Conscious Construction II: A Theory-Based Approach to a Construction Technology Lecture Course

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SYNOPSIS

The research and reflections, contained in this paper, establish a theory of making and craftsmanship. The theory addresses the intrinsic relationship of the art of making and science of craft. The paper presents an experimental didactic approach to building construction technology. It proposes a way to resolve the current dilemma of the need for students to gain a basic understanding of making, craftsmanship, and learning by doing, under the restrictive and typical conditions of large class size, issues of liability, and time limits. The paper postulates that the responsibility of architects, engineers, and industrial designers, for the level of quality and craftsmanship, will continue to increase as we move into the 21st century. This will happen as the skills of the average construction apprentice are lowered, and in many areas eliminated, due to increased use of industrial assembly methods that are further linked with electronic technology.

The research led to an educational experiment, described in the paper and demonstrated by means of video. The experiment was double-faceted. It involved teams of architecture students constructing a distinct building assembly and making a video of the process. The building assembly was taken from their schematic design projects done in studio. It became a full scale assembly that employed the real materials and methods of construction, appropriate for the endeavor. The video documented the process. Its primary function, however, was to provide the students with a multisensory representational media for both communicating to the entire class, and for self evaluation. ***The video report demonstrated that this medium has the potential to give students the ability to step back, during and after the actual making, to observe and then reflect upon their art of making and the science of employed craft.***

The theoretical base established for the course was: *The designer determines the quality of construction by functioning as the master of assembly—**Archassimulare**. The art (quality) of architecture, which imparts to the building a special worth and value, is determined by the level (higher or lower) of the designer's responsibility and knowledge based authority for what is designed for construction—**Archifundare**. It follows that the study of important connections would start at an early stage of the design process. The scientific foundation of the necessary skill brought to a building site is not an important requirement of the construction assembler. Rather, it is established by the architect prior to the actual act of assembly.* The following analysis of making and craftsmanship helps to explain how the theory was developed.

MAKING

The usual definition of *making* is: to compose as parts and materials, to fashion or construct and to cause to be. Another, less familiar but more powerful, definition is: *to understand.*[1] Louis Sullivan explained this to the student, in ***Kindergarten Chats***, as he answered the questions: why should he (the student) become a poet, and how he might express poetry in architecture? Sullivan responded by explaining: poetry was a necessity of life and that one expresses poetry in all and everything that makes life worth living. He told the student that knowing how to do this would come from living life and being able to learn from the experience. To express life or any aspect of it, we must first know and understand it. He went on to say that complexity is best understood from grasping and viewing a thing from many angles and apparent contradictions. To know the complexities was to learn the "deep-down simplicities."[2]

The separation of artist and artisan in the art and science of building, which began in the 13th century, is well documented and understood. When artist and artisan were one, the skill of making was the art of building. The building artists knew the complexities and had a higher level understanding of the deeper simplicity of their art. Today, however, there is a critical need to understand that a building must be designed in recognition of the skills of workers who manufacture and construct it. Almost ten years ago, Forrest Wilson recognized that the long predicted development of industrialized labor skills had occurred.[3] Today, there has been a further increase in standardized, automated, industrial procedures and computerized production scheduling, costing, and building processes. It would be both very difficult and unfair to make an accurate judgment about the competency of today's construction workers based on pre-industrial building skill levels, methods and procedures. Wilson defined Industrialization as: "the rationalization of production, in which complex tasks are reduced to simple ones, which, when assembled, produce complex products in large quantities."[4] He concluded that the lower end of the skill hierarchy had indeed become less competent. His judgment of competency can be seen as based upon a similar concept, defined in a different context by Marshall McLuhan, as "Synesthesia," a unified sense and imagination.[5] Synesthesia clearly defines artist and artisan as unified. The semi-skilled construction worker of today is primarily an assembler of pre-designed and pre-manufactured parts. As such, they are responsible for the process of building up a complete unit from parts already manufactured.[6] This responsibility requires some sense, but little imagination. The paradox is, while construction skills have diminished, the skill requirements and responsibility of all design professionals have increased as a natural result of increased environmental, technological, legal, and financial requirements of today's buildings. If synesthesia is recognized as a requirement of the building process, then the responsibility for its provision now rests with the design professional.

From this base of responsibility, the architectural designer determines the art (quality) of construction by functioning as the master of assembly. The art of architecture comes from being responsible, and attaining knowledge based authority, for what we design for construction.[7] This can be seen to apply at a broad range of scales, from urban design to the building component connection.

CRAFTSMANSHIP

Craft is the art or skill of any occupation or profession where it is required. The title, craftsman, is not only applied to one who engages in some area of the building industry, it is also a complementary reference to such people as: musicians, writers and computer software programmers. A craftsman is anyone who takes the responsibility to understand, and seeks to attain excellence in, their craft.

Forty five years ago, Matthew Nowicki stated that, based on his study of architecture and architectural writing of the early 1920's, one could get the impression that the architect considered construction as a necessary evil. Architecture was idealized and dematerialized. He observed that almost all conditions related to structure and materials of construction become minor concerns in pursuit of form. Detail was eliminated in favor of purity.[8]

However, he spoke of a time when Walter Gropius and other young architects were arriving at their own understanding, for their time, that the machine was becoming the modern medium of design. These young designers, struggling to come to an understanding of what was really beginning to happen in the 1920's, sought to come to terms with it. Architectural craft and craftsmanship were seen as the "lost cord" between the artist and the reality of assembly like building methods then emerging.[9] The idea was not to go back to an elitist and expensive hand-made arts and craft mentality, but to improve the tools and processes. The intention was to increase the responsibility and authority of the artist-architect on work involving standardization and assembly techniques. The Bauhaus curriculum for technical building instruction was supplemented with more advanced study in design. The students became directly involved, as apprentices in training workshops, to learn about the nature of materials and the machines and methods for working those materials.

In the same period that Nowicki speculated architects had abandoned building craft, Gropius was observing that traditional master-craftsmen no longer existed. To overcome the deficit, he proposed a method of having the design student taught by both a skilled technician and faculty artist. He felt that this approach would allow for a future generation to attain a reconnection with good craftsmanship. The intention of this didactic approach was that students would become industrial designers and architects, in the coming age of advanced industrialization and building complexity.[10]

There seems to be a major conflict between the opinion of Nowicki and the direct observation of Gropius. Nowicki wrote his opinion in 1950. It may be that he was unconsciously evaluating his own time. This was, after all, when traditionally educated architects were just beginning to be confronted with the rapid spread of post-war industrialization in the building industry. A review of construction technology texts clearly shows that much of the contemporary construction materials and methods have been either invented, reinvented, or started to incur major modifications in approximately the last one hundred years. Rapid development and widespread use has only occurred since the end of World War II.[11]

Today, we can compare the craft of architecture with the essential knowledge of layering for the skillful use of CAD software. Layering provides a way to dissect, manage, and reassemble drawings.[12] This allows the designer to be able to discover design issues. Another important aspect of this issue is the reference of Chermayeff and Alexander to the *interstices* (the space between) as a way of answering some of the "crucial questions" of design at the scale of a community. They advocated the careful split of the design problem and the grouping of parts.[13]

Applied to the need for consciously understanding construction, both layering and interstices suggests that we gain a knowledge of the material parts to be assembled, the space (possible connection) between, and the skill level of the assembler. We use this knowledge to help identify important parts, separate into groups of parts that can be isolated, and then recombine the parts onto a whole. Le Corbusier seemed to sense this, in 1938, when he defined the modern architect as an organizer and not a drawing board artist.[14] This suggests that interstices and layering should occur at an early stage in the design process, then followed through construction documentation and building. The level of craftsmanship, brought to a building site, is really dependent on the depth of search, research, and layers of detail developed by the architect.

SO MANY STUDENTS, SO FEW FACULTY

From a student and management perspective, in most professional schools of architecture in the U.S., construction technology courses meet three to four hours per week and are usually required at a specific year of a student's formal education. As a result, almost every student from one class year will enroll at the same time. The course in which this experiment was conducted involved all second semester sophomores. The total enrollment, in such courses, tends to be large. While students may feel very frustrated looking at slides of construction,[15] we should recognize that many professors are also frustrated by having to show only slides to a class numbering from 50 to over 100 students. Jerry Bancroft has pointed out, in his recommendation for the inclusion of construction videos in architectural education, that travel distance *makes just visiting a construction site very problematical.*[16] Add the factor of class size and the educational management requirements increase dramatically. The original educational intentions of a construction site visit are reduced to herding a large group of students around and through the site. The faculty can only a hope that some of the students might learn and a few may understand. For similar reasons, it would be virtually impossible for one (or two) faculty member(s), even with qualified teaching assistance, to effectively (and safely) manage a building crew with so many novice students.

How the Experiment Addressed this Issue

Approximately sixty students per semester were involved in the experiment. They selected their own teammates on the assumption that this helped promote compatibility, organization, and the sharing of work. Each team consisted of only two or three students. The projects were due at different times during the second half of the spring semester. This allowed my teaching assistant and me to provide advice and guidance to each team on a regular basis. Additionally, most students did their project in the school shop. The shop became moderately active and our shop supervisor was enthusiastic about helping. He commented that he enjoyed managing the shop, when "real building" was happening.[17]

SAFETY AND LIABILITY

While observing traditional design/build studio construction exercises and reviewing published photographs of architecture students doing similar construction, it was difficult not to become alarmed by the lack of many basic safety standards, including hard hats and safety work boots. We need to address this issue because the great majority of our novice students are not aware of the health and safety hazards connected to the circumstances of a construction site. Today, these types of projects use a large amount of pre-manufactured and pre-assembled elements. We are finding that some of these use toxic materials that were not originally thought to be harmful. We should also notice that industrial machinery and electric power are normal to most building sites. If the construction project does not employ common equipment such as: pneumatic nail guns, electric saws, and backhoes, we cannot truly say that we are introducing students to the minimum reality of the modern building process. However, the potential for serious injury increases dramatically if such equipment is used without thorough training. Currently, there are many state laws that govern accidents and dangerous products. The were one million tort cases, for alleged wrongs, filed in state courts last year. A typical case takes over two years to come to trial and almost half the total cost goes to the lawyers. "It seems that lawyers constantly discover or invent new areas of potentially lucrative litigation.[18] In 1989, according to the National Safety Council, there were an estimated 2,200 construction-related deaths in the U.S.[19]

How the Experiment Addressed this Issue

The experiment recognized the reality of modern construction as having more to do with the design and assembly of relatively small component parts. It also recognizes that, in a typical (whole) building project, the student would need to be aware of the work occurring around, under, and above them, over an extended time. It is a four-dimensional activity in which even experienced workers often error. The nature of component assemblies reduced the potential for accidents. All work occurred in a supervised school shop environment and was done by teams of two or three students. A few teams went to the building industry to use shop space and equipment, under the supervision of local contractors and fabricators. Most teams reported that the project took only 40 worker hours to complete. Some of the teams reported that they kept the construction assembly area less cluttered with materials and equipment. This was due to the use of video. They wanted clear viewing and a neat appearance which inadvertently improved safety conditions.

STUDENT PREPARATION FOR THE REALITIES OF BUILDING

In the 1920's, Gropius observed that there were few, if any, true master crafters still in existence. Wilson verified and finalized this observation in 1984. Therefore, it should come as no surprise that the sons and daughters of master crafters are not currently enrolling in our architecture schools. The pedagogical objectives recognize that the majority of our students have suburban backgrounds where their primary work experiences were in the areas of food service and retail sales. Their parents are more likely to be employed in the information service industry, than the construction industry.

It is necessary to build an information and knowledge base by making (understanding) assemblies at various scales, supported by research, with sufficient layering of detail, and constructed with materials and by methods appropriate for the endeavor. A whole building design model would be made at small scale using such materials as clay, basswood, or cardboard. Next, more detailed assembly design, contained within the whole building design, would be investigated, at large scale, using the actual components, materials, and methods of construction.

How the Experiment Addressed this Issue

The students were asked to make a large scale detail assembly that was taken directly from one of their recent studio projects. The schematic building design was developed in studio. This provided a knowledge base of concept, aesthetic and function. The overall appropriateness, studied at a smaller scale, had been previously reviewed by the studio faculty. The design development and construction of the detail assembly allowed every student and student team to: do detailed research, consult with experienced building personnel, make and correct design and construction errors, be able to reflect upon what they had done through the video production and editing process. In most cases, students were able to identify problems or mistakes, and attempt to solve or correct them.

TIME

Building, and thinking about what is intended to be built, takes the sustained effort of those involved. We recognize this as extremely difficult under normal semester conditions, due to course loads and schedules inside, and outside, of the architecture curriculum. Besides having the best weather for building, summer becomes the most common time for hands-on construction classes. This automatically eliminates students who use the summer to work for next year's college costs, take advantage of travel opportunities, or pursue other needed course work.

Another person's time must be considered in this situation. The educator is also a critical component. Gropius spoke of combining the skilled technician/builder with the studio artist as team teachers.[20] Many times, it is one professor who attempts to function as both for the design/build studio. To build even a small house, and do it well, requires that the professor take on the role of a building contractor. This role is a full time job in the building industry, from the financial planning stage to finish out and clean up. A good home builder pays attention to the work seven days per week (especially if it rains). If not, something is bound to go very wrong.[21] Most architectural educators are limited in both time and reasonable qualifications to assume such a role effectively, unless it is the only role they assume on the faculty.

How the Experiment Addressed this Issue

In contrast, the experiment was an attempt to include actual making within the typical time limitation of a normal 15 week semester. It required the student teams to do detail design, research, and construction outside of regular class time. This is much the same as written research reports done for a traditional lecture course. It provided them the opportunity to consult with experienced designers and technicians in the building industry. Equally important, it recognized the normal role of the professor as one who sets learning objectives, provides guidance, acts as an enthusiastic advisor and knowledgeable resource, evaluates results, and provides response.

CONCLUSION

Making the Assembly

This part of the experiment was successful with regard to pedagogical intentions. During the course of the research and construction phases, most of the students became very aware of the weakness of their original design intentions and took steps to correct the errors. Additionally, they were able to gain a better understanding of the inherent possibilities and limitations of the materials employed.

The theoretical issue of the designer's responsibility for important connections was a major problem for some student teams. This critical element of the theory was either not addressed by some students, due to the particular assembly selected or, because a student team choose to ignore or work around the issue without addressing it in a complete manner. This area needs more review and structure in both preparation and focus. While there are connections within an individual component assembly, there should be more value to the construction of a dual or multi-component assembly, in which the interstices are explored at more than one level of complexity. This will be true if the theory is properly applied to the course of study.

The Video Report

It was during this part of the project that students reported that they began to understand the importance of research, teamwork, and time management. The primary problems in using this medium are technical in nature. Those student teams who took the necessary small amount of practice time to become familiar with the medium did very well. Their presentations were not broadcast quality and that was not the intention. However, this generation of students seem very comfortable with the medium. The use of voice overs and background music, appropriate to the visuals, was surprisingly well done, given the minimum amount of equipment available at our school. In several cases, the videos were very informative and engaging. Additional information about making video presentation is needed to improve the process and final results. This may take the form of: Tips and Hints Manual for Making Videos, and is currently being researched.

The necessity of complete, well organized written scripts and well developed story boards became very apparent during the student presentations. In a few cases, teams did not develop an adequate level of organization and cooperation. This was reflected in almost all aspects of their report. The teams that had the least success seemed to be those that were formed by default rather than by choice. Those who had done solid research and translated that information into a good script were more successful. Those teams who took the time to carefully structure the information and ideas into a complete story board had much better organization and pacing to their presentation. Those teams reported the highest level of reflecting upon what, how, and why they were approaching their construction in a particular manner. It is this aspect of the experiment that needs the most attention, organization and understanding by both students and faculty. This research project has been assigned once again for the spring semester, 1997 and will include some of the observations and recommendations stated above.

NOTES

[1] Webster's New Collegiate Dictionary, G. & C. Merriam Co. 1956.
[2] Louis H. Sullivan, Kindergarten Chats and Other Writings (New York, Dover, 1979).
[3] Forrest Wilson, "Art Comes From Being Responsible For What You Build," *Architectural Technology* (Fall, 1984)
[4] F. Wilson, "Art Comes From."
[5] Marshall McLuhan, *Understanding Media: The Extensions of Man* (New York, McGraw-Hill, 1964)
[6] F. Wilson, "Art Comes From."
[7] F. Wilson et al. explores this idea in greater detail. See: *Architecture: Fundamental Issues* (New York, Van Nostrand Reinhold, 1990)
[8] Bruce Harold Schafer, *The Writings and Sketches of Matthew Nowicki* (Charlottesville, University Press of Virginia, 1973).
[9] Walter Gropius, *the new architecture and the bauhaus* (Cambridge, M.I.T. Press, 1965).
[10] Ibid. p. 75.
[11] The review included several current texts published for construction technology education, 1993 Sweet's Catalog File, and the 7th, 8th and 9th editions of *Architectural Graphic Standards*.
[12] Mark Lauden Crosley, *The Architect's Guide to Computer-Aided Design* (New York, John Wiley & Sons, 1988).
[13] Serge Chermayeff and Christopher Alexander, *Community and Privacy* (Garden City, Doubleday & Co., 1963).
[14] Le Corbusier, "If I Had to Teach You Architecture," *Focus* (1938).
[15] Mark Alden Branch, "Building to Learn," *Progressive Architecture* (March 1994).
[16] Jerry Bancroft, "Building Construction Audio Visual Resources: Assessment, Growth, and Development," Montana State University, (1989).
[17] The shop supervisor at the College of Architecture is W. A. Austin. I take this opportunity to officially thank him. The pedagogical success that may have occurred was dependent on having both a fairly well equipped shop and a competent, good-natured, shop supervisor. THANKS W. A.!
[18] Robert J. Samuelson, "Lawyer Heaven," *The Washington Post, National Weekly Edition*, 11/35 (1994): 28.
[19] Edward Allen, "Construction is Least Safe Industry in U.S.," *Construction Education Update*, VI/I, (Fall 1990).
[20] W. Gropius, *the new architecture and the bauhaus*, pp. 72-75.
[21] This observation is based on personal experience.