to focus on the tectonic and poetic expression of the condition, assembly and construction of joints between the realms of *inside and outside*, between *like and dislike material conditions* and finally between *material and immaterial conditions*.

STRUCTURE, CONSTRUCTION AND TECTONICS

For many young students the term structure and construction are all too familiar, with firmly rooted connotations. Begin-

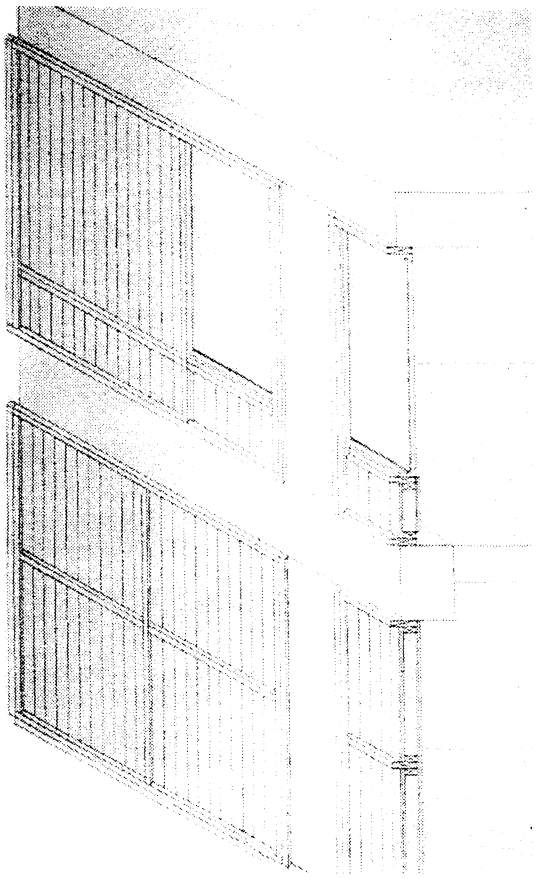

Fig. 4. The Wall exercise 1995: axonometric study.

ning 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 often capricious will of the artful architect. However, placing the issues of tectonic expression in a larger realm of ideas and conceptual thought seems a strategic way to enter the design studio. To broaden an understanding of both the architectural quality of the term *structure* as well as its larger principles, the studio discusses and explores this definition relative to: the structure of a conversation, the structure of a film, the structure of a painting and finally the structure of a wall section. This analysis also helps us understand why we so quickly and off handed-ly 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 discussed as a 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.[15] Ultimately, the appropriate (expressive) relationship between structure and construction depends upon the architect, artist or designer's skill and ability to judge and design.

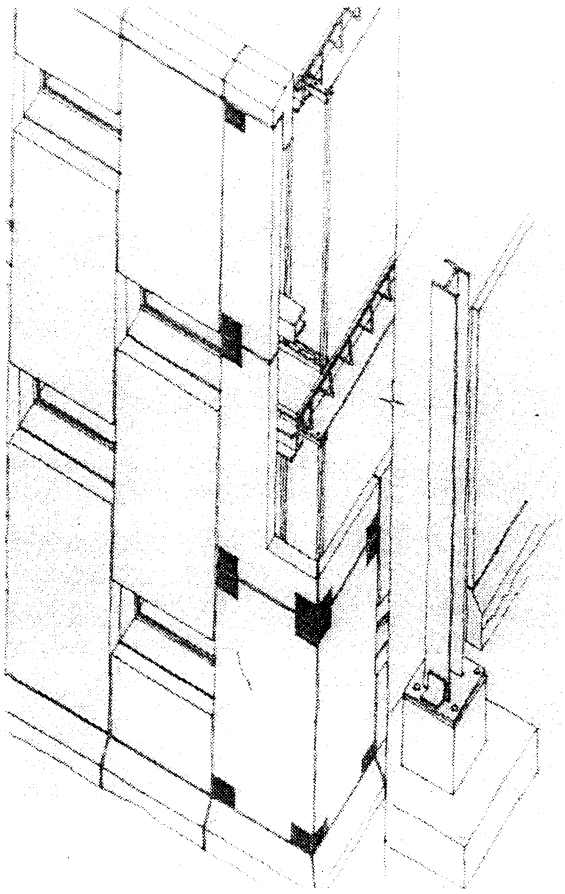

Fig. 5. The Wall exercise 1995: axonometric study (Kemner studio section).

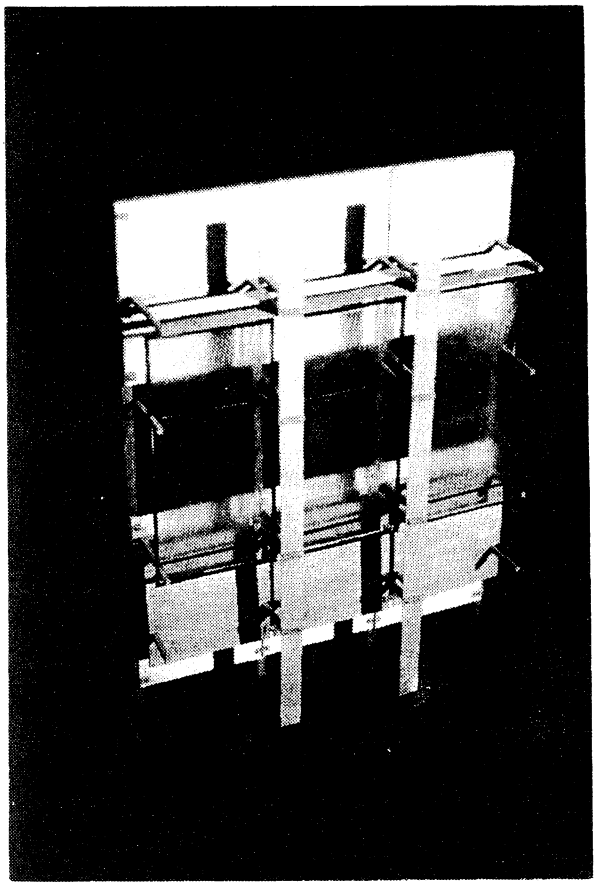

Fig. 6. Design study of exterior wall assembly 1994

The studio pedagogy discussed in this paper intends to present building technology and materials as a constituent component of the art of architecture and most significantly, proposes to place these issues at the core of the foundation design students' exploration of form, and space. This manner of working engages the speculative and prepositional activity of design with the materials and methods of the artifact's production very early in one's education, to be extended and built upon by subsequent studio projects. The central premises and goals of the studio exercise are further developed as follows:

- building technologies to be 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 to be 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 to be identified as a system of relationships of forms and practices with the significant

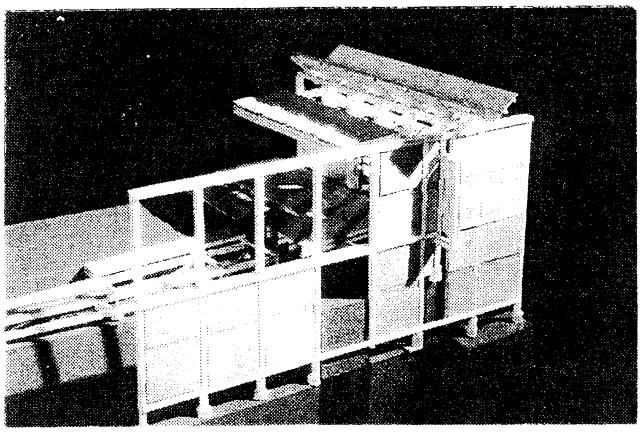

Fig. 7. Semester end studio project 1994.

capacity to manifest metaphysical, cultural and phenomenological relationships and ideals.

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.

- Le Corbusier, *Towards a New Architecture*

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 always aspires to more superior materials and higher levels of accomplished craft. With these visits to construction issues, the emphasis and value of the exercises is firmly placed in the student's *experience* of the construction process.[16] Although these are very admirable studio options and programs, unfortunately there is always a limited number of students who can participate. The time constraints of the semester often work well with construction techniques and methods directed toward simple residential framing and other building techniques that, although once part of our shared cultural knowledge, do not, however, approach the vastness of construction systems significant to the production of architecture today. As educators we need to address the profound correlation between the knowledge and skills for *constructing in the field* versus the knowledge and skill required for the *design of construction.*

Within most five year Bachelor of Architecture degree programs, issues of building technologies, construction and materials are typically introduced in the upper levels of the third or fourth year curriculum.[17] When considering most core or foundation design programs, a student's first two of the three years of studio work focuses on the design of form without specific consideration to the inevitability of construction. Generally, architectural programs are structured with material, building technologies and building systems as *support* lecture courses to the *synthetic* studio. Thus, the remarkable synthesis and transformation of the practical and functional aspects of building systems and construction, is a responsibility that rests with the individual student.

The critical relationship of building and construction to architecture is 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's *Dictionaire raissonnè,* 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 reconsider the potent and imaginative content of technology by going beyond the satisfaction of functional requirements and open the creative and imaginative possibilities of 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 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.

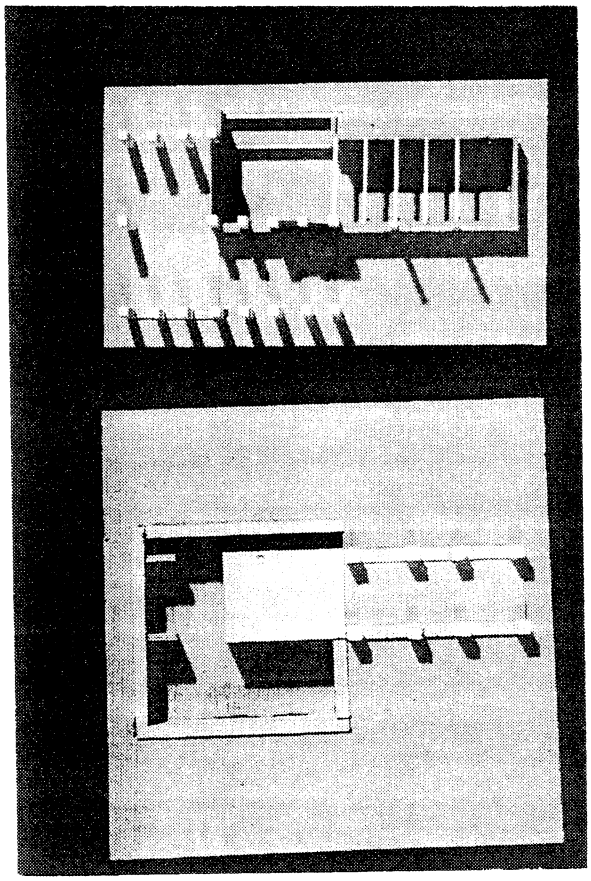

Fig. 8. Foundation studies for two volumes 1995.

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

CONCLUSIONS

The evolving design studio 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 system of practical applications. These organizations and classifications are based on constituent elements and consistent rules which support identifiable aesthetic qualities and manifest specific characters of form, space 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 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.

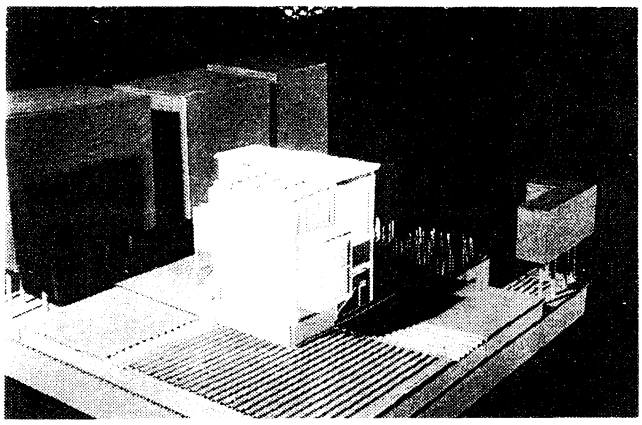

Fig. 9. Design / development of structure and enclsure and site construction strategies.

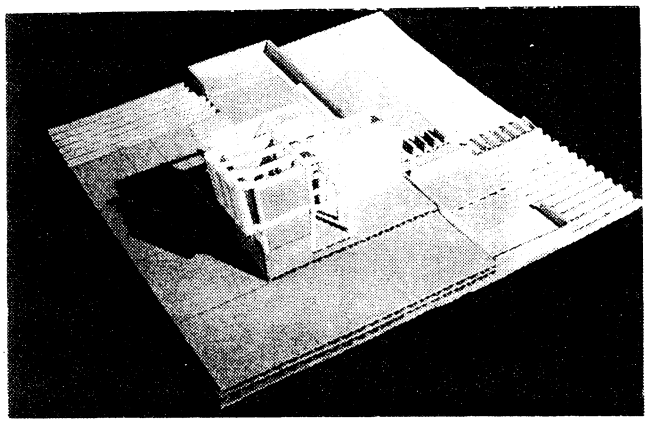

Fig. 10. Semester end project 1995.

NOTES AND REFERENCES

[1] Giuseppe Zambonini, "Notes for a Theory of Making", *Perspecta 24*, (New York: Rizzoli International Publications, Inc., 19880, pp. 2-23.

[2] see American Institute of Architects contract documents: Agreement between Architect and Owner (Washington, DC: American Institute of Architects, 1994)

[3] see Reyner Banham, "Theory and Design in the first Machine Age", (New York: Praeger, 1960) pp. 276-279.

[4] Based on a curriculum survey in 1995 of 20 Southeast Regional Schools of Architecture and a survey of the student body at UNC Charlotte College of Architecture

[5] Eduard Sekler, "Structure, Construction, Tectonics", in *Structure in Art and Science,* Gyorgy Kepes, ed, (New York: 1965)

[6] see also Marco Frascari on his discussion of the terms *constructing* and *construing* in "The Tell-the-Tale Detail", in *VIA 7: The Building of Architecture* (Cambridge: MIT Press, 1984), pp. 23-37.

[7] see Kenneth Frampton's discussion of the etymology of *tekton* in the introduction of, *Studies in Tectonic Culture*, (New York: MIT Press, 1995), pp. 3-8.

[8] Kenneth Frampton, Rappel a l'orde: the Case for the Tectonic", Architectural Design v. 60, #3-4 (New York: St. Martin's Press, 1990), see also Kenneth Frampton's discussion of vernacular building construction and forms in the introduction of, *Studies in Tectonic Culture*, (New York: MIT Press, 1995)

[9] The studio exercises developed for the second year design studio between 1992 and 1995 represent a genealogy of pedagogic issues as well as evolving studio paradigms which explore possible relationships between building construction, technology and design. These exercises were developed in dialogue with many of the faculty teaching in the sophomore studios as well as through the companion theory seminar in which most all of the studio instructors actively participated. The seminar often had the ability to be a protagonist and fertile research vehicle for the "applied research" that was conducted in the studio. A selection of seminar readings follows this essay.

[10] This studio work received ACSA's 1995 award for the integration of issues of technology within the design studio.

[11] The Wall exercise was first given in my studio in the spring of 1994. Although perceived as a successful project by second year faculty, a critical appraisal of the project recast the exercise in its current form that was given again in the spring of 1995. The simple notion of the wall section is now discussed in terms of the repetitive elements and the structural bay condition. Further, each structural system related to a wall enclosure is recognized as having far reaching spatial and

tectonic implications within a building's volume that are proposed as unique and inherent to the tectonic expression. Although the Wall exercise was promoted as a single exercise to develop ideas of assembly, detail and connection in order to lay the groundwork for a dialogue between tectonic joints, thresholds and spatial conditions, the Wall exercise has developed into a literal foundation upon which to build the remaining semester's work. About a third to half of the way through the semester, the students are given two simple interpenetrating volumes, one hovering above the ground and one embedded in the ground and are then asked to design foundation proposals for a configuration of these volumes. This design project continues to develop using the incremental stages of construction as a lens to focus and develop subsequent issues.

[12] Additional distinctions that could be made of the frame, such as the moment frame or braced frame construction are not addressed in the scope of this project. In addition, the second year students do not take courses in structures or materials until their third year where some elaboration of the frame will certainly make a logical extension to the concepts presented in this studio.

[13] Marco Frascari, "The Tell-the-Tale Detail", in *VIA 7: The Building of Architecture* (Cambridge: MIT Press, 1984), pp. 23-37. See also, K. Frampton's "Carlo Scarpa and the Adoration of the Joint", *Studies in Tectonic Culture*, (New York: MIT Press, 1995) pp. 306

[14] In the fall of 1994 I was joined in the sophomore studios by Kevin Kemner, who through his collaborative efforts made many of the pedagogic discussions richly provocative and more accessible to other faculty. I am indebted to Kevin Kemner for these observations and subsequent investigations with his studio section.

[15] Eduard Sekler, "Structure, Construction, Tectonics", in *Structure in Art and Science*, Gyorgy Kepes, ed, (New York: 1965)

[16] Several prominent schools provide venues for actual construction through 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. The design charette often uses a collaborative group of students to produce 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. (see Mark Alden Branch, "Building to Learn: More and More Architecture Students engage in Building Projects as part of their Education", *Progressive Architecture*, March 1994, v. 75 n. 3, pp. 56-60). Some Universities are beginning to offer a studio each semester with Habitat for Humanity

[17] Based on 1995 curriculum survey of 20 Southeast Regional Schools of Architecture.