Classroom and Site Integration: Utilizing Site Documentation and Classroom Assignments to Make Connections Between Theory and Practice

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Abstract

The late Italian master builder Luigi Nervi said "A good architect is someone capable of seeing the main problems of a design, capable of examining with serenity the various possible solutions, and who finally has a *thorough grasp of the technical means necessary to accomplish his project*." Ernest L. Boyer and Lee D. Mitgang, in their report Building Community: A New Future for Architecture Education and Practice, stress that the education of the architect must be integrative and include the technical knowledge to which Nervi refers[1].

A picture says a thousands words. A video provides, through moving images, an understanding of the process as well as words. Seeing the actual construction through site visits provides first hand experience and memory retention through seeing the actual process, hearing dialogue and providing opportunities to develop direct relationships between theory and practice. Relating construction theory and practice to students, especially during the early years, is a challenging task. Classroom materials, including site photographs and video, can help but not as effectively as having students experience, through direct observation, the actual materials, methods and practice of construction.

Introduction

"'Well building hath three conditions: Commodity, Firmness, and Delight.' Architecture is a focus where three separate purposes have converged. Architecture requires 'firmness'. By this necessity it stands related to science, and to the standards of science. The inherent characters of marble, brick, wood and iron have moulded its forms, set limits to its achievement, and governed, in a measure, even its decorative detail. On every hand the study of architecture encounters physics, statics, and dynamics, suggesting, controlling, justifying design. It is open to us, therefore, to look in buildings for the logical expression of material properties and material laws. "[7] These words of Geoffrey Scott, written in the early years of the 20th century, refer back to the writings of Vitruvius (1st century AD) and his *Ten Books on Architecture*.[7] They indicate a recognition of the importance for architects to understand the principles and methods of materials and construction.

This recognition has continued throughout the history of architecture and architecture education. Curricula in schools of architecture include courses in materials and methods.

Many, if not most, of the courses also include a goal to expose students to construction sites. The significant difference comes when schools combine the theory wrapping around materials and methods with construction documentation methodology and the development of the student's skills in observation, sketching and site documentation.

Context of Technical Courses

At the University of Hartford, the melding of materials and methods of construction theory, construction documentation methodology and the development of the student's observational and sketching skills occurs in the construction documents sequence of courses. These two courses occur in semester 3 (*Materials and Methods of Construction and Documentation*) and semester 4 (*Contract Documents*) in the sophomore year. These are prefaced by a first semester freshman course in drafting (*Introduction to the Architectural Process*) in which a generalist basis is established with respect to construction documents, materials theory and organization. A second semester freshman course, *Architectural Design I,* sets a base for the understanding of and respect for the role of the sketch in the education and practice of architecture.

2001-2002 AET Curriculum

Semester 1	Course	Credits
AET 110	**Intro to the Arch. Process**	**4**
AET 155	Architectural History I	4
EN 111	English I	3
ET 111	Intro to Engrg Technology	1
MTH 112	Math for Technologist I	3

Semester 2	Course	Credits
AET 113	**Architectural Design I**	**4**
AET 156	Architectural History II	4
PHY 120	Algebra-based Physics I	4
MTH 122	Math for Technologist II	3

Semester 3	Course	Credits
AET 232	**Mat. & Meth. Const./Doc.**	**4**
AET 233	Architectural Design II	4
MTH 232	Math for Technologist III	3
PHY 121	Algebra-based Physics II	4

Semester 4	Course	Credits
AET 241	Principles of M E P	4
AET 242	**Contract Documents**	**4**
AET 244	Architectural Design III	4
MTH 241	Math for Technologist IV	3

Semester 5	Course	Credits
AET 236	Mechanics of Materials	4
AET 352	Architectural Design IV	4
AUC 1	All Univ Curr Elective I	3
HSS 1	Human Social Sci Elective	3
TECH 1	Technical Specialty I	4

Semester 6	Course	Credits
AET 243	Structural Analysis	4
AET 367	Architectural Design V	4
EN 241	English II	3
AUC 2	All Univ Curr Elective II	3
TECH 2	Technical Specialty II	3

Semester 7	Course	Credits
AET 351	Design of Steel Structures	4
EN 481	English III	3
AUC 3	All Univ Curr Elective III	3
PROF 1	Professional Elective I or/	3
	Arch. Programming	4
SCI 1	Basic Lab Science	4

Semester 8	Course	Credits
AET 361	Design of Concrete Strt	4
AUC 4	All Univ Curr Elective IV	3
PROF 2	Professional Elective II	3
PROF 3	Professional Elective III	3
TECH 3	Technical Specialty III or/	4
	Senior Thesis	5

Both sophomore courses, *Materials and Methods of Construction and Documentation* and *Contract Documents* rely on a combination and balance of lecture and lab. The lecture provides the theory and professional applications through examples while the lab provides the opportunity for construction site visits or in-class student work on construction documentation.

Site Documentation: The Sketch

"The sketch is a graphic means for recording and communicating a visual experience or mental image. To be able to do this quickly and effectively is an invaluable tool which can be used in many fields of endeavor…"[6] Throughout the practice and education of architects the sketch has been the means by which architects have conveyed their intent, documented the significant buildings of history and recorded the significant personal images of their lives. The sketch today plays no less a role. In architecture programs the sketch is developed early to provide tine for the student to develop their individual skills and techniques but also to make the sketch become second nature to their thinking process. The sketch process consisting of skills and very simple materials, paper or trace and pencil, marker, crayon or whatever medium works, is an instant recording device for any experience the student or practicing architect encounters. At the University of Hartford we endeavor to instill in students the ease, immediacy, importance and, yes, excitement of the sketch. We do this by bringing the sketch into all the AET courses. We want the students to combine their innate curiosity about the built environment and design with the methods to document, analyze and understand.

The traditional use of the sketch was to develop designs, record the past and to document completed structures (or those once complete but now in ruins). We have our students learn to use the sketch to not only develop their designs and document the past but to use it to ask questions. To use the sketch as an extension of their minds throughout architecture and the process of building. Students learn to, as does David Macaulay, be "…increasingly intrigued by the nuts and bolts…Why this shape and not that? Why steel instead of concrete or stone? Why put here and not there?"[5] Asking these types of questions take our students "back to the basic design process, which itself begins with questions as engineers and designers struggle to identify and prioritize the problems that must be solved."[5]

Site Documentation: Technology

The sketch provides a "no tech" approach to site documentation, a methodology that can be used anywhere and any time. Although, during the winter months, it does have the problem of cold fingers and the resulting sketch is more sketch than image!

To supplement the free-hand sketch we introduce more technological methodologies. These range from simple 35mm cameras through video imaging and digital cameras. The obvious advantage of these is that the images captured are exact images of the work. Unlike the sketch, the film or digital images capture the precise image or, with video, the process. These also provide the opportunity to use the images either directly with the

digital files or via a scanner to convert the film into digital. The images also are quicker to capture than the sketch, providing the means to capture several images quickly.

Linkage to Class Lectures

The links between lecture, lab and site observation is made by careful development and updating of syllabus, the timing of site visits and the schedule of assignments. The lecture topic, site visit and lab exercise must be coordinated for the connection to be effective.

The lecture topics, for *Materials and Methods of Construction and Documentation*, follow the sequence of construction and the Construction Specifications Institute (CSI) sequence. This is a logical sequence for the students to follow since it parallels the construction process, is divided into logical and comprehendible groups and, for the most part, follows the documentation process as well. Thus, the CSI and lecture sequence is as follows:

Division 1:	General Requirements	Division 10:	Specialties
Division 2:	Site Work	Division 11:	Equipment
Division 3:	Concrete	Division 12:	Furnishings
Division 4:	Masonry	Division 13:	Special Construction
Division 5:	Metals	Division 14:	Conveying Systems
Division 6:	Wood and Plastics	Division 15:	Mechanical
Division 7:	Thermal & Moisture Protection	Division 16:	Electrical
Division 8:	Doors & Windows		
Division 9:	Finishes		

Due to the focus of the program on architecture, lecture materials concentrate on Divisions 1-9 and 14. An overview of Divisions 10-13, 15 and 16 is included. Divisions 15 and 16 are covered in a separate course in semester 4, *Principles of Mechanical, Electrical and Plumbing*.

Assignments for lab and outside class follow the lecture topics. Assignments include drawing details, research into historic use of materials, research into methods of construction and the analysis of existing documents. The focus for the latter is on the actual documents produced for and used during the construction of the projects we visit. This provides direct links between materials, drawings, contract documents and actual construction methods.

The construction site visits also parallel the lecture topics. The site visits, however, many times cover more than one lecture topic due to the schedule of construction.

Examples of past and current projects, goals and outcomes are listed in the following chart.

Project	Goals	Outcome
UH Magnet School (Fall 2000 – Spring 2001)	Site work and utilities	Sketch, record, analysis
	Concrete form, reinforcing	Sketch, record, analysis
	Masonry including cold weather construction	Sketch, record, analysis
	Steel erection, detailing and coordination	Sketch, record, analysis
	Coordination of trades	Observation and analysis
	Documentation and construction relationships	Analysis and observation
	Vertical circulation systems	Coordination and equipment
	Mechanical, plumbing and electrical systems installation and coordination with architecture	Sketch, record, analysis
	Finishes	Sketch, record, analysis
Alsop Meadows (Fall 2000)	Field measuring and documenting existing building	Hands-on experience, measuring techniques
	Client meetings	Client contact and review
	Design and Documents	Produce contract documents from student's design
E. O. Smith High School (Fall 1998 – Spring 2000)	Concrete form, reinforcing and cold weather pours	Sketch, record, analysis
	Masonry use and cold weather conditions	Sketch, record, analysis
	Steel erection, detailing and coordination	Sketch, record, analysis
	Finishes	Sketch, record, analysis
	Coordination of trades	
	Documentation and construction relationships	Analysis and observation
U of H Accessible Ramp (Fall 1998 – Spring 1999)	Site constraints	Existing buildings, grades, utilities, circulation documentation and coordination
	Accessibility requirements	Research and documentation
	Concrete (sloping)	Sketch, record, analysis
	Construction experience	Hands-on concrete reinforcing placement and finishing
Residence – "Log Home" (Fall 1999)	Use of wood in traditional construction and large scale members (logs)	Sketch, record, analysis
	Joinery	Sketch, record, analysis
	Shrinkage of materials	Sketch, record, analysis
	Uniqueness	Sketch, record, analysis
	Documentation and construction relationships	Analysis and observation

Resulting Reference Materials

The combination of student site visits, sketching, digital photography and CAD naturally lead to an integrated presentation for lecture materials. The lecture topics for *the Materials and Methods of Construction and Documentation* are being transformed from writing s on the wall to integrated documentation. The documents, ultimately resulting in a course companion text, Materials and Methods Handbook, as well as a corresponding web site, combine traditional text with student sketches, site photography and, in the case of the web site, links to web sites where students can find further information about the topic.

One section of the Handbook, concrete, is included here as Figure 1 on the following page.

Materials and Methods
CONCRETE

Concrete is a highly versatile material that can be used effectively in a broad range of applications including building foundations, floor slabs, the building structural system, precast exterior walls and for sub-surface utilities.
Concrete is in a semi-liquid state prior to its application. Therefor, it requires formwork be used to determine the final shape of the concrete, provide a means to properly set up the necessary reinforcing and, in some cases, to provide the finish look.
Concrete is strong in compression but weak in tension and shear. Consequently, steel reinforcing is used to provide the strength in these areas. The reinforcing may be in the form of steel mesh, commonly referred to as welded wire mesh (WWM) or welded wire fabric (WWF), or steel rods of various diameters.

Composition

Concrete is composed of:

Portland cement: lime, silica, alumina, iron

Water: clean and free of oils, alkali, acid
potable

Aggregate: 75% of volume typically
affects cost and quality
clean and free of organic material

Admixtures: chemicals added to mix to do one or more of the following:
1. improve workability
2. reduce separation of course and fine aggregate
3. entrain air
4. to accelerate or retard setting and hardening

Reinforcing: use to provide tensile strength
Corrosion of reinforcing must be avoided by proper design and attention to the types of admixtures

Portland Cement: Type I: normal cement; residential applications; 28 day strength
Type III: High early strength; all types;

Figure 1: Sample page for Integration of Lecture Material and Site Visit Documentation

Conclusion

Opportunities to provide experiences for students that link classroom lectures, lab exercises, research and theory can not be denied. Walking through a construction site shortly after being exposed to the theory of materials and construction or after doing a lab exercise gives the student a connection to the applicability of what we teach and the real world. Walking a construction site brings the senses to bear on what was previously bare facts and flat images. On a site visit, students see the various trades in real time; can follow the flow of materials from staging to installation; see the coordination and integration of trades; hear the dialogue between contractors and contractor and architect; and can see, feel, smell the very materials they are detailing in the lab.

Simply walking the site, however, does not make the most of the opportunity. Students must document their experience. The process of documentation requires students to think more fully what they are observing. Technology provides the means to record the images and the movement. Important and lasting references for further study, analysis and understanding. The sketch provides the means to record what the student is seeing with their own hand. The sketch, while not as accurate as the photograph or video, is a necessary tool on the site. When one photographs or videos a site the camera does the work. When one sketches, the eye, mind and hand of the observer must work together. The act of sketching requires one to look closer at the scene. The sketch can capture the essence of the scene quickly and fluidly.

Site visitation for architecture students will always be an integral and important part of the educational experience. The challenge is to make the effort to search out the appropriate construction site and to work with all parties involved, owner, architect, construction manager and contractor, to provide the best overall experience for the student. The site experience extends beyond construction. It can teach the student the roles of the owner, architect, construction manager and contractor in a real environment and with real challenges.

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