

Project-Based Delivery System for an Integrated Residential Construction Course

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This paper presents the delivery system for a residential construction course in construction management at a major university. The course was delivered similarly to a capstone course by combining Residential Methods, Estimating, Scheduling, and Contracts into one class with one overall final project. The course introduced students to land acquisition, land development, construction services, operations, finance, marketing, and sales. Information about the course lectures, guest speakers, labs, field trips and final project are provided in this paper. The students' perspectives about the course delivery system are presented and discussed. The authors conclude that integrating Residential Methods, Estimating, Scheduling, and Contracts into a project based curriculum better prepares students for the homebuilding industry.

Key Words: homebuilding, residential construction, project-based learning, students' perspectives

Introduction

The core subjects in construction management are scheduling, estimating and contracts which are typically delivered in a lecture format in standalone classes (Chinowsky, Brown, Szajnman, and Realph, 2006). "The traditional segmented, topic-based approach to construction management curricula clearly has been successful at facilitating the attainment of specialized skills and concepts such as quantity surveying, estimating, or scheduling. However, the world does not always present problems that are topic specific and solved in a non-holistic manner." (Montoya, Kelting, and Hauck, 2009 p. 66) In the traditional construction management curriculum model students have a hard time "connecting the dots" between these classes "to grasp the overall process of construction management as a dynamic, synergistic engagement of subject matter and skills until they reach their final term or participate in a single capstone experience at the end of their education." (Hauck and Jackson 2005 p. 72)

Chinowsky et al. 2006, found the following results for students who went through their project-based learning courses:

- Students were more mature with greater communication skills and understanding of industry.
- Students obtained the ability to form questions that extended beyond the normal boundaries of the assignment.
- Students gained a deeper understanding of the construction industry.
- Students recognized they need to address challenges and create solutions to open-ended problems.

The delivery system described in this paper is similar to the paper Peterson (2008) published in the Associated Schools of Construction Proceeding in 2008. The intent of the course reviewed in his paper was to "provide students a broad perspective of residential development and construction process as viewed by production homebuilders and multifamily developers and builders." (Peterson, 2008, p. 111) The primary difference between Peterson's course and the one described in this paper was the students. Peterson's (2008) course was a capstone course for graduating seniors and the audience was second year students for the course described in this paper. Peterson provided the following conclusions about the project based delivery system for residential courses:

- Helps students in the transformation from "academia to industry".
- "Classroom structure and theory" is important for student motivation
- "Smaller sized groups" helps with keeping all students involved
- Developing a strong relationship with industry is a vital part of the project based delivery system. (Peterson, 2008, p.114)

Project Based Delivery System for an Integrated Residential Course

Spring 2008 was the first quarter the faculty officially implemented the delivery system described in this paper. There were many iterations of pilot studies where the students provided the faculty feedback to get the course to its current state of development. Montoya, Kelting, and Hauck (2008) discuss some of the student feedback in the areas of space utilization, ensuring individual learning when assigning work in groups as part of the project based delivery system, and the appropriate role of industry in the classroom.

The average class size was 24 students and they were divided into six teams of four for both the lab assignments and final project. The class met sixteen hours a week for a ten week quarter in a laboratory space that was dedicated solely to homebuilding education. The class combined components of the following four classes: Residential Methods, Estimating, Scheduling, and Contracts. The following teaching methods were used in the class: lectures, guest speakers, labs, field trips and an overall capstone project with student presentations.

Research Questions

The following research questions were asked of the students:

- How well did working in a team environment help improve your communication skills?
- How well did working in a team environment help improve your teamwork skills?
- How well did the final project simulate the building process in the current market?
- How well did working in groups help you learn about setting the proper expectations with your peers?
- How well did the final project help your understanding of the learning objectives?
- How well did incorporating estimating, scheduling, contracts and building methods in one class help you with your understanding of the overall building process?
- How well did the field trips help your understanding of the learning objectives and assist you with the final project?
- How well did the guest lecturers help your understanding of the learning objectives and assist you with the final project?
- How well did the lectures help your understanding of quality control and its importance in the construction process?

Lectures

The faculty strived to immerse students in all aspects of the homebuilding industry through lectures and interactive discussions. The lectures covered material from acquiring land through the warranty process. The instructor introduced students to the following management concepts: land acquisition, land development, construction services, operations, finance, marketing, and sales. Current market conditions were discussed in great detail as they were vital to the success of the final project. The lectures were designed to give students information needed to apply the skills learned in the classroom to lab assignments and their final project. Peterson (2008) reported that, when delivering a project based residential capstone class, it was difficult to find the right balance between discussing theory and practical project construction knowledge related to the project. It was easy to overwhelm the students with too much of either one resulting in students who lack motivation and interest. Lectures were created so the examples of the theory discussed in class were tied to the final project and labs.

The lecture material in this course was designed to be interactive by assigning pre-lecture assignments and short class assignments during the lectures. The lectures were delivered in Power Point and multi-media with the use of clicker personal response systems to encourage participation. All lecture material was posted on the course website so that students may refer to it.

Guest Speakers

Guest lecturers were brought in from industry to discuss various topics of the course based on their experience from the different departments of residential building companies. The faculty tried to incorporate speakers that have actually worked or were working on the assigned project. This assisted with bringing the class project to life. The guest speakers were able to answer questions students had about the project and gave them insight and information that the lectures did not cover. This also strengthened the relationship between the building industry and the students. The following guest speakers were invited to speak:

- A Land Acquisition and Development manager from a nationwide homebuilder gave a history of the project and went over the original feasibility analysis that was done for the entire project. They discussed the entitlement process for the project and land development activities that had been accomplished to bring the project to a finished lot stage.
- An Area Construction Manager gave a presentation on construction operations, scheduling, home owner relations and the warranty process.
- A Director of Marketing from a nationwide homebuilder gave a lecture on strategic and operational marketing. The discussion entailed current market trends and what it takes to market and sell homes in today's market condition.

Labs

A series of labs were assigned throughout the quarter. The labs were designed to reinforce the concepts covered in class and assist the students with their final project.

The quarter consists of four lab assignments:

1. Lumber Market Lab: Groups of students tracked the lumber market weekly. The students created a graph that tracked the lumber market and updated it weekly. One group was randomly selected weekly to present the current state of the market. The students were required to interview a lumber company. The interviews covered but were not limited to the following topics: state of the current lumber market, how long the company will lock lumber prices; lead time for orders, and how lumber is organized and delivered to the jobsite. The students selected a time and length of lumber pricing lock for their final project based on their interview and additional research of the market and notified the instructor at time of lock.
2. Foundation Lab: Students were given two different foundation designs for all homes on the final project. Students prepared a detailed quantity takeoff and cost estimate of the two different designs. They selected a foundation to use for their final project based on their estimate, soils report, risk analysis and additional research. Students provided a written explanation of their recommendation.
3. Neighborhood Review Lab: During the quarter, the class visited two residential job sites. Each student was given a scorecard to complete. The students assigned a score of 1-5 along with written comments of the following areas: signage, entrance, models, sales office, field office, storage area, homes under construction, safety and inventory of showcase homes. Then the students averaged their scores as a group and provided a write up of the pros and cons of both jobsites with suggestions for improvement. This lab was dependent on the current market conditions and production rates of local projects.
4. Scope of Work Lab: Students compared two different companies' scope of work for the same trade. They provided a detailed list of similarities and differences and a detailed analysis of both scopes of work. Each student also made a recommendation regarding which scope of work they would recommend using based on their analysis.

Field Trips

The students went on three field trips during the quarter. The three field trips were:

- Two field trips were to jobsites. Depending on the stage of the project, the project manager of the jobsite walked the students through pre-drywall or post-drywall orientation of the home. The students also had an opportunity to view the items in their neighborhood review lab mentioned above.
- The third trip was to the local truss manufacturing facility. They met with the facility manager and area sales manager. The students were provided with information about the truss manufacturing design and process as well as their floor joist manufacturing process. After the introduction, the students were taken on a tour of the facility to see the truss and floor systems being produced, sent through quality control and loaded onto the trucks to be delivered to the jobsites. The facility is a LEED certified building and the students learned about the different LEED components as they took their tour.

Final Project

The final project was a series of assignments that were to be completed throughout the quarter and then compiled to compose a final project. The length of time for each assignment was dependent on the difficulty of the deliverables. Each group met with the instructor and presented the deliverables of each assignment at the time of its due date. This allowed the students to receive constructive feedback throughout the project. The project consisted of 102 finished lots that were currently part of a neighborhood that was for sale. These lots were contiguous to a project that was currently under construction by the same builder. This site can be used for future projects in the next few years as long as it remains for sale. The price of the lots and the solution will change from quarter to quarter with the market conditions. The project will be changed once the neighborhood is sold in order continue to create a real-life situation. The students were tasked to review the project as if they were working for a company that was considering it for purchase. Each team was to present the project to the instructor for consideration to fund and acquire or to explain why this project may be too risky to acquire. The students received all the construction documents necessary to complete the project.

The quarter project consisted of seven assignments:

1. Students prepared a strategic and operational marketing analysis for the project. Students provided information on jobsite location, community appeal, weather, views, school systems, cost of living, population statistics, local job opportunities, percentage of commuters and how they linked to their targeted consumer groups. They prepared a graphical representation of the adjusted and unadjusted sales prices and square footage of their project verses the competitors. They also provided information about how their team would deliver the message and attract customers -for example, model grand openings, newspaper, television, radio, billboards, signage, and incentives.
2. Students completed a detailed construction estimate and budget including a quantity take-off of all labor, material, and equipment necessary to complete the project. The project consisted of six floor plans with three elevations each. Each group of four students narrowed down the six plans to four based on the information from their operational marketing assignment discussed in item number one above. This allowed each student to prepare a complete estimate for a home.
3. Students found creative ways to reduce costs by value engineering, purchasing strategies and changing standard amenities of the current plans and specifications. Students were challenged with reducing the vertical construction costs without reducing the quality of the homes. Students were encouraged to research national purchasing agreements, commodity pricing, ease of installation, delivery systems, rebates, and warranties. The students were encouraged to research and apply green building techniques in this portion of the project. This stage of the project encouraged the students to continue researching their competition and their standard amenities.
4. Students prepared a computer generated CPM schedule for one home. The durations were based on the production rates from their estimates. The students then determined an overall project schedule based on current absorption rates and they generated a matrix schedule and phasing map. Students created two site layout plans. The first one showed housing mix, model plans and locations, projected sales and production release size. The second one showed all site logistics including, but not limited to, staging areas, traffic

flow and control, any necessary SWPP items, and any other construction related items required to complete the project.

5. The students determined their proposed project management and organization for staffing the project. The students summarized the roles they needed in their organization to make this possible. These roles had been drastically changing due to market conditions. The students applied their understanding of the business and the current market to make decisions regarding what staff was needed to manage the project. Each student played the role of one of the team members and presented on their responsibilities.
6. Students created financial information for the project. They created an income statement and cash flow projections for the proposed project based on the absorption rate determined from their marketing analysis and schedule. The students were challenged with providing different scenarios based on market fluctuation.
7. The students prepared an Executive Summary including their recommendation for purchasing the lots. The Executive Summary described the property, deal structure, major risks, financial information, length of project, market analysis, assumptions, and conclusion.

Students' Presentations

Students were required to conduct a professional presentation representing their solution to the problem. The students presented to a panel of instructors and peer groups of students at the end of the quarter. The reviewing peer groups of students were able to showcase their knowledge of the project by asking the presenting group questions. The presentations were 20 minutes in length and covered the highlights of the following topics:

- A concise executive summary.
- A summary of their project schedule and plan for completing the work.
- A summary of the project estimate, budget and cash flow projections.
- A description of their value engineering.
- A description of their marketing analysis.
- Their recommendation to the panel regarding acquisition of the lots.

Instructor Assessment of Students

The following criteria were used to assess the students' performance:

- Exam 1: 15%
- Exam 2: 15%
- Class project: 35%
- Class participation: 15%
- Homework and labs: 20%

Students' Perspectives of the Course Delivery System

A survey of the student's perspectives of the course was conducted in the Spring of 2008 and the Fall of 2008. The survey was created to obtain feedback from the students in order to ensure the delivery system was effective and to improve areas that may not be effective. The class size was 24 students in Spring 2008 and 19 students answered the survey. The class size was 26 students in Fall 2008 and all 26 students answered. The survey was anonymous. The results of the students' perspectives are in Table 1. A questionnaire was developed by using Olbina's (2008) questionnaire. It was put through a peer review process that customized it for the purposes of this study. The students answered on a rating scale of 1 to 5 with 5 being the highest. The results are posted as the percent of students that scored each question in the corresponding column.

Table 1

Results of student perspectives

Questions	Scale for Student Responses					Mean	Quarter
	1	2	3	4	5	Response	
1 How well did working in a team environment help improve your communication skills?	0.0%	0.0%	0.0%	31.6%	68.4%	4.68	S08
	0.0%	0.0%	3.8%	23.1%	73.1%	4.69	F08
2 How well did working in a team environment help improve your teamwork skills?	0.0%	0.0%	5.3%	21.1%	73.7%	4.68	S08
	0.0%	0.0%	3.8%	34.6%	61.5%	4.58	F08
3 How well did working in groups help you learn about setting the proper expectations with your peers?	0.0%	0.0%	5.3%	21.1%	73.7%	4.68	S08
	0.0%	0.0%	3.8%	23.1%	73.1%	4.69	F08
4 How well did the final project simulate the building process in the current market?	0.0%	0.0%	0.0%	26.3%	73.7%	4.74	S08
	0.0%	0.0%	0.0%	30.8%	69.2%	4.69	F08
5 How well did the final project help your understanding of the learning objectives?	0.0%	0.0%	0.0%	0.0%	100.0%	5.00	S08
	0.0%	0.0%	0.0%	19.2%	80.8%	4.81	F08
6 How well did incorporating estimating, scheduling, contracts and building methods in one class help you with your understanding of the overall building process?	0.0%	0.0%	10.5%	15.8%	73.7%	4.63	S08
	0.0%	0.0%	0.0%	11.5%	88.5%	4.88	F08
7 How well did the field trips help your understanding of the learning objectives and assist you with the final project?	0.0%	0.0%	10.5%	31.6%	57.9%	4.47	S08
	3.8%	3.8%	11.5%	30.8%	50.0%	4.19	F08
8 How well did the guest lecturers help your understanding of the learning objectives and assist you with the final project?	5.3%	0.0%	31.6%	36.8%	26.3%	3.79	S08
	0.0%	7.7%	7.7%	61.5%	23.1%	4.00	F08
9 How well did the lectures help your understanding of quality control and its importance in the construction process?	0.0%	5.3%	0.0%	47.4%	47.4%	4.37	S08
	0.0%	0.0%	3.8%	57.7%	38.5%	4.35	F08

Discussion of Survey Results

The authors performed the following tasks to analyze the survey results:

- Evaluation of the frequency of responses.
- Evaluation of the mean response value.
- Comparison of the frequency of responses for Spring 2008 and Fall 2008
- Comparison of the values of the mean response for Spring 2008 and Fall 2008. (Based on Olbina, 2008 p.55)

Ratings with “values of 4 and 5 were considered positive, 3 neutral and 1 and 2 negative.” (Olbina, 2008 p. 55) The following results were derived from the student evaluations using the methodology stated above:

1. 100% of the students in Spring 2008 and 96% of the students in Fall 2008 felt working in a team environment helped improve their communication skills. The mean response was above 4.5 in both quarters. The high level of response demonstrated to the instructor that working in teams was beneficial for the students. In Fall 2008, the frequency of positive responses decreased by 4% and the mean increased by 0.01. Although the frequency of positive responses decreased the mean remained nearly the same and reinforced the instructor’s assessment of team work and encouraged the instructor to continue to facilitate teams for future projects.
2. 95% of the students in Spring 2008 and 96% of the students in Fall 2008 thought that working in a team environment helped improve their teamwork skills. The mean response was above 4.5 in both quarters. The high level of response showed the students place a high value on teamwork. The frequency of positive responses increased by 1% and the mean decreased by 0.10 in Fall 2008 compared to Spring 2008. The decrease in the mean was not significant because the overall mean scores were still above 4.5 showing an overwhelming majority of the students found working with teams helped their teamwork skills.
3. 95% of the students in Spring 2008 and 96% of the students in Fall 2008 thought learning in groups helped them learn about setting proper expectations with their peers. The mean response for both quarters was above 4.5. The instructor was pleased with these results. Residential construction is typically a business to consumer relationship and many of the national homebuilders place a large emphasis on properly setting expectations in order to maintain satisfied customers who will recommend the builder to their friends. The frequency of positive responses increased by 1% and the mean increased by 0.01 from Spring 2008 to Fall 2008. The minimal change showed a consistent positive response from the students. Not only were setting the proper expectations important for homebuyer relations it was also important for the business relations with all parties involved in the development and building process.
4. 100% of the students in Spring and Fall 2008 felt the final project simulated the home building process in the current market. The mean response was above 4.6 for both quarters. The instructor did not expect an overwhelming positive response. The students encouraged the instructor to continue to work closely with industry to keep current projects for the students to work on in this course. There was no change in the frequency of positive responses and the mean decreased by .05 in Fall 2008 compared to Spring 2008. These results encouraged the instructor to continue to work with industry and provide students with a final project that is a current project being worked on by industry.
5. 100% of the students in Spring 2008 and Fall 2008 thought the final project helped them understand the learning objectives. The instructor expected some of the students to feel this way, but was pleasantly surprised to find all of the students unanimously agreed. The mean response for Fall 2008 was a perfect 5 while the Spring was a 4.81. There was no change in the frequency of positive results and the mean decreased in by .19 from Spring 2008 to Fall 2008. The results were important because they showed the students learn well in a project based learning environment.
6. 90% of the students in Spring 2008 and 100% of the students in Fall 2008 thought the incorporation of estimating, scheduling, contracts and building methods in one class helped them understand the overall building process. The mean response was above 4.5 for both quarters. Although there was a lower frequency of positive responses in Spring of 2008, the mean response was still very high. The frequency of positive responses increased by 10% and the mean increased by 0.25 from Spring 2008 to Fall 2008. The positive change informed the instructor that teaching the four areas was an excellent way for the students to understand the overall building process in the homebuilding industry.
7. 90% of the students in Spring 2008 and 81% of the students in Fall 2008 thought the field trips helped them learn the course material and assisted them with the final project. 8% of the students in Fall 2008 thought the field trips did not help them learn the course material nor assist them with the final project. The mean response was between 3.7 and 4.2. The instructor did not expect negative results. The frequency of negative results increased by 8 % and the mean decreased 0.4 from Spring 2008 to Fall 2008. The instructor expected a decrease from Spring 2008 to Fall 2008 because the field trip in Spring 2008 was to the final project jobsite and the Fall 2008 class was unable to travel to the final project jobsite. These results demonstrated to the instructor the importance of traveling to the final project jobsite. The instructor may consider traveling to the final project jobsite even though it is far away and cancel the other field trips to make up for the time spent. The faculty will address the students’ negative perception by informing the

guest lecturers of the project the students are working on and how it relates to the course material. This preparation will assist the guest lecturers with connecting their lecture with the project and course material.

8. 32% of the students in Spring 2008 had a neutral response to the guest lecturers and how they helped them learn the course material and assist with the final project. However, 63% of the students in Spring 2008 and 85% of the students in Fall 2008 found the guest lecturers helpful in learning the course material and assisting them with the final project. The mean response was between 3.7 and 4. The frequency of positive results increased 22% from Spring 2008 to Fall 2008. The mean increased by 0.21 from Spring 2008 to Fall 2008. The increase in positive responses in Fall 2008 showed that guest lecturers should continue to be used as part of the delivery system for future quarters. The faculty will address the negative perception of guest lecturers by better informing the guest lecturers about connecting the course material with their experiences and the final project.
9. 95% of the students in Spring 2008 and 96% of the students in Fall 2008 thought the lectures helped their understanding of quality control and its importance in the construction process. 5% of the students in Spring 2008 found the lectures did not help them. The mean scores were between 3.7 and 4.35. The frequency of positive responses increased 1% and the mean increased .56 from Spring 2008 to Fall 2008. The major difference between the two quarters was the instructor partnered up with industry more to develop current material for the residential means and methods portion of the class that was used in Fall 2008. The results showed the instructor that the new material was helpful for the students to better understand how to build a quality home.

Conclusion

The delivery system described in this paper was similar to that of Peterson's (2008) and Olbina's (2008) in that the students applied their knowledge to a real-life problem for a quarter long final project. However, in this study the students learned the majority of the information during the course, rather than applying the knowledge gained to a capstone course with additional instruction. The three highest results in the students' survey reinforced the faculty's decision to deliver a capstone style course in the students' second year of education. These results revealed that students perceived working on a quarter long final project simulating the current market helped them better understand the course material. The most impressive results were the students' perspective of the integration of estimating, scheduling, contracts and building methods. They felt the integration of these core subjects helped promote their understanding of the overall building process.

Lectures, field trips, and guest lecturers were the main methods of educating students in a standalone residential course. These three areas were rated lowest by the students. That result took the faculty by surprise, as these delivery methods have been relied on for many years. The faculty agrees with Peterson (2008) that it is difficult to find the right balance between discussing theory and practical project construction knowledge. The faculty will work on continuing to focus and strengthen the project based delivery system by having more meetings with the teams and making smaller assignments that are turned in on a regular basis. The faculty will work on lecturing less and find additional ways of delivering the course content to the students. A stronger focus also will be put on visiting the actual project. The faculty also will ensure that the guest lecturers are familiar with the specific project and how it relates to the course material so that they can assist with insight on intricate components of both.

Based on the students' perspectives, the authors conclude that delivering a project based curriculum offered to every student in their second year successfully prepares them for the homebuilding industry. The authors will continue to use this survey, along with student outcomes and feedback, to improve the delivery system described in this paper. A potential area for further research would be a follow up study to understand which method of information delivery (e.g. lectures, field trips, etc.) is more effective and appealing to students.

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