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Enhancing Communication in the Design and Construction Industry through Multi-Disciplinary Education

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The Architecture and Construction Industries are struggling in their attempts to work as a team in the successful delivery of projects. To a large degree this is the result of a lack of understanding of the needs and processes required by each respective industry. Attempting to address this situation early in their "careers" and to promote better understanding and communication between Architecture and Construction, the College of Architecture at South Central university brought together four disciplines to collaborate in a multi-disciplinary team approach to develop schematic design alternatives and construction budgets for a high-rise office building. Students from Architecture, Construction Science, Interior Design, and Landscape Architecture worked together to deal with issues of building design, site design, interior design, presentation, project management, construction estimates and construction scheduling. This initiative enriched learning beyond the confines of a single course or discipline. More reflective of a real-life situation than the typical University classroom experience, it exposed students to the necessities and complexities of working as a team, along with the achievements teamwork makes possible. Such a foundation is vital to success in the Architecture and Construction Industry as increasing emphasis is placed upon alternative project delivery systems.

Key Words: Multi-disciplinary Education, Teamwork, Construction Education, Construction Industry Cooperation

Introduction

Seeking to understand and to be understood, four disciplines in the College of Architecture brought together students to collaborate in a multi-disciplinary team approach to develop schematic design alternatives for an Edge-City Tall Building project. Students from Architecture, Construction Science, Interior Design and Landscape Architecture worked together to deal with issues of building design, site design, interior design, presentation, project management, construction estimates, and construction scheduling. The decision to attempt such a complex project was based on the instructors' mutually shared perceptions about the lack of understanding among the four disciplines in both the College and Industry. The instructors saw this approach to collaborative learning as an opportunity to foster better understanding, communication and teamwork that would better prepare students to meet the demands of the rapidly changing architecture, interior design and construction industry. This initiative enriched learning beyond the confines of a single course or discipline. More reflective of a practice experience than a University experience, it exposed students to the necessities, rigors, and achievements possible through cooperation. Such a foundation is vital to success in creating the built environment.

Course Objectives

In addition to the specific goals of each individual course, the following joint objectives were established:

1. To create a cooperative learning experience for all disciplines involved.
2. To require students to communicate outside their disciplines, to work in teams and to adhere to schedules set to assure success for the total project.
3. To develop a sense of the roles and responsibilities of the various disciplines.
4. And finally, through the shared use of an assigned project, to familiarize students with the level of detail required to accomplish the work of different disciplines.

Disciplines Involved

Architecture

The architecture students participating in this project were all fifth year students. They were in their last semester design studio that is a capstone course for their Bachelor of Architecture degree. The Tall Building Project lasted the entire semester. Eleven students enrolled in the course. In addition to the final review, their semester grade was based on interim evaluations of various subsystems designed for the project. Each student was required to prepare a Project Manual recording work plans, schedules, and the design process. They met on Monday, Wednesday and Friday from 1:30-5:30 PM.

Construction Science

The thirteen Construction Science students were enrolled in a graduate level estimating course. The Tall Building Project represented approximately fifty percent of their semester grade. That portion was broken down into twenty percent for a feasibility estimate and thirty percent for a conceptual design estimate. The latter required a formal presentation to the Architecture and Interior Design students who then selected the best team proposal. Scheduled class times were Tuesday and Thursday from 4:30 to 5:45 PM.

Interior Design

The Interior Design students were all fourth year students in their last semester design studio that is the capstone course for the Bachelor of Interior Design degree. Nineteen students were enrolled. The Tall Building Project represented approximately twenty-five percent of their final grade and was one of three projects completed during the semester. This project was assigned at the beginning of the semester so that the Interior Designers could have input as the architects developed their designs. Only during the last four weeks of the semester did they concentrate fully on the Tall Building Project. Their high-rise designs culminated in a formal joint presentation with the architects. The Interior Design studio met at the same time as the Architecture studio, but in a different location.

Landscape Architecture

The Landscape Architecture students were second year graduate students. The Tall Building Project was assigned at the beginning of the semester and represented approximately fifteen percent of their final grade. Five students were enrolled in the class. As a group, they were required to conduct a site analysis. Periodically throughout the semester, each student was required to consult with two different architecture students on site design issues. In addition, group critiques of each design occurred at mid-semester and again near the end of the semester. This studio met at the same time as the Interior Design and Architecture studios, but in a third location.

Project Requirements

The project involved the design of a fifty to sixty story building. Located on a twenty-acre site at the periphery of a metropolitan area next to a major mall on a main highway, the skyscraper was to house a hotel, a corporate office complex, and tenant office space. The respective areas broke down into roughly one third of the total for each. Design criteria are listed below:

1. The maximum gross square footage was to be 900,000 square feet.
2. The net usable square footage was to be at least seventy-five percent of the total gross square footage.
3. The minimum floor plate size was limited to 15,000 square feet, while the maximum floor plate size was limited to 24,000 square feet.
4. Office space was to be within 40 feet of an exterior window.
5. Office parking required 1,285 spaces and hotel parking 450 spaces.
6. Elevator banks were to be separate for hotel and office functions.
7. The building was to conform to the 1991 BOCA Building Code.

The hotel was to provide 300 rooms and 150 suites for guest accommodations. Additional space requirements included a lobby, reception, administration, housekeeping, Laundromat, lounge and restaurant, shops, and banquet and meeting rooms.

Team Responsibilities

Architecture Students

The architecture students were given the role of Architect in the service of the Developer for the Tall Building. They were required to produce a set of schematic design documents to include floor plans, elevations, sections, structural diagrams, elevator operation diagrams, and a model. Along with these requirements, they were responsible for maintaining a Project Manual that recorded the design process. This included library searches into the history and style of tall buildings, structural and mechanical information, code checks, sketches, photos and notes from field trips, calculations, interim review notes and evaluations, and a work plan logging time spent on each task. Additionally, the architecture students were responsible for the coordination of efforts by other disciplines. This included the receipt and distribution of information and

drawings, scheduling meetings and work sessions, devising compromises to resolve misunderstandings and conflicts, and integrating the opinions of others into their design. This last requirement was particularly important because the interior design students were the designated representatives for the two major tenants whom the Developer had agreed to accommodate.

Construction Science Students

The construction science students were given the role of General Contractor. Their first assignment was to work in teams of four to produce three feasibility estimates based on low, medium, and high quality standards of construction. These estimates were presented to the architecture students in three formal packages. Each written proposal included a cover letter, all inclusions and exclusions, and a breakdown of the estimate into foundations, substructure, superstructure, exterior closure, roofing, interior construction, conveying systems, mechanical and electrical systems, any special construction, site work and general conditions. Based on the estimates and in conjunction with the architecture students, the construction students were then to select three designs, which they would monitor as the Architects, developed them. Lastly, they were to choose one of the three fully developed designs for the final schematic design estimate. Along with this final estimate, they were to develop "company" marketing materials and give a formal presentation to the architecture and interior design students. Staged as an interview with representatives of the Owner (Architecture, Interior Design and Construction Science faculty), the students were to demonstrate their qualifications in order to be selected to join a partnering venture with the Developer's team. This scenario was chosen to reflect the increasing popularity of alternative delivery methods in today's industry.

Landscape Architecture Students

The landscape architecture students acted as Consultants to the architecture students and were responsible for collecting initial site data related to environmental factors (sun, wind and the elements), transportation and access, detention and retention of water, earth formations, and parking. Periodically they met with the architects to review site plan development, providing input and critiques related to opportunities and constraints for each design. Originally assigned to consult with two architects each, the landscape students soon initiated group critiques for each architect. They were not required to prepare any presentation documents.

Interior Design Students

The interior design students were assigned the role of Interior Designer, but acted more like joint venture partners than consultants because they functioned as sole agents for the Corporate and Hotel Clients upon whom the Developer was dependent if the project were to succeed. They provided the architecture students with their Corporate Client's preferred spatial organization. The architecture students were required to insert these requirements into their skyscraper design. In addition, the Interior Design students were responsible for developing detailed floor plans, interior elevations and perspectives, and selecting materials, finishes, fixtures and furniture for the Hotel portion of the project. They also acted as Consultants to the architecture students throughout the semester to provide input on space allocation, accessibility and circulation, core

and room layouts, materials selection, and color choices. Finally, they shared responsibility with the architecture students for the formal presentation.

Consultants And Field Trips

Besides the usual responsibilities of coaching students on how to achieve their design goals, the studio faculty (Architecture and Interior Design) responded to requests for information and clarifications in much the same way as would representatives for the Developer. Other faculty, who teach structures and controls, agreed to act as engineering consultants. Industry volunteers (Kawneer, Montgomery Elevators, etc.) agreed to cooperate with students as manufacturers' representatives. They lectured, provided technical manuals and analysis, sponsored field trips, and gave the students samples of their products.

A Dallas based architectural firm (HKS) with tall building experience arranged for the students to visit I.M. Pei's Fountain Place, along with two other high-rise projects. Students toured behind the scenes facilities of each. HKS also presented a general overview of tall building design for the students before the site visits. After the tours, HKS was host to a question and answer session. Students then formed discipline specific groups to talk with experienced architects, engineers, interior designers and cost estimators.

Other field trips included visits to the site, to a curtain wall installation under construction, and to a glass supplier's fabrication shop.

Process

Preparation

Throughout the semester prior to this class, faculty and consultants brainstormed and strategize to create a syllabus and to integrate the project into the spring 1995 semester workload. Sabbatical leave for one of the architecture instructors greatly reduced the formal project management component. A standard hypothetical high-rise project was selected for use in this class.

Execution

During the first week of the semester, the Landscape Architects and Architects visited the site. The Interior Designers were teamed with the Architects and began research into plan types for the corporate office space and the hotel. While the Landscape Architects performed their site investigations, the Architects began the first of two intensive design charettes. By the end of the fourth week, they had each completed concept models for two alternative schemes. Meanwhile, the General Contractors formed three teams and began their feasibility estimates based on generic information and assumptions that would yield low, medium, and high results. At the end of the sixth week, they presented their results to the Architects.

Concurrently, the Architects selected the alternative each wished to develop and began work on the core. The Landscape Architects distributed their site report and pulled off to do a project for another "client". Likewise, the Interior Designers were involved with another project, but kept abreast of developments and provided input on their own initiative. During the third week of the semester, Architects, Interior Designers and Contractors made the Dallas field trip to tour skyscrapers and the HKS office.

After the feasibility study presentations, the Architects selected three projects out of the eleven under development that seemed to best represent the low, medium, and high categories. Each designer was to be responsible for maintaining the flow of information to the Contractors so that by week ten a decision could be made as to which of the three would be chosen for the final estimate. As discussed later in this paper, this process did not work as well as had been envisioned by the instructors.

Outside consultants dominated the middle period (weeks 6-12) of the schedule. Montgomery Elevator representatives presented their vertical circulation analysis. Kawneer presented their curtain-wall system and donated technical manuals. A mechanical engineer explained HVAC systems for high-rise buildings. The structures faculty consulted individually with each team. A glass supply house, an authorized Kawneer fabricator and installer, sponsored a construction site visit and donated samples of glass.

Also, during this period, the Landscape Architects reviewed the site development progress once officially, and several more times on their own initiative. The Interior Designers followed a similar pattern of self-initiated work sessions with their respective teams. The greatest burden of responsibility fell on the shoulders of the three teams interfacing with the General Contractors. The instructors had hoped these three teams would take the lead in making choices and documenting their design decisions. Unfortunately, this did not happen which forced the Contractors to select the project for their final estimate based on which team demonstrated the most earnest response to their requests for information and documentation. Even so, a series of deadlines were not met which compromised the optimum learning potential the instructors hoped to achieve.

By the eleventh week, the Interior Designers were back on the Tall Building Project full time. During the twelfth week the Landscape Architects concluded their participation with a group critique of all eleven-site designs. The thirteenth and fourteenth weeks were given over to preparations for the final review. During this period the General Contractors were completing their estimating and scheduling packages for formal presentation at the end of the semester.

The final review was held during the final week of the semester with eleven teams of one Architect and two Interior designers presenting their proposals to a review panel consisting of three practitioners and the two design studio faculty. The General Contractors presented their proposals to the Construction Science instructor, the two design studio faculty and the Architects during their final class session.

Results

Each discipline became much more aware of the various roles, responsibilities, benefits, and constraints of the other disciplines. The architecture students recorded this information and many more aspects in their Project Manuals. The interdependence of each discipline in completing the total project led to a clearer understanding of the need for cooperation. With eleven design teams and three estimating teams working on the same project, differences in the way people learn and at what speeds had to be accommodated. When drawings were incomplete or decisions vague, other disciplines were adversely affected. Peer pressure and the effects of interdependence served to motivate students in a way more characteristic of the work-place environment than the usual classroom setting. Every student who participated learned what it means to work as a team toward shared goals, to perform tasks based upon a schedule, and to effectively deal with the complexities of collaboration through communication and cooperation in an atmosphere of mutual respect.

The tangible products that resulted from this effort were not as impressive as student work in previous years when the team approach across discipline lines was not attempted. As with all explorations, the element of risk is very high and acts as an inhibition to creativity. This effect will surely diminish with repeated attempts and associated refinements. Any project in which four disciplines collaborate requires an enormous amount of extra coordination and planning. The Architecture Design studio instructor assumed the responsibility for these tasks. With repetition, the time required to meet this responsibility effectively will also diminish, freeing the instructor to more actively coach the architecture students to produce more creatively. Because of the inherent complexity in the Tall Building Project and its rarity in the building industry in this country, another building type may be better suited to this kind of team approach. Indeed, it may be more desirable to introduce this type of collaborative learning at an intermediate level in the respective curricula. This would give students a more accurate understanding of how work is accomplished in the professional world and would allow them time to reflect on what skills they need to develop during the balance of their education.

This class was particularly enlightening for the construction class, the Architect and the two Interior Designers whose project was selected by the Contractors for their final conceptual estimate, schedule and formal presentation. With so much of their "profits" (grades) depending upon the work of others, the Contractors soon realized that they were not in control of their own destiny. The final deadline for their presentation could not change, while everything else in between the beginning of the semester and their final presentation could and did slip, leaving them less and less time to accomplish their tasks. With only four weeks remaining in the semester, the Contractors took charge of the entire situation. On their own they sought out the Architects, determined which Team could provide the most information, along with their Interior Designers, and began to schedule meetings and to give the Architects the information required by the Contractors along with deadlines for this information. By the time the contractors had received enough information to accomplish their work, there were only one and one-half weeks left before their final project was due. The Architects and the Interior Designers were amazed at the amount of detail required by the Contractors. Even more amazing to them was the fact that they agreed that the Contractors needed this information in order to prepare budgetary estimates. Much as owners have come to realize, these students came to realize the benefits of alternative

project delivery methods that require the various disciplines to work as a team. However, even more importantly, the Contractors, Architects and Interior Designers that were fortunate enough to work together during the final four weeks, began to understand the processes involved, needs, and requirements of the other Disciplines and to understand the interdependence of the various disciplines in the Construction Industry.

Suggested Improvements

This was the Division of Construction Science's first attempt at a multi-disciplinary class. The Architecture Division took the lead in developing this class and in making the necessary arrangements, while Construction Science, Interior Design, and Landscape Architecture brainstormed with Architecture in developing schedules, required field trips and assignments. In order for this class to be of the most benefit for all parties, especially in its relevance to a real world experience, the following improvements need to be implemented.

The project should be much more realistic than a high-rise project. Even the Architects in their discussion with the Contractors felt that a project, which they were more likely to encounter, would have been of greater benefit. Today's students want realism.

All deadlines should be strictly enforced. This is an attempt to emulate a real world experience. In a Team approach such as this, if one Team member falters it creates a chain reaction. When the Architects failed to provide schematic drawings on the required dates all of the other disciplines had to adjust until there was very little time left for them to accomplish their work.

The project should not be based on the standard method of project delivery; i.e., make it a design-build or Construction Management method of delivery in lieu of the standard design, bid, build type of project.

Although this was a graduate class for the Construction Science Division, for the maximum benefit of all participants, consideration should be given to making this an undergraduate class.

Strong consideration should be given to joining with an industry partner on a real-life project. This not only increases the realism of the project but it also strengthens academic and industry relationships. Additionally, students are given added incentive to create a more professional product if they know that industry is involved.

These suggestions, when incorporated into the existing multi-disciplinary class will enhance the learning potential for all students involved.

Conclusion

By bringing together four disciplines, Architecture, Construction, Interiors and Landscape Architecture, and focusing their efforts on a common project, The College of Architecture, is preparing their graduates to better meet the needs of industry. A common project such as the Tall

Building project forced the students to work together to finish their assignments and thus they became aware of the interdependence of each discipline. Additionally, as the students began to understand the roles and responsibilities of each discipline, they realized that by working together, by becoming a team, they could more quickly and efficiently accomplish the assigned tasks. This multi-disciplinary class emphasized the unique requirements and responsibilities of each discipline. Thus, the students also became aware of the importance of effective communication skills and the needs of each discipline. Teamwork, communication skills and understanding the needs and responsibilities of the various disciplines are integral elements to successful project delivery in today's industry. The need for these skills is more clearly defined in a multi-disciplinary setting and becomes more readily apparent to both students and faculty when they are required to work together. Additionally, by emphasizing these skills through the use of a multi-disciplinary class such as the one at this university, students will be better prepared to begin their careers in industry in addition to potentially being more productive and of greater benefit to industry earlier in their careers.