FROM FOUNDATIONS TO INTEGRATION IN STRUCTURES: A Response to Curriculum Consolidation

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ABSTRACT

Integration of technology within design education has taken various forms and has been widely debated as to methodology and effectiveness. Prior to 2008, the curriculum in the four year program of Environmental Design relied on core lecture courses to provide structural and environmental systems instruction. Upon the enactment of legislation by the State requiring that all degree programs at publicly funded institutions have no more than 120 hours of coursework unless accreditation requirements could not be met, the program was faced with the reduction from 135 credit hours to 120. Based on years of discussion to revise the degree program and faculty interviews with the Academic Affairs committee, the proposal for the new plan of study was presented in the fall of 2007 and quickly passed by the University Curriculum Committee. Then discussion for the implementation the following academic year began.

The changes affected the technology coursework by scheduling it in the last two years of the program, but more significantly, the second course in the structures and environmental systems course series were eliminated to in order to offer "integrated" technology experiential learning and direct application in the first semester senior design studio.

This paper addresses the response to the curriculum consolidation with respect to the structural technology courses (from foundations to integration), the planning and collaboration, the first and second integrated design and technology courses offering, the successes, lessons learned, and challenges still to be faced.

KEYWORDS

collaboration, structures, design, pedagogy

INTRODUCTION

In 2005, the legislature of the State of Texas enacted a statute limiting the number of semester credit hours that a public university requires for any bachelor's degree to 120 hours applying to degrees awarded to students enrolling in the institution in the fall semester of 2008 and after[1].

At the time the legislation was enacted, the four-year undergraduate architectural design program of Department of Architecture at Texas A&M University required 135 hours to earn a Bachelor of Environmental Design degree. The program consisted of design foundation and required courses at the first year, with materials and methods, first level technology, history and theory courses with design detailing, and a studio in the second year. The third year consisted of a study abroad or intern semester with electives and a semester of design and advanced technology courses. The final year consisted of studios, professional practice, electives and government courses required by the State of Texas.

Circumstances

The formation of a proposal to restructure the curriculum and meet the 120 hour mandate began in early 2007 – at the same time that preparations were beginning for an accreditation visit by the National Architectural Accreditation Board (NAAB) in the spring of 2008 for the professional degree program with review of the supporting undergraduate program. It was with the close examination of the student performance criteria outlined by the NAAB[2] that the process of reducing of the program hours was undertaken.

PROCESS

The administrative team developing the proposal, which would need approval by the department before being submitted to the University Curriculum Committee, initially focused on providing a studio in every semester having a progressing themes and context while core or supporting classes were assigned in the beginning of the plan of study. This proposal was provided to the faculty late in the spring semester of 2007 to solicit comments.

The proposal was to change the structural technology coursework, consisting of two sequential courses of an introduction to statics, mechanics of materials and design taken in the 2nd year, and structural design taken in the 3rd year, to a foundational course in the 3rd year in preparation for a course focused on integration with studio design in the 4th year. A materials and methods course was also specified in the plan.

The faculty of the existing courses investigated the structural technology instruction required at well-established programs after one of the reasons for the change was identified. It was noted that the administration believed there was "too much" structural instruction because a recent graduate was waived a course in another master of architecture program. The 5-year programs reviewed commonly had distinct structural technology coursework, often more than 2 courses, while the 4-year programs were mixed with some offering separate coursework, or combining the technology content into courses entitled "Construction".

The faculty of the existing courses was supportive of the change, while well aware that integration efforts in their courses and in those of other programs had varying levels of success without validation by the studio instruction[3,4]. They also felt the new sequence would provide the students with a positive reinforcement of the correlation between technology and the design studio, and dispel the opinion of some students that technology is a separate course they just need to "pass".

As input was solicited and received from the affected faculty, particularly with respect to allocation of faculty resources and time, the final proposal in the fall of 2007 contained the new sequence of foundational and integrated technology courses, but no longer provided a materials and method course.

When the curriculum plan was present to the University Curriculum Committee at the end of 2007[5] the background information stated that the curriculum prepares students to enter a professional degree program without duplicating courses that can be taken at the master's degree level. It also stated as significant changes to the degree plan that lecture course content from courses no longer required were integrated into the design studios, and that the foundation level studios increased in credit hours while the upper division studios were reduced in credit hours. It stated that a new fourth year studio had been created and linked to required courses in integrated systems and structures.

The following course descriptions were approved:

Foundations Structures: Introduction to the physical principles that govern statics and strength of materials through the design of architectural structures from a holistic view, in the context of architectural ideas and examples; introduction to construction, behavior of materials, and design considerations for simple and complex structural assemblies; computer applications.

Integrated Structures: Selection and economics of structural systems in the context of integrating structural systems into a building through good design; analysis and design of wood, steel, concrete, and composite systems and members in relation to building design.

Integrated Studio: A comprehensive design studio focused on the integration of design theory with functionally sustainable environmental and structural systems; consideration of a project from site analysis and programming through design detailing.

Preparation

While the transition for the currently enrolled students who could change curriculum plan to take advantage in the reduction of courses required to graduate was not flawless (and could warrant a separate discussion), the main focus for the next academic year was to determine the method of delivery of the greatly expanded material at the foundation level, identify who the faculty involved could be, and how to offer the old courses (for those continuing under the previous curriculum) in parallel with the new courses.

The preparation, particularly for the foundation courses that coming fall (while the integrated courses would begin the following fall) relied on a model proposed by a design faculty who taught studios at the upper undergraduate and graduate level (Figure 1). The structures faculty was also invited to visit and provide guidance for a senior level studio once a week during the second half of the spring semester before the new courses were to begin. The studio project involved a long span sports and entertainment venue.

The plan for the new foundation structures course was rather lofty. It called for covering three main areas; I. structural analysis and design, which would include statics, mechanics, design codes, load calculations and design based on material; II. structural behavior and assemblies; and III. system selection for architectural design, which would include span lengths, building heights, grids, load tracing, foundations and material systems. In addition, it called for incorporating holistic exercises such as conceptual sketches, spatial orientations or vignettes to replace analytical exercises.

The traditional order of examining component behavior (the “little picture”) and then assemblies after understanding forces and material behaviors, was shifted to focus on system planning, requirements and design issues (“the big picture”) up front.

The structural design content repeats the order of beams, columns, and connections for the primary materials of timber, steel and reinforced concrete, with an introduction to masonry design.

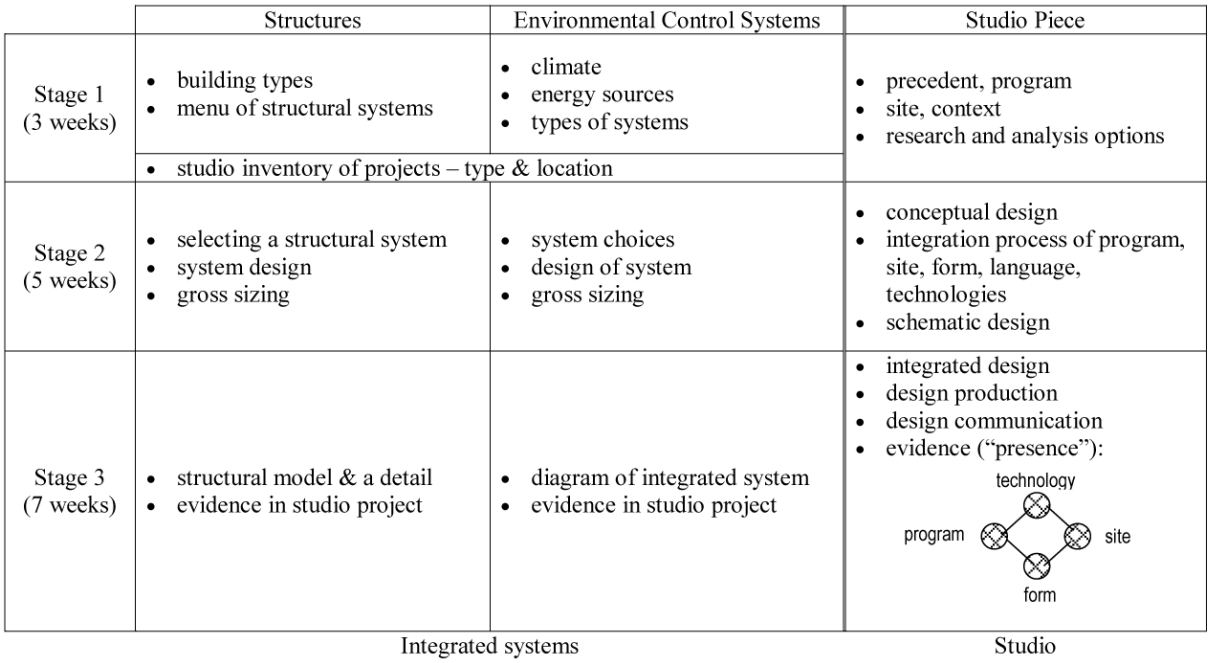

Figure 1: Integrated Studio Model.

The plan for the new integrated structures course was contingent upon who the faculty members were that would be assigned to the integrated studio, their coordination with the technical faculty, and the scheduling. It was envisioned that the integrated courses would consist of a lecture prior to studio once a week and visits to 2 studios on a weekly basis, resulting in biweekly visits to each studio section.

The schedule for implementation was to plan the integrated studio and technology course syllabi based on the model by the end of 2008, and in the spring of 2009 to identify the studio faculty and pairings and bring them into the discussion.

For the first implementation of the integrated courses it was decided to offer only two sections of the integrated studio while the remaining five sections were instructed as they had been under the 135 hour curriculum. The students enrolling in the sections were aware that the studio would be challenging and a new opportunity.

Upon the final appointment of the two studio faculty, it was determined that they would develop one project with input by the technical faculty on the corresponding technical information the integrated technology courses could provide. The project type chosen was an institutional building with long span or large space and small spaces requiring zoning and control with the environmental systems. The phases of the project were proposed as the following:

Design charrette
Site inventory
Alternative schemes
Program
Schematic bones modeling
Spaces and placeholders
Schematic integration
Schematic development
Schematic drawing set
Spaces for development system diagram
Spaces, structural and systems diagrams
Delineation of spaces and lighting

For the first half of the project, the integrated technical courses would focus on content, while in the second half they would primarily concentrate on desk critiques.

With the content and deliverables taking shape, attention turned to how to evaluate the student performance, particularly with respect to credit for each of the three courses in the integrated studio set.

IMPEMENTATION

The new foundation technology courses were first offered in the fall of 2008. Students who had taken the first of the old sequence were encouraged to take the new foundations structures course to learn the content in the second half of the course, but very few did so. The content of the new foundations systems course was not affected by sequenced material.

The students found the course load for the fall semester they were on campus (versus study abroad or internship) to be extremely challenging, with the majority of the students able to learn and apply the expanded content of the foundations structures class. The students who had studied away the fall semester were unprepared for the accelerated pace upon their return in the spring.

First Studio

The new integrated studio, integrated structures and integrated systems courses were first offered in the fall of 2009. For the subset of students who were eligible (by having all the prerequisites) there were two studio sections offered.

The two design faculty met regularly to plan the phases of the common project worked on by design teams of two students. There was a single structures faculty member for the two sections, while there individual systems faculty were assigned to each section.

The studio project, which the students worked on primarily in teams of two, consisted of a new library with an auditorium to be located in the downtown of a neighboring community to the college campus. An example of student work with the integration of structure is shown in Figure 2.

The integrated structures course was structured around homework assignments, in-class exercises specific to the project, the project at midterm, and the final project. There were tours of campus buildings and construction site visits.

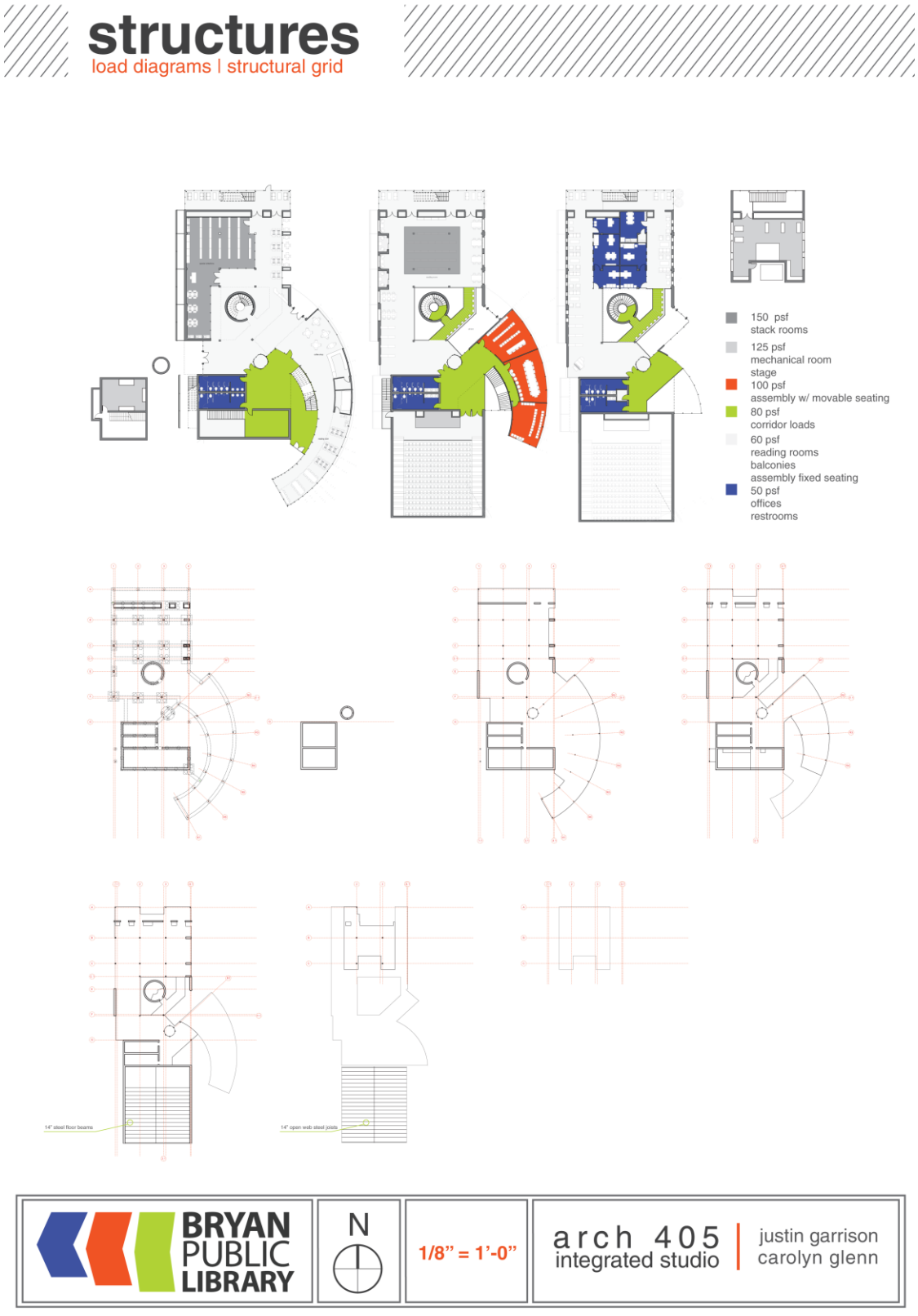

Figure 2: Example of Student Work - Fall 2009.

Students also presented a case study. Office hours were used as time in studio for consultation.

The weekly lecture, which met in the studio spaces thereby enhancing the integrated experience and provided the atmosphere like that of a design office, followed the topics listed below:

System Assemblies and Load Tracing
Design Loads and Structural Performance Requirements
Structural Systems Selection
Methodology and Building Codes
Reading Drawings
Foundation Selection and Design
Design for Lateral Loads
Wood Construction
Steel Construction
Concrete Construction
Masonry Construction
Composite Construction
Connections
Structural drawings

Second Studio

In the fall of 2010, the integrated studio and integrated technology course set was offered to all students in the degree program at the fourth year that had completed all prerequisite course work. There were a total of six sections; two sections for each studio faculty member who had taught the first offering, and two sections by design faculty that had not previously been involved.

All studio sections were "paired" with the one faculty member who had taught the first offering of integrated structure, while two additional systems faculty were assigned along with the two systems faculty that had taught the first offering of integrated systems. (Only one combination of faculty was replicated).

With only three lecture times available each week, two integrated structures sections met together in the adjoining studio spaces.

The integrated structures course followed the same format and topic list as the first offering with office hours used as time in studio for consultation in addition to in-office hours. For the in studio office hours, the structures faculty moved from studio to studio to attend to each design team. During the concentration on integration of structure in the studio project, consultation was offered nights and weekends.

The studio projects were coordinated for only the studios of the faculty who had coordinated projects in the first offering. Because they had two studios each, they paired one section each to work on a fire station project and on a library for the 21st century at the same site in a downtown nearby the university as used for the project in the first offering. The students worked primarily in teams of two. The other studio faculty independently chose senior centers for their projects. Of these studios, one had individual student projects, while the other allowed the option of individual or two-member team work.

In addition to practice assignments and exercises for the integrated structures course, the design teams were required to present preliminary framing plans at midterm. The final project requirements included a structural (bones) model, color coded floor plans based on live load values and location, materials selection criteria with general and project specific advantages and disadvantages, a description of the framing and lateral resistance, structural detail drawings, structural innovation, and design calculations for a beam and column. Each student was to construct a scale model of a structural detail from their projected they found of interest, preferably one that was exposed. The majority of the requirements could be included on the final presentation boards, while the additional evidence was presented in a report. An example of student work with the integration of structure (framing plan) is shown in Figure 3. An example bones model and detail model of the tubular beam, column and floor system are shown in Figure 4 and Figure 5.

RESULTS

The first implementation of the integrated studio and integrated technology courses required weekly planning sessions by the design faculty involved, and communication with the technical faculty. The major observation on the delivery of the courses included the coordination of the teams and agreement on expectations for the design, the systems, and the structure, and the lack of contact hours to adequately provide desk

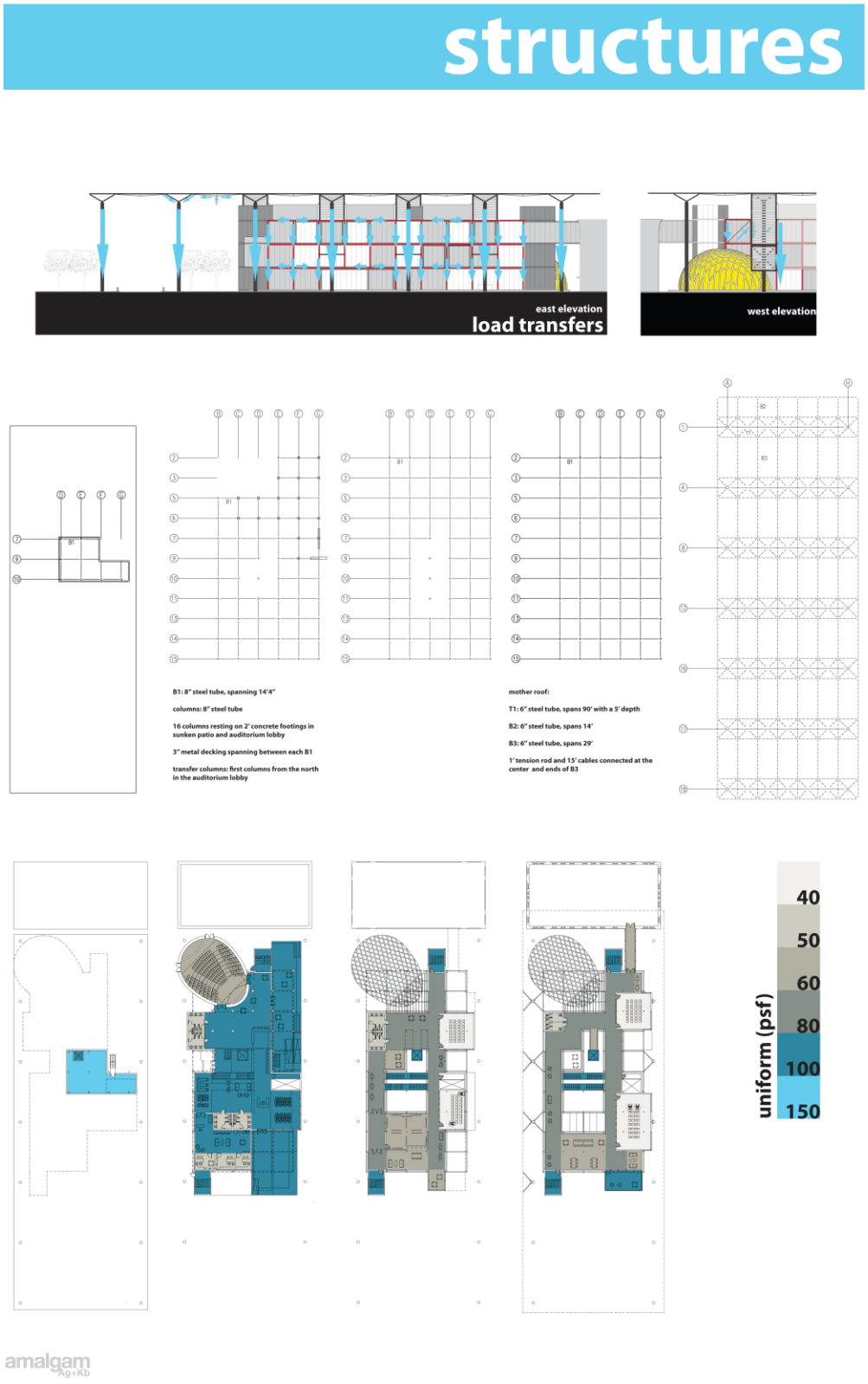

Figure 3: Example of Student Work - Fall 2010.

(full “bones” model)

(model detail)

Figure 4: Example “bones” model (left and right).

Figure 5: Example detail model.

critiques. The correlation of assignments across the courses wasn’t feasible because the critical questions were unique to each design. The discussion of the minimum level of preparation by the students with respect to the design instruction through the entire curriculum began in earnest.

Positive Outcomes

The work by the students of the first integrated studio, structures, and systems instruction surpassed the work by students in the traditional fourth year studio. The work drew significant discussion and excitement by its innovation during the external review of the Environmental Design program late 2010.

The students personally commented that they found the technology integration exciting, and a formal exit survey of the students validated the favorable opinion of the studio experience with respect to the interaction with the faculty, project scope and planning process and the coordinated reviews with the two sections.

The students of the second implementation of the integrated studio courses reported learning a great deal from the discussions with the design faculty and integrated technology faculty within studio, while the faculty found it useful as well to limit the amount of repetition of material from project team to project team when they encountered similar issues.

Students of the integrated studio courses also reported that they were being admitted into graduate programs without being required to take leveling courses like their peers who did not have integrated projects to present in their application portfolios.

For the first implementation of the studio, the structural (bones) model was required by one the design faculty. The students found the bones models to be extremely helpful for envisioning the structure within the design. With the second implementation, the project was required of all the integrated structures sections in coordination with the studio faculty to when in the design process the model could be constructed.

The quality of the project depth and presentation has significantly enhanced the student portfolios submitted for admission to graduate programs in the spring semester following the integrated studio. At least one student from the first offering found a passion for the integration and is currently pursuing a joint masters' degree in architecture and structural engineering.

It was also observed by one integrated studio faculty that the level of excitement and interest at the review of the projects was greater than any experienced throughout their affiliation with the department.

Difficult Lessons

As mentioned earlier, the major impediment to obtaining the course goals was the imbalance of the contact hours by credit hours both in the studio and for the technology faculty, particularly with respect to time spent in the studio for both the first and second studio offering. One technology faculty found that by starting the lecture early and working through the brief break between lecture and lab hour, he could get more material covered.

The structures faculty found the schedule of lectures for the combined sections, in addition to the time in studio on individual projects, to be less than ideal because of the specific issues for each studio. The possibility of scheduling the lab time for the sections at the beginning or end of studio time which could be used for consulting is prohibited by the university. (Student cannot take multiple classes scheduled at the same time.)

In addition, the point at which the students were able to construct a structural (bones) model with the development of the design varied from studio to studio, requiring careful monitoring of the deliverable schedule for all six sections. And the proximity of the general lessons, such as with foundation design, to the application of the material, often at the last minute, often resulted in incorrect and inappropriate incorporation in the students' designs.

The physical location of the studios hindered the observation by all integrated design student amongst the projects of the integration levels being achieved and desired. Some technology faculty found lecturing with computer technology commonly used in their teaching to be unusual or difficult in large, well-lit studio spaces.

The students of the studios in which individual projects were either required or optional expressed dissatisfaction with the clarity of the scheduling of the benchmarks at which the integration should occur. The students, in general, were keenly aware when there was a difference in the direction for integration as suggested by the studio faculty from that suggested by the systems faculty.

For the second implementation, it was observed that the overall level of quality was lower than the first implementation, which was attributed to the level of the students who chose the integrated studio at the first offering.

A significant difficulty arose when there was a difference in the level of performance by a student in the studio, the integrated structures course, and the integrated systems course because the work was interrelated. The problem occurred most often with the integrated technology performance as substandard.

PROSPECTUS

As the refinement and response to the peculiarities of the integrated studio instruction are evolving, the impediments have been primarily institutional rather than cultural.

Determining the minimum level of contact hours and increasing the contact hours for credit hours is being pursued and supported with evidence for the justification. In addition, ways to increase the quality with the time constraints, possibly by requiring coordinated projects between two or more studios, are also being investigated.

The assignment of the studio faculty to the integrated course is subject to staffing, qualification, and interest prior to each semester of the integrated studio, while the addition of a structures faculty for the next offering is anticipated. The importance of communication and clear goals, along with the technology required on the final drawings and the items listed on the design review forms, will continue to be emphasized to the new faculty involved in the integrated instruction.

The creation of space dedicated to provide proximity of all integrated design studios is in the proposal stage, and is expected to raise the level of integration across studios as the students work together outside of formal studio hours. It also is expected to reduce the repetition of material specific to the project stage when project teams can gather for impromptu lectures.

SUMMARY

The process for the development of studio instruction focusing on the integration of structural and environmental control systems technology was prompted by a real need to reduce the number of credit hours for the undergraduate program in environmental design as mandated by legislation. The desire to provide students with the skills and knowledge to adapt to the rapidly changing profession, while satisfying the student outcomes required by accreditation (which reflects the body of knowledge for preparation to practice) informed the nature of the curriculum revision.

The foundation technology courses, and in particular, the foundations structures course was developed to provide the basic concepts, skills, theory, and general design knowledge necessary to prepare students of the integrated studio and integrated structures courses to apply, integrate, and produce architecture of quality, and enable a valuable experience in preparation for the practice of architecture.

The mechanics of the application with focus on critical areas of integration continues to be refined, as with any good design, but the value of the curriculum change for the students and undergraduate design program will continue to be evident and exciting.

NOTES

Figure References

Figure 3: Work by Kali Barber and Allyson Gray

Figure 4: Photo by author (Holliday)

Figure 5: Photo by author (Holliday)

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