1:1 Constructed Historic Details

JORI ERDMAN
Clemson University

The whole history of architecture revolves exclusively around the wall apertures.
—5 points towards a new architecture, LeCorbusier and Pierre Jeanneret

The typical case study in architectural discourse provides students with a limited exposure to the architectural work, through drawings, photos, written description, analysis and representational models. The case studies conducted by my students over the last three years in a course entitled Construction Principles provided the students with an opportunity to understand the chosen buildings through the constructive, or reconstructive, process. Through a hands-on approach to the case study the students were able to participate in a broader discussion of architecture as it relates to tectonics, technology and the history of construction. Because of the inherent tension between interior and exterior, as well as the technological developments that occurred in the twentieth century, the case studies focused on aspects of construction relating to enclosure.

Construction Principles, a course offered in the second year of a professional five year architectural program, provides students with their first approach to the integration of concepts of technology and history as they relate to architecture as well as their first formal educational experience with full-scale construction. The course is taught by myself, an architecture professor, together with the school's wood shop supervisor. The methodology of the course promotes an understanding of the history of tools, materials and construction methods through a format of lectures and lab work, culminating in the full-scale construction of an architectural detail. Fundamental to the course is the belief that architectural education must provide ways for students to experience the act of building and think about the technological questions of building as part of the design process. The case study methodology is used as way to bring an understanding of way that architects have approached these issues throughout time.

technology — the body of knowledge available to a civilization that is of use in fashioning implements, practicing manual arts and skills, and extracting or collecting materials // Greek — tekhnologia, systematic treatment of an art or craft: tekhne, skill // teks — to weave, to fabricate, especially using an axe

Our approach to and understanding of technology is framed through the above definition as well as Heidegger's essay, "The Question Concerning Technology." An understanding of technology is fundamental to the making of architecture, as well as many other applied arts. Architectural education inevitably addresses technological issues directly and indirectly through courses in structures, materials and methods, mechanical systems, history/theory and design. Unfortunately, the more specific idea of "tectonic," or the art of construction, gets lost in the consideration of technology as a purely practical and pragmatic issue. As Kenneth Frampton points out in Studies in Tectonic Culture, architecture in its built form is one of the most powerful indicators of our culture and spirituality as humans. Therefore, it is imperative for architectural education to begin to address the ways of making buildings directly, through physical contact with actual building materials and processes, in order to develop architects trained in ways of thinking about the act of construction.

In choosing to investigate a building at full-scale one must immediately begin to hone in on the essence of the building to capture a single, meaningful moment. In looking for that moment we were informed and influenced by the history of architecture and architectural theory. As early as 1851 Gottfried Semper, in The Four Elements of Architecture, identifies enclosure as one of the four defining elements of architecture. He elaborates a history of the wall-fitter or weaver as the first architect. We return to the above etymological root of technology in teks, meaning to weave. He goes on to theorize a history of architecture in which the wall bears the symbolic and physical markings of culture though its execution and decoration.

With the advent of the Industrial Revolution and the emergence of new technologies and materials, architects began to rethink the wall as enclosure and develop a paradigm which was intimately bound to construction. Walter Gropius speculates in The New Architecture and The Bauhaus that the nature of the wall will inevitably change based on the emergence of new building technologies, particularly glass. He argues that standardization and rationalization in structure and construction will bring a new architecture and a new culture. He uses this theory as a basis for his radical approach to architectural education in the Bauhaus. Arguing for the necessity of practical, hands-on education as well as intellectual education, Gropius hoped to graduate architects that would be capable of expressing the cultural and technological shifts which occurred as a result of the Industrial Revolution.

As Gropius predicted, the walls we make have undergone a dramatic change. And as Le Corbusier noted above, much of the history of architecture is still related to the way that we mediate the relationship between interior and exterior. This shift is evident in the materials and techniques we use to construct our buildings and reflects deeper changes in our understanding of culture, space and theory. The modern movement in architecture was able to provide entirely new definitions of space and enclosure which allowed the wall to become free of ornament, style and even function. Enclosures continue to define how we view the development of architecture and our evolutionary progress as architects. Thus, it became inescapable that the case studies we conduct should focus on the wall. This decision in turn affected the development of the course content leading up to the construction of the case studies.

construct(v): -ed. ing.s1. to form by assembling parts: build. 2. to create (an argument or sentence. for example) by systematically arranging ideas or terms (n): 1. something formed or constructed from parts. 2.a. a concept. model or schematic idea. b. a concrete image or idea . the latin root is ster — meaning to pile up

construction: 1.a. the act or process of constructing. b. the art. trade. or work of building. 2.a. a structure. such as a building. framework or model b. something fashioned or devised systematically. c. an artistic composition using various materials: an assemblage or collage. 3. the way in which something is built or put together

principle: 1. a basic truth. law or assumption. 2.a. a rule or standard. especially of good behavior. b. the collectivity of moral or ethical standards or judgments 3. a fixed or predetermined policy or mode of action 4. a basic or essential quality or element determining intrinsic nature or characteristic behavior 5. a rule or law concerning the functioning of natural phenomena or mechanical processes

As stated previously, the course was developed as an experiment in a "hands-on" learning approach. This attitude developed as a reaction to the oft-heard complaint from recent architectural school graduates that their training and education in school did not prepare them for the "real world" of schedules and construction documentation. Many architects practice architecture as a primarily cerebral exercise, rarely finding an opportunity to actually participate in the physical act of constructing the edifices they spend months and sometimes years drafting, editing and re-drafting. Of course, it is easy to rationalize why this has happened and one can only speculate that as information technology becomes faster and more powerful, that the architect will become yet further removed from the construction process. As Edward Ford has stated in The Details of Modern Architecture, the evolutionary loss of the craft of architecture is a complex series of events, no one more to blame than the others. Yet he goes on to say that the architects from history whom we agree have contributed the most to the study of form and design, have all also had an implicit or explicit philosophy of building as well, such as Mies van der Rohe and Frank Lloyd Wright. We learn not only from their successes, but their failures as well. For instance, we study the inconsistent results R.M. Schindler achieved when trying to mix local sand with Portland cement for the concrete in his Pueblo Ribera project in La Jolla, California.

Principles of construction were investigated through the course in lectures, demonstrations and lab exercises. Based on the exercises suggested in Mario Salvadori's book, Building: The Fight Against Gravity, students performed assignments demonstrating the basic structural principles behind certain shapes and forms, such as the arch and the serpentine wall. Group exercises included working to form a human flying buttress and building models of tensile structures using straws, string and paper. They also observed the appropriate use of various structural systems while on field trips to local building sites and fabrication shops. Once a basic understanding of certain fundamental structural principles was achieved, the remainder of the course was organized around a study of the primary materials used in construction and the principles of their usage and development as building components.

MATERIALS AND TOOLS:

material: greek root is mater or materia — meaning tree trunk. as in hard wood or carpentry, i.e.. building

tool: 1. a device used to facilitate manual or mechanical work. 4. something used in the performance of an operation: an instrument

Throughout the course we focused on primary materials historically used in building, including masonry, wood, concrete, steel and glass. Each material was introduced to the students through lectures and readings, presenting both historical and specific technical perspectives, including cultural and geographical effects on the development of technology and the spatial implications of various materials. There was a conscious effort throughout to expose the students to both typical building practices as well as to expose them to examples of the ways in which architects have thought about and manipulated these materials in less typical applications. Through this introductory component of the course, the students could develop the framework for a working knowledge of accepted practices, as well as begin to think about how their preconceived notions of technology and construction could be challenged and improved.

Physical properties of the materials and tools were explored by the students through the lab exercises. For instance, one exercise involved framing a wall using basic wood stud construction techniques. In this exercise the students were also exposed to different tools through an impromptu race between a normal hammer and an air powered nail gun. Another exercise allowed the students to mix mortar and lay brick in low walls forming a corner. They quickly learned that there is an art to keeping mortar on a brick that they had previously under appreciated. They also learned there is a significant difference between mortar and cement when we realized we had gotten bags of cement, without any sand, instead of pre-mixed mortar. All students participated in lab exercises, thus ensuring that each individual student developed an appreciation of tools and materials. An additional benefit of these exercises was that they could all see the inevitable failures of unskilled laborers and poor craftsmanship, a necessary component of working with any material. Most importantly, it allowed them to begin developing ways of thinking through the construction process logically and productively.

DETAIL CONSTRUCTION:

detail: 1. individual part: an individual separable part of something, especially one of several items of information 2. each and every element 5. small element of art or structure: a small element of a work of art or building structure, considered separately // French early 17th century — détail, literally "piece cut off," from détaillir "to cut up," from taillier "to cut."

After the completion of the materials lectures and exercises, the students divided into groups to study different materials in relation to specific buildings and architects focusing on the primary building materials of brick, steel, concrete and wood. The case study methodology was employed to focus on a specific detail of the building and construct it at a scale of one-to-one. Over the last three years we have conducted 14 case studies and built 13 consisting of the following buildings and architects:

Brick	Louis Kahn—Exeter Library
	Sigurd Lewerentz—St. Mark's Church
	Renzo Piano—IRCAM Center
Steel	Frank Lloyd Wright—Fallingwater
	Pierre Chareau—Maison de Verre
	Dominique Perault—Bibliotheque Nationale
Concrete	R.M. Schindler—King's Road House
	Frank Lloyd Wright—Millard House
	Carlo Scarpa—Brion Cemetery Chapel
	Tadao Ando—Koshino House
Wood	Greene and Greene—Gamble House
	Alvar Aalto—Villa Mairea
	Charles Moore—Sea Ranch

Working in groups of 6-7 each, the students prepared a 10 page research paper for each project, focusing on issues of construction and materiality, more specifically, in terms of tectonic, and historical significance. By studying the primary materials in depth, they became aware of the ways in which each architect deviated, rejected or developed new ways of looking at standard building practices through the projects. Students then chose wall sections that expressed the essence of the building and the architect's approach to materials and construction. Upon completion of the research component, each group presented their work to the class as a whole, thus allowing everyone to see the comparative value of each architect's approach.

This research allowed the students to appreciate the architect's approach to materials and building processes. This appreciation informed the student's decisions throughout the detail development and construction. For instance, the group studying Louis Kahn and the Exeter Library fully embraced Kahn's famous conversation with the brick wherein he asks the brick what it wants to be and the brick replies, "I like an arch." This lead them to the decision to construct one half of a jack arch from the library. In this section the brick is 3 rows thick but when it was suggested that they might ease their work and the structural load by creating a "false-front" to the arch by building a boxed out frame and cladding it with one layer of brick, they summarily rejected the suggestion as untrue to Kahn's principles. The impact of the this decision was great as they realized through studying Kahn's actual drawings from the library that each brick had been specially cut at different angles to create a smooth arch, not just one row but all three. Still they persevered and built the arch as intended because of their desire to pursue Kahn's principles; a desire that developed as a result of their research.

Simultaneously with the research paper, each group prepared fully detailed drawings and a study model of the wall section they had chosen to build. They prepared lists of materials, tools, and outlined construction schedules required for each wall section. Each wall section is constructed in actual full size materials, coming as close to the reality of the actual building as physically possible. Donations from the local building community supplied the majority of our building materials but when necessary we were able to purchase them with school funds. Through this part of the process, they became aware of the compromises inherent in any built work, for instance, lack of access to redwood for the Gamble House resulted in a compromise on cedar. As the materials were being gathered for the construction process to begin in earnest, preparations were made to the site.

As the building and construction process unfolded, the students quickly became aware of the limitations of the drawings and models they had previously believed to be complete representations of the details. This has often revealed failures and gaps within the translations from drawings to buildings...not just on the part of the students, but on the part of the architect's as well. For example, the Fallingwater team (working in steel to reconstruct the original Hope windows) realized that the hinges were not going to be commercially available so they spent hours designing and making prototypes of approximations of the actual hinges. In the end, their hinges were virtually identical to the originals. In addition, the entire piece had to be constructed of stock steel angles and flat stock so their previously "completed" drawings, in the form of blueprints in the shop, became an inscrutable Rosetta stone of calculations and drawings and re-drawings of each section they had to construct. These tattered blueprints remain the true testament to the thought process they went through as they built the piece.

ANALYSIS

What the case studies reveal to us at this point is the increasing lightness and thinness of wall construction. As Gropius predicted, the wall has truly become a thin veil separating interior and exterior and has ceased to be the sole determinant of space. However, several assumptions of the modern movement have not come to pass as predicted. The wall has not dematerialized, in fact, the construction and detailing of the wall has become more complicated than ever. The constructed details reveal sections of walls where transitions between opaque materials and transparent materials are sometimes impossible to understand or predict as in the case of Exeter Library and the Bibliotheque Nationale. And sometimes they reveal sections where the transition is deliberately left unresolved (at least in traditional terms of weatherproofing) in the cases of Sea Ranch and St. Mark's Church. But never do these walls and connections lack material presence.

Also, Gropius' assertion that standardization and rationalization of the construction process would provide a new architecture has not come to pass as expected. Every one of the case studies proves that great architecture includes a high degree of craft for even when standard materials were used, they were modified and sculpted by the architect to the point of obliterating the benefits of standardization. While this is obviously a limited study of the topic, the architects and buildings selected provide a fairly good cross section of intentions and attitudes to the production of architecture.

In order to fully understand the nature of the details as they exist we have to look at their placement. In physical terms the details are placed along a walkway leading directly to the northwest entry of the school of architecture. Each wall section is approximately 4 feet wide by 8 feet tall and of a thickness which varies from project to project, based on the construction type and materials. The sections rest on 6-18" deep site-cast concrete pads and are fairly permanent installations at the school. In terms of curriculum, the case studies fall in the semester after an intensely rigorous theory course and immediately before the semester that students graduate from the foundations program to the professional program. The next courses the students take are in the history of modern architecture as well as structures. By being placed prominently both physically and within the curriculum, the experience of the case study exercise shapes the rest of the student's architectural education. The long-term effects of this placement are beginning to register as the first group of students to engage the process are entering their fifth and final year.

FINAL THOUGHTS

Part of the unique quality to the course is the combination of historical significance and construction, with minimal design decisions to be made. We would argue that this is particularly appropriate for Foundations level students and that this project can take the form of a more traditional design-build project later in their architectural education. We would hope that the heightened tectonic sensibilities of the students will stay with them throughout their careers.

In a more far-reaching view, the projects which formed the culminating experience of the course provide invaluable examples of construction principles and building of Modern architecture for all students. This approach to technology through the process of construction has proved to be one of the most invigorating experiences the school has had in years. In fact, the faculty recently agreed to adopt the paradigm of construction as a guiding force for the restructuring of the entire curriculum. One possibility for this may be incorporating more materials explorations in the Foundations sequence. Another possibility may be that language used in the curriculum would reinforce notions of construction, such as "building a concept, or curriculum."

The ultimate success of the course rests in the knowledge gained by the students in going through the process. While the hands-on approach to learning is not necessarily unique, we have found this model to be particularly interesting and successful in getting students to think and feel confident in the knowledge gained by going through this process. The success of the project lead to the offering of an advanced construction principles elective in which the students spent an entire semester researching a detail and ultimately building one of their own design. Those students were also able to contribute in the second-year level course by working in the lab component to execute their own research. The long-term effects of the confidence were felt last spring as those first students to build presented a comprehensive proposal of change to the faculty in which they demanded the option of a year-long thesis for their final year.

Another by-product of the course was a reaction from those upper-year level students who had missed the opportunity to participate. Last spring a group of three got together and developed a design/build proposal for their final studio — simply as a way to get some construction experience. Their project, an art gallery and storage room, is an awe-inspiring success and has lead to multiple new commissions. They see this as an exciting alternative to a traditional practice. They feel their experience makes them better and more responsible architectural interns.

Yet another student who has just completed the course spent part of his summer continuing his study of tectonics by constructing a primitive hut on his grandparent's farm. He wanted to spend more time thinking about the topic and details he had worked on in the class and did so without course credit or payment of any kind. He spent his days building and his nights drawing and reading. He consulted in a very limited way with his family and myself throughout the process. The resultant structure and narrative are exquisite and sublime. I can not imagine a better determinant of success than these small projects and the great young minds that have created them.

BIBLIOGRAPHY

The American Heritage Dictionary of the English Language. 3rd ed. 1992.

Ford, Edward. Details of Modern Architecture. Cambridge: MIT Press, 1990.

Ford, Edward. Details of Modern Architecture, Volume 2: 1928 to 1988. Cambridge: MIT Press, 1996.

Frampton, Kenneth. Studies in Tectonic Culture. Cambridge: MIT Press, 1995.

Frascari, Marco. "The Tell-the-Tale Detail." VIA 7 (1984): 22-37.

Gropius, Walter. The New Architecture and the Bauhaus. Cambridge: MIT Press, 1965.

Heidegger, Martin. Basic Writings. Ed. David Farrell Krell. San Francisco: HarperSanFrancisco, 1993.

Le Corbusier and Pierre Jeanneret. "5 Points Towards a New Architecture." Programs and Manifestoes on 20th Century Architecture. Ed. Ulrich Conrads. Cambridge: MIT Press, 1970.

Sekler, Eduard. "Structure, Construction, Tectonics." Structure in Art and in Science. Ed. Gyorgy Kepes. New York: George Braziller, 1965. 89-95.

Semper, Gottfried. "The Four Elements of Architecture." In Search of Architecture. Trans. Wolfgang Herrman. Cambridge: MIT Press, 1984.