Fostering Disciplines' Understanding among Design and Construction Students through a Design-Build Senior Project

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Abstract

With many disciplines involved on a construction project, conflicts and disputes become inevitable. Each discipline, whether designers or contractors, view the project and prioritize the goals from their own perspectives. They also tend to carry misperceptions about each other's roles, which yield to misunderstandings and disagreements, and ultimately delays and cost overruns. Though this is well-rooted, very minor steps have been taken, if any, to address these misperceptions and misunderstandings in our engineering educational institutions or courses. This study, thus, aims at fostering the understanding between design and construction students working on a Design-Build senior project in a civil engineering department. The study uses partnering concepts by creating a senior project environment that fosters collaboration and problem solving. The study entails a 4-step methodology: (1) forming an interdisciplinary senior project team (both civil and construction engineering students), (2) benchmarking perceptions of each other's disciplines through a survey, (3) starting work on the project through activities that intend to foster open communication, trust, and a willingness to solve problems, and (4) retaking the survey to investigate if students perceptions have changed. Results of the study show that, through the interdisciplinary senior project and the structured activities planned, students' perceptions of each other's disciplines, roles, and stereotypes changed, and they were able to gain a better understanding and appreciation of each other's disciplines, and work collaboratively towards the project goals. The study, thus, shows the potential that incorporating such educational activities and experiences in students' learning environment could positively affect their careers making them ready for the increasing trend of integration of designer and builder roles in the larger workforce.

Introduction

With many disciplines involved on a construction project, conflicts and disputes become inevitable, especially with each discipline, whether designers or contractors, viewing the project and prioritizing its goals from their own perspectives. The misconceptions each discipline has for the other and the differences in priorities is well-rooted and known all across the industry.
The move to integrated project delivery methods (PDMs) is part of the industry's efforts to contractually obligate the designer and the builder to establish a cohesive and collaborative work environments. Increased mutual understanding could help in addressing and resolving such conflicts, and eventually result in a more collaborative work environment, ultimately leading to cost and time savings.

Over the last decade, the construction industry has seen an increased use of alternative PDMs that integrate the roles of both designer and contractors into a single entity, and offer more collaboration opportunities among the various disciplines. One of these growing alternative PDM is Design Build (DB). DB has experienced increasing popularity in the construction industry ultimately for its recognized benefits, including overall reduction of project cost and completion time, compared to traditional Design Bid Build (DBB) PDM. A quick comparison of the major differences between the two PDMs shows that in a traditional DBB, the owner hires an engineer

to design the project and develops the plans and specifications. The project is later put up for a competitive low bid procurement process to hire a general contractor. The major challenge with this system is the adversarial relationship that often develops among the project participants and the lack of input from the contractor in the design process, which likely leads to change orders. Since the design process is complete with no contractor input, the probability of the lack of understanding of drawings and submittals during construction phase is high, ultimately leading to adversarial relationships. As for DB, the owner hires one party that serves as both the contractor and designer, allowing contractor's input in design, faster delivery, and a single point of responsibility *(1, 2).* In recent years, the use of DB has considerably increased in the U.S., making this PDM one of the most significant methods in design and construction today *(3).* However, this also dictates a new set of skills that needs to be acquired by both engineers and contractors for their variations in their typical standard role.

With the evolving nature of the construction industry, the change in roles, and the well-rooted misconceptions especially between the designer and the contractor, there is yet still limited research directly focuses on investigating these misperceptions early during students' education.. This paper, thus, aims at fostering the understanding between design and construction students in a civil engineering program, during their senior year through a DB senior project experience. The project was designed to allow students to experience and simulate a true project from award till delivery, and most importantly provide them a reality check of what they will face when venturing into this evolving construction market. The paper will start with a brief summary of relevant work, followed by the methodology employed, then the results and conclusions.

Previous Research

A recent study *(4)* assessed the issues that lead to miscommunication between General Contractors and Designers. Through a survey developed and distributed to designers and contractors in the construction industry, the results highlighted the common stereotypes and personal conflicts between the two parties. Typical stereotypes about designers include doubts about their level of knowledge about methods of construction, and their capability of timely recognizing design or construction errors. Contractors, conversely, are considered to be interested uniquely in the profit on a project, never select the specifications requested by the designer, and lack of capability of seeing and interpreting plans. The variation in educational background and training were identified as possible sources of conflict. It was seen that construction and design professionals have distinctive forms of learning that result in the typical perception of the construction industry as a blue collar job, and of the architectural and structural design as a white collar job. Due to the current tendency of educating the two disciplines in different fashions, the study revealed that only 46% of graduates felt their education prepared them for the collaborative nature of the industry. The study concluded that the most important step toward resolution of this issue would be getting the construction industry to acknowledge the incidence of this problem in current methods of communication. Changes in education are also advocated as highly desirable, even if they will inevitably require a period of time before they are assimilated and begin to impact the construction industry.

There has been a number of successful recent efforts aimed at integrating these two disciplines in education. For example, Tran et al *(5)* developed a two-week intensive course for architecture

and civil engineering students to increase the collaboration between building design and construction on real residential building projects. The course was developed at the University of South Australia and undergraduate students from civil engineering and architecture experienced hands-on design and construction activities through collaboration. The goal of the study was to evaluate the students' perceptions earned from collaborative learning and find out the relationships between students' understanding and quality of the built project through interviews, surveys, and class observations. The research found that students fully understood the positive potentials of the interdisciplinary nature between architects and engineers through the course. Students recognized that the interdisciplinary nature in construction project was a very positive way to increase work efficiency that needs to be improved in the building industry by collaboration works between Architecture, Engineer, and Construction (AEC) Professions.

Lopez and Strong *(6)* presented students' learning outcomes from a DB course organized by both construction industry and faculty. This course was cross-listed for undergraduate and graduate students of the construction management program in University of Puerto Rico. It was developed to provide students the opportunity to improve their understanding of the DB system and prepare them for the 'Designated DB Professional' certification. Two faculty instructors from different schools (Architecture and Civil Engineers) taught the fundamentals of DB system and they also invited guest lecturers from the construction industry. The outcome of the paper indicated that all students had a better understanding of fundamentals and practices of DB systems through interdisciplinary participations (architects, engineers, contractors, and business) in the course.

The interdisciplinary experiences was not only a topic addressed in the civil engineering discipline but was also seen, for example, in a study conducted on a mechanical engineering program. Masi et al. (*7*) highlighted the need to broaden disciplinary perspectives in the mechanical engineering discipline to equip students to face broad and complicated global problems. They, thus, developed two different curricula: a traditional mechanical engineering degree program and a cross-disciplinary engineering degree program with a strong core of mechanical engineering. They then surveyed both alumni and students who took these classes and found out that there was a statistically significant difference between the two programs in the students and graduates abilities to address complex technological problems.

With the industry moving towards a more integrated approach of project delivery, existing misperceptions between the design and construction professionals may hinder the establishment of cohesive and collaborative work environments. As suggested by various studies *(4)*, this problem should thus be addressed early on during students' undergraduate years through a structured curriculum; it should be part of a learning process that prepares students for the continuously evolving roles of both designers and contractors. The role of a contractor who becomes contractually responsible for reviewing designs for constructability and value engineering. In addition to the role of the designer who has to accommodate changes to make the design more efficient and constructible, and the ultimate necessity of both disciplines to work collaboratively to achieve overall project objectives.

There are currently two undergraduate programs running parallel pathways within California State Polytechnic University, Pomona's (CPP) Civil Engineering Department: the Construction Engineering Technology (CET) Program and the Civil Engineering Program (CE). While CE

students concentrate more on the design work, preparing them for a career as design professionals, CET students take fewer design courses. One of the main reasons behind the integration of the CET program within the Civil Engineering Department was the potential benefit that arises from shared educational goals between the two programs. *This study, thus, aims at fostering the understanding design and construction roles through a DB senior project experience that was designed to allow students to experience and simulate a true project from award until delivery.*

Methodology

A DB Senior Project was introduced with the aim of promoting this integration, through common learning tools that can be shared by CE and CET students. The cross-links between the disciplines in the senior project mimic common professional practices. On one side, Civil Engineers primarily focus on specifying loads, designing beams and connections, and the structural performance of the building as a whole. On the other side, Construction Engineers generally concentrate on material quantities, cost, constructability, jobsite work coordination, work clash detection, construction sequence, and overall construction schedule. The implementation of the proposed teaching modules is aimed at teaching students in both disciplines about the interrelation of information required throughout the building process. Traditional curriculum for CE students does not address issues of constructability or economy of size in either lecture or coursework. Traditional CET classes focus on surveying, estimating, scheduling and management, but only address basic concepts of structural design. Neither discipline fully addresses the essential information exchange between disciplines to construct real-world projects. This gap may leave students confused whether seemingly extraneous pieces of information are actually necessary in the real-world. The final goal is to familiarize students with modern construction practices, and highlight how building information is specifically used for structural analysis, design, and construction purposes.

The DB senior project was set up following a typical DB project structure and schedule where the first portion of the project involves more design tasks compared to construction. Thus, more design students (15 students), and less construction students (4 students) were enrolled in the first quarter. In the following quarters, an almost equal number of CET students enrolled in the DB senior project (totaling the enrollment of CET students to 10). However, it is important to note that the Civil Engineering Department has more CE students than CET students (1000 versus 300 students) which could partially explain the lower number of construction students enrolling in the second quarter. The senior project was also set-up to suffice both CE and CET students' requirement of completing a senior project.

The methodology of this study included four major steps (Figure 1). Step 1, as mentioned earlier, involved enrolling students from both the CE program and the CET program into a joint senior project, in which they were provided the opportunity to work on a DB project throughout the entire academic year. The senior project was designed such that it would encompass both civil and construction engineering faculty advising all through the different phases. It was divided into 3 phases in 3 quarters starting from Fall through Spring, and it encompassed the design and construction (model) of a garage parking structure located on campus. The first phase of the project was largely concerned with conceptual design, reaching 30% complete design

development, and conducting preliminary cost estimates and schedules. The second phase encompassed the completion of the foundations construction drawings, and start of construction with updated cost estimates and schedules. The third phase encompasses the completion of project and entails some change orders issued by the project's actual project manager and faculty (as owners). The project involved high industry involvement by providing students an actual project and making them experience all the phases of the project development from award as design-builders to completion.

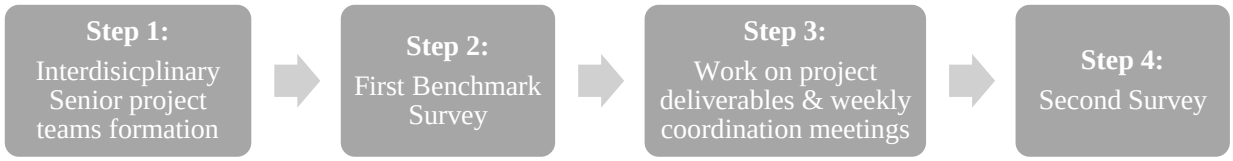


Figure 1: Study Four-Step Methodology

Step 2 involved administering a web-based survey to benchmark students' perceptions of each other's disciplines before starting the project. This was followed by step 3, which involved starting the actual work on the project, including weekly coordination meetings to communicate work done by both disciplines, discussion of progress and upcoming milestones (whether construction or design), request of constructability reviews and economic analysis from the CET students into the design developed by the CE students, and communication to the owner (faculty) of any upcoming requests for information (RFI). This is, in addition to other smaller meetings between the project manager (from the CET side) and the design manager from the CE side to coordinate work between the 2 groups. The objective of this step was to allow more interaction between the CE and CET students and mandate them to report, as a group rather than a subgroup, their work each week. It also provided them the true experience of multidisciplinary project meetings where parties' objectives could be different and the level of effort it takes to reach a common ground to meet the project's objectives, rather than each parties' preferences.

The fourth and final step entailed a second cycle survey of students' perceptions after being provided the opportunity to work jointly on this project. Both surveys encompassed three main sections. The first section asked general questions regarding civil and construction engineering professionals' responsibilities. The second section was targeted only to CET students asking them about their perception of the designers, in general and their expectations. On the same lines, the third section was targeted only to CE students and asked about their perceptions of and expectations from working with construction management professionals. Some of the questions were adopted from the survey developed conducted by Davier et al. (2007) that targeted actual construction and design industry professionals' perceptions of each other as well. Most questions were closed-ended questions, with a few open-ended asking about their experience in the project.

Respondents' Demographics

Following a typical DB project structure and schedule, in the first benchmark survey more CE students (15 students), and less CET students (4 students) were enrolled in the senior project for the first quarter. In the following quarters, an almost equal number of CET students enrolled in the DB senior project (totaling the enrollment of CET students to 10). Students were asked to take the survey at the very beginning of the project in the first quarter (1st cycle), and again in the following quarter (2nd cycle). In the first benchmark survey (1st cycle), 15 CE students and 4

CET students took the questionnaire; in the second survey, 14 CE students took the survey, in addition to 6 more CET students. The age group of students varied from 21 years to 29 years. More than half of the students in both disciplines had at least 3 months of work experience (Figure 2). Seventy percent of the students were male and 30% were female. Even though majority of students were CE students, 50% of all students had either a Contractor/CM experience or an equally Contractor/CM and Design experience, with only 18%, having only design experience. This data might be the reason why these students were originally interested in this kind of interdisciplinary project.

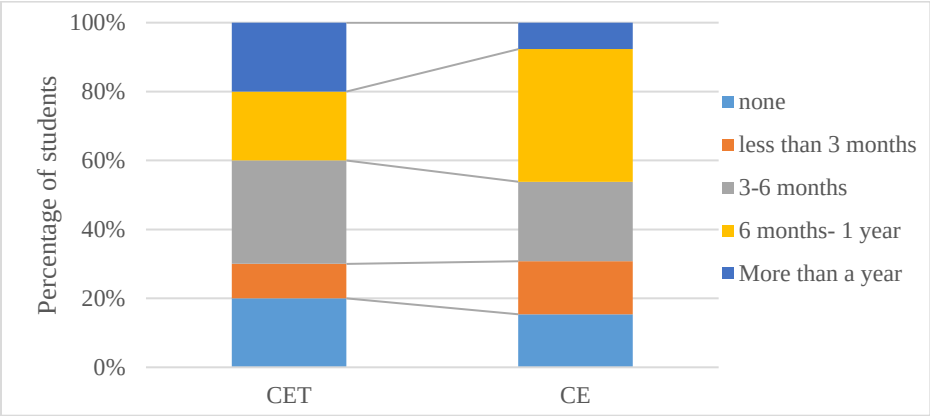


Figure 2: Students' Industry Experience

Results and Analysis

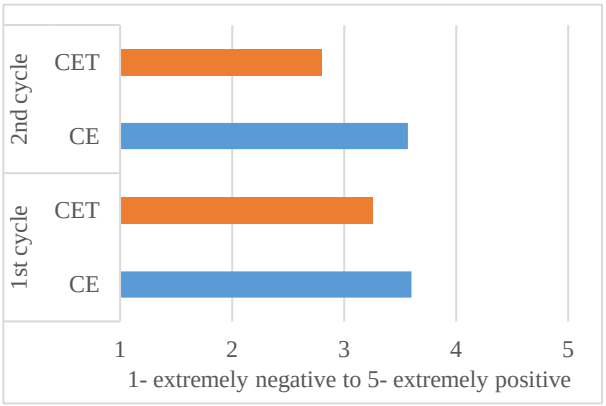
The following sections will report results of both surveys and compare the findings. It is divided based on the survey sections organization, starting with the general questions addressed to both students on their perceptions of designers and construction professional responsibilities, and then reporting the results of specific CE and CET students' perceptions of each other disciplines and work responsibilities.

General Questions targeted at both student groups

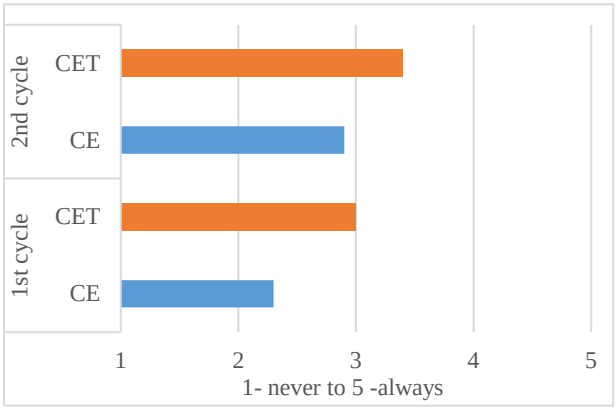
This section reports the results of the questions that were asked to both CE and CET students. When students were asked to rate their perception of ***resolution of conflicts*** between designer and contractor, from 1 to 5, with 1 being extremely negative to 5 being extremely positive, CE students had more optimistic perception of conflict of resolution compared to the CET students in both surveys. A slight decrease in overall students' perception, in both disciplines, of conflict resolution difficulty, is shown in Figure 3a. When students were asked to rate their perception of whether they think conflicts will be resolved in their favor before going to court, from 1 to 5, with 1 being always to 5 being never, CET students were more confident that conflicts will be resolved in their favor compared to the CE students in both surveys, showing an increase in the confidence level of both groups, by the second survey. Overall, students were seen to be more optimistic that the conflict will be resolved in their favor compared to the first survey (Figure 3b).

When students were asked to prioritize a list of project specific items in terms of their concerns on a project from 1-5 (with 1 being most important and 5 being least important), it was seen that in the 2 consecutive surveys, all students ranked 'owner satisfaction', as the first priority;

keeping the project within budget was ranked second, followed by quality. The CET students then ranked employer as the next priority while CE students ranked schedule next.



(a) Resolution of conflicts between designer and contractor are usually:



(b) How often do you think conflicts will be resolved in your favor before going to court?

Figure 3: Students' perception of conflicts with other disciplines

There were some interesting discrepancies seen between the disciplines. For example, in the first survey, 60% of CE students thought Construction Engineers think that Civil Engineers (designers) work for them; this number dropped to 35% in the second survey; all CET students did not agree with this statement in both rounds of the survey. Also, while 74% of CE students thought construction engineers mostly work on site, only 50% of CET students agreed on this statement. The CET students' agreeing to this statement percentage slightly decreased (40%), which could be attributed to their high level of involvement in preconstruction activities in this project, including constructability reviews and value engineering.

As for needing detailed drawings to start estimating, CET students showed a decrease in agreement on this statement (from 75% to 50%), which could be related to the conceptual estimates they had to provide earlier in the project phase, when minimum detailed design was developed by the CE group. It was also interesting to see how the percentage of CE students agreeing that construction engineers value a project in terms of construction time decreased (from 87% to 64%). This could have been attributed to the constraints placed by the CET group on the CE group to complete design making the CE students realize the importance of the preconstruction phase on the project schedule and completion. A high percentage of CE students (42%) thought that Construction Engineers consider Civil Engineers (designers) as theorists, while CET students themselves mostly did not think so (10%). While half the CET students (50%) thought Construction Engineers know about the design process as much as Civil Engineers (designers) do, the majority of CE students themselves did not think so (7% only agreed). It was interesting to see that CET students realized in the second survey they did not know as much as they thought they did and more interestingly CE students realized CET students knew more than they originally assumed they did. Also, almost 50% of CET students thought construction engineers value a project in terms of structural efficiency, while only 7% of the CE students thought so. This percentage of CE students was increased to 23% in the following cycle, which also could be attributed to more CET students' involvement in design reviews with CE students.

Figure 5 shows the responses of students when asked about which statements were true about Civil Engineers in both the first and the second survey. Some of the interesting observations was seen in CET students' perception of Civil Engineers visiting the construction site; the first survey all CET students thought the civil engineers visited the site but this dropped to 50% by the second survey. Another interesting aspect was observing how the percentage of CET students perceiving that civil engineers consider cost aspects in their design dropped from 47% in the first cycle to 20% in the second cycle. CET students might have realized through working with the CE students that what they are mostly governed with in their designs are the standards and the code requirement, and they were less likely to consider the cost aspect and constructability unless noted to them by the CET students during their meetings.

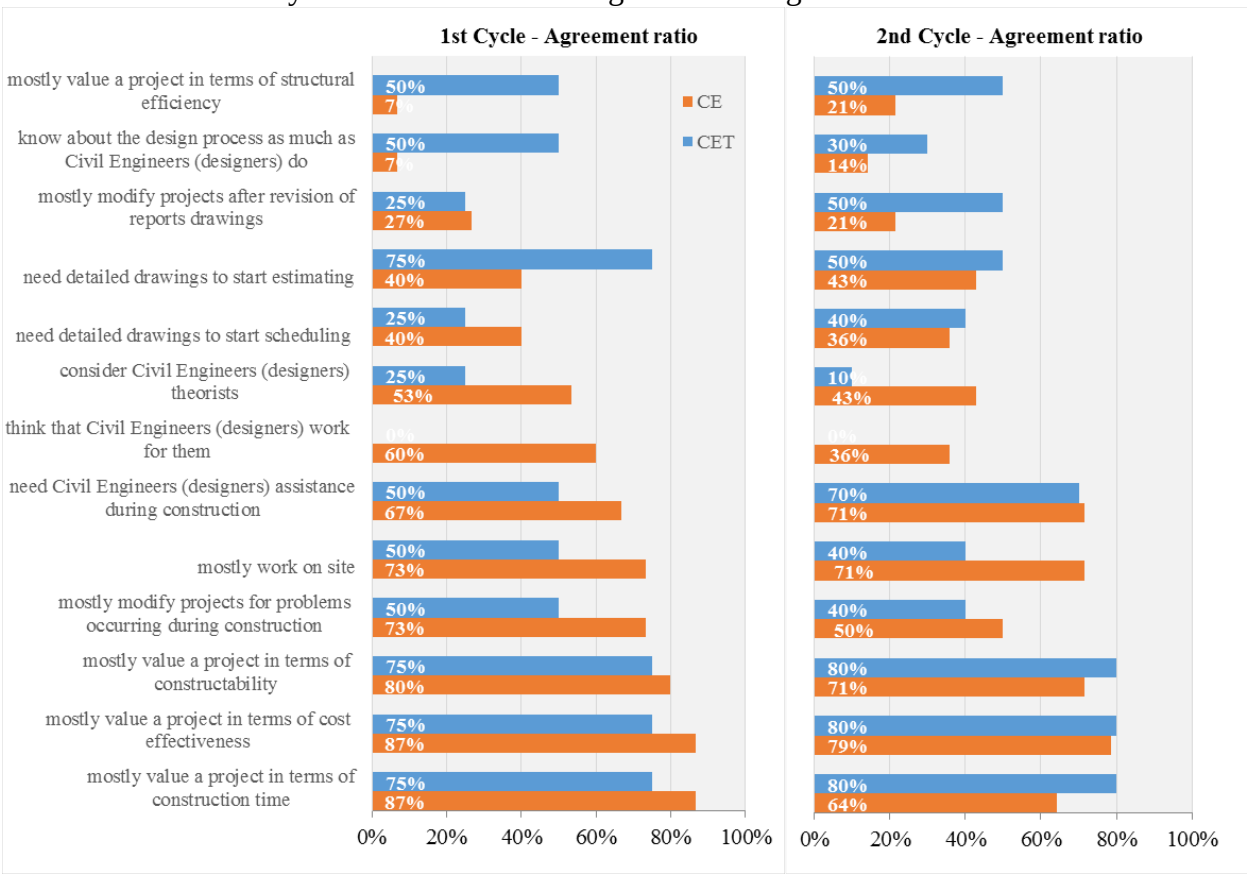


Figure 4: Which statements are true about Construction Engineers? (% respondents agreeing)

Other interesting observations were seen with both the CE and CET students less likely agreeing with the statement regarding civil engineers modifying their design in case of construction issues from the first to the second cycle of the survey. While CET students 100% agreed with the statement on civil engineers mostly valuing a project in terms of structural efficiency, this was seen to decrease in the second survey (70%), possibly showing that based on their experience with CE students, CE students were willing to reach common ground with CET students on other aspects of the project, such as time. This was observed with a common increase in agreement between CE and CET students on Civil Engineers valuing a project in terms of construction time, showing more understanding of the importance of coordination to meet project objectives, specifically time. Another interesting observation was seen with less CET students agreeing that

Civil Engineers assist Construction Engineers during construction in the second cycle compared to the first survey cycle (from 100% to 50%).

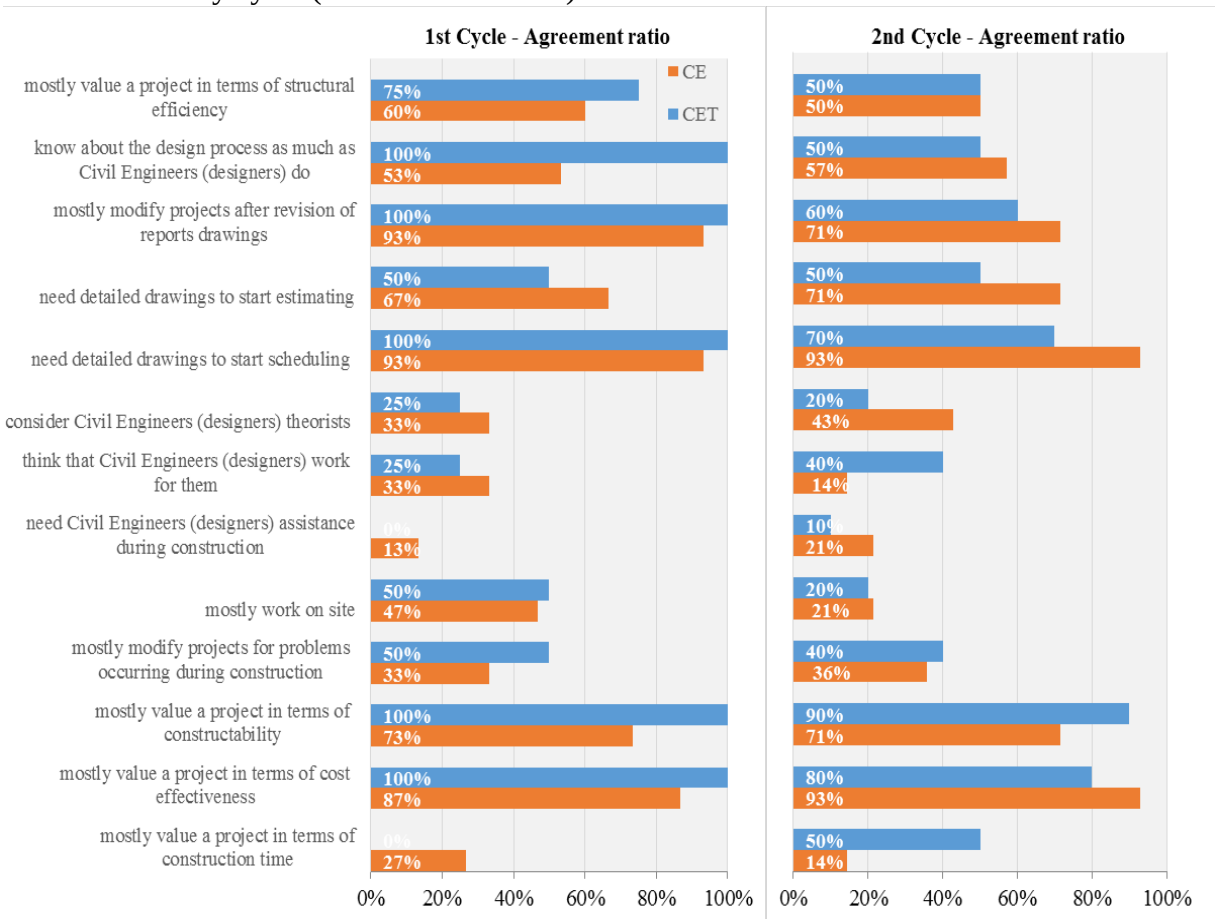
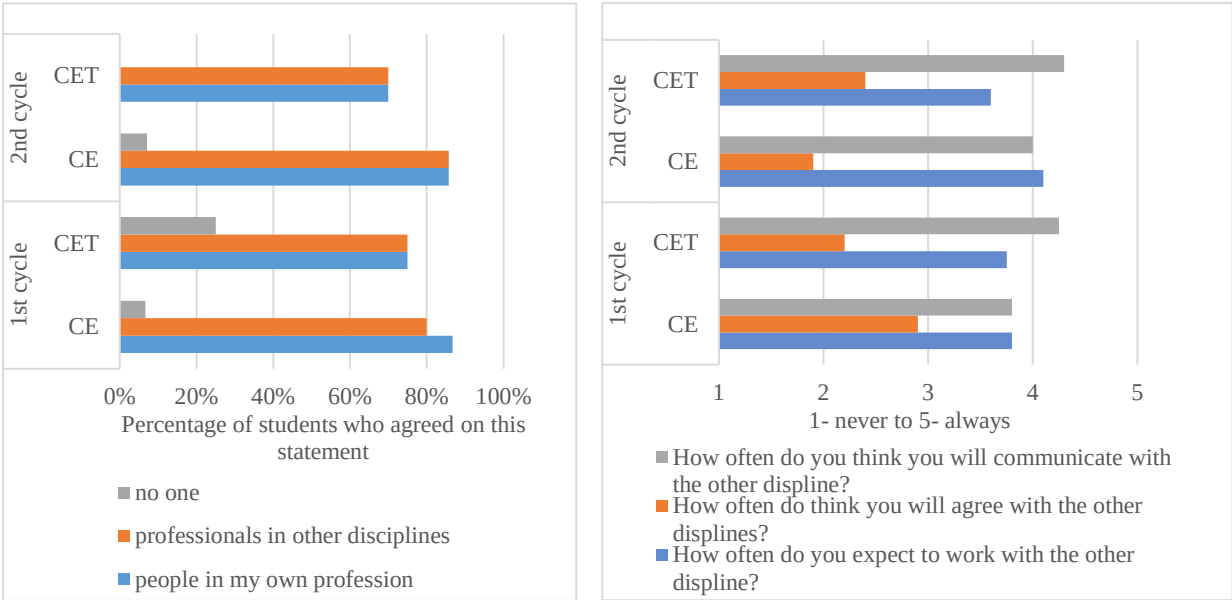


Figure 5: Which statements are true about Civil Engineers? (% respondents agreeing)

When both groups were asked to select their preferences in terms of working with their own profession, other disciplines, or no one on the job site, both CE and CET students showed no major difference in preferring to work either way, with same discipline preference scoring a little higher for both CE and CET groups (Figure 6a). As for the advantages and disadvantages of working with different disciplines, CET students listed ‘knowledge of topics I would unlikely learn about in my field” as the first advantage while CE listed ‘problem solving and thinking outside of the box’. As for the disadvantages, both groups agreed that ‘having different priorities’ is the major disadvantage with working with other disciplines.

When CET students were asked how much they expect to work with an architect/designer from never being 1 to always being 5, they responded consistently in both surveys from half of the time to most of time (Figure 6b). CE students showed an increase in their perception with interacting with the CET students in the 2nd cycle. As on how much time they expect to agree with the architect/designer, a slight increase was observed in both group responses showing they expect more agreement with the other discipline’s methods compared to the benchmark survey responses. In addition, an increase in the perception of communication between both disciplines in the second survey was seen compared to the first, with CET students expecting more communication in general compared to CE students. Students might be starting to realize the

conflicts that truly exist between contractors and designers when working towards a common goal. This could also be a result of the more communication that is happening amongst them.



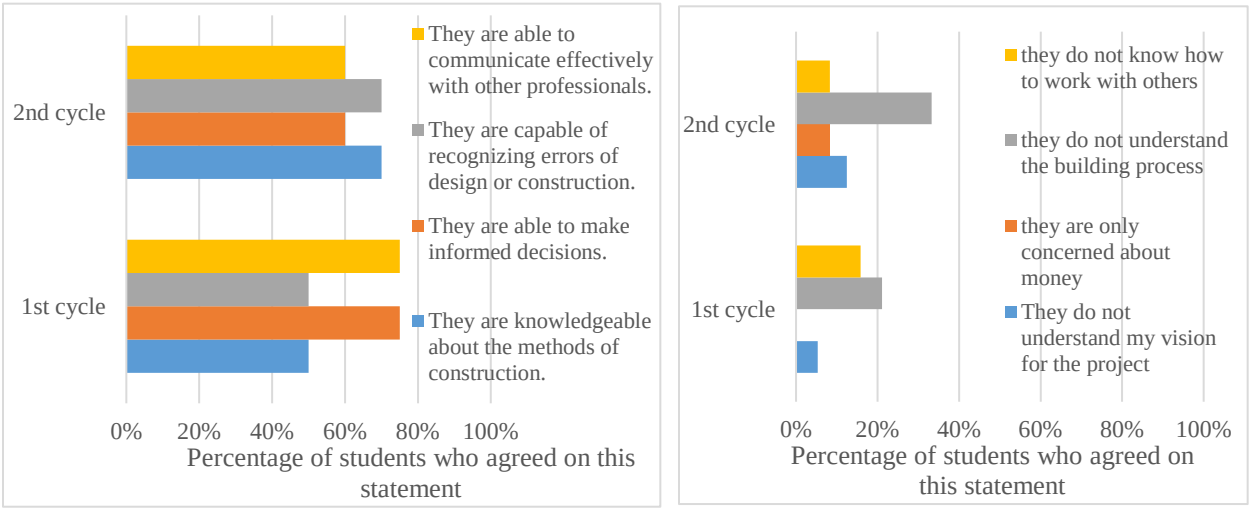
(a) Students' preference to work with which disciplines

(b) Students 'perceptions of interface with other disciplines

Figure 6: Students' perception of work with the other discipline

CET Students Perceptions of Civil Engineers

This section reports the results of the questions that were addressed specifically to CET students on their perception of designers. Figure 7a shows what CET students thought of designers in both first and second cycle of the survey with minor differences observed. As seen in Figure 7b, as when asked about their biggest concern working with a designer, the first concern of CET students was that they didn't understand the building process, which actually increased from cycle 1 (21%) to cycle 2 (33%). This was followed by 'they don't know how to work with others' which actually dropped in the second cycle (from 16% to 8%).



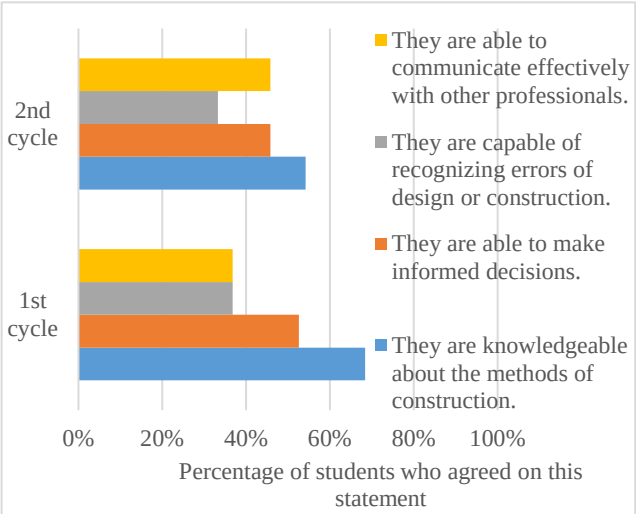
(a) What do you think of the designers you will work with?

(b) What is your biggest concern when working with a designer?

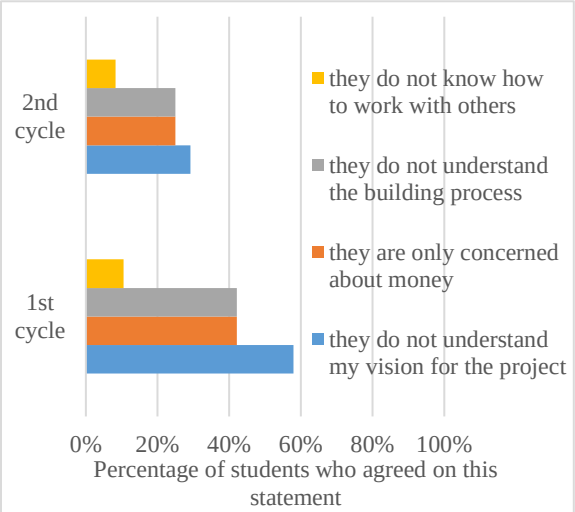
Figure 7: What do you think of the designers you will work with?

CE Students Perceptions of Construction Engineers

This section reports the results of the questions that were addressed specifically to the CE students. Figure 8 shows what CE students thought of contractors in both first and second cycle of the survey with minor differences observed; in both cycles, CE thought contractor's knowledge about the methods of construction was a great advantage. As seen in Figure 8, when asked about their biggest concern working with a contractor, CE students' first concern was that they didn't understand the designers' vision for the project. All the concerns however, significantly dropped in the second cycle, showing less stereotypical perceptions, and reflecting more of their real-life experiences working with CET students.



(a) What do you think of the contractor you will work with?



(b) What is your biggest concern when working with a contractor?

Figure 8: Perception of CE students about working with contractors

Feedback received from students on the project and discipline interaction

The students were asked a few open-ended questions regarding the major challenges and conflicts they have experienced or anticipate to experience, at different stages of the project. Most of the comments received from the students followed the theme of "understanding and communication". For example, a CET student noted that "The lack of understanding the construction aspects of a project (and vice versa) will cause delays/conflicts". While a CE student noted that a major challenge was the "different level of understanding with respect to various topics." And he/she also noted how the "Schematic design was altered due to construct-ability [reviews done by CET students]". It was also noted by that a major challenge is "effective communication", and that "often times we just assume that we understand what the other party wants or needs." in addition to "not getting clear definitions of things we don't know". Two very interesting statements noted by the students from both perspectives were:

> *"Lack of understanding at how important materials selection and construction design effects the end result. No one will care if you have a structurally safe project if the project takes six times the cost and six times the duration to complete."*
>
> *"Communication between the design team/contractor is harder to maintain, since both teams have different sets of goals and priorities"*

Students were also asked to state the common stereotypes of their profession. CE students stated they are known to “calculate stuff”, “not real engineers”, are “smarter than everyone”, “don’t know a lot about the project construction process or duration since they are not on the jobsite”, have “no social skills”, and “don’t care about money or cost”. On the other side, CET students’ common stereotypes included being “greedy”, “working only for money and cut corners”, “always bossing architects and engineers”, and finally “do not like the architects”.

Discussion

Some of presented observations are of a certain interest as they show that both disciplines are learning more about each other’s responsibilities. For example, the 7% of the CE students agreeing that construction engineers value a project in terms of structural efficiency, increasing to 23% in the following cycle, shows that CE students are starting to see some common language to talk to CET students about their design process. The second cycle of the survey also showed an increased students’ awareness of each other disciplines. An interesting example was how at the first survey, 60% of CE students thought Construction Engineers think that Civil Engineers (designers) work for them; this number dropped to 38% in the second survey also showing a more collaborative environment being fostered between the 2 groups. It is also noticeable the high level of misconceptions associated to common stereotypes among undergraduate students.

Conclusions

The objective of this study was to foster the understanding between design and construction students of each other disciplines, and increase their awareness of the importance of the roles they both play on a construction project. This was achieved through a 4-step process that encompassed forming an interdisciplinary senior project team including both construction and CE students, administering a survey to benchmark their perceptions of each other’s disciplines, followed by the actual work and coordination meetings on the project, then finally conducting a second survey to collect again their perceptions, and investigate if any of which has changed. The study used partnering concepts to create a senior project environment that fosters collaboration and problem solving.

Results of the study show that, through the shared common project goal conveyed to the entire team, and the partnering activities such as the regular coordination meeting, students were able to gain a better understanding and appreciation of each other’s disciplines, and work collaboratively towards the project goals. Through a structured senior project and the interaction we provided our students, their perceptions were changing regarding each other disciplines, specifically the roles they each play. Most interestingly of which were the stereotypical perceptions assumed of a construction engineer or a civil engineer. These perceptions were seen to change from the first benchmark survey to the second, showing mostly a better understanding of each other’s roles and responsibilities. Also, allowing students to experience a real-life project modeling a true team that consists of both contractors and designers, as well as owners (modeled by actual owner project manager and faculty), increased the effectiveness of the students experience. The results also show potential for such a model to be replicated in other programs. Such an understanding between disciplines will ultimately lead to fresh graduates ready to interact with other disciplines that he/she does not commonly interact with during their undergraduate years. It also clarifies and removes the stereotypical opinions of what their roles are, and enhances and fosters the

understating and readiness to communicate and negotiate for the overall benefit of the project, rather the specific goals of each discipline.

This is the first interdisciplinary design-build senior project that the department has started. It was set-up to highlight the importance of interdisciplinary interaction between our students. The project will be further extended to upcoming semesters and more awareness and outreach to students will be done to increase the enrollment in future projects. On the long term, similar senior projects are expected to impact both Civil and Construction Engineering students' learning experience. The collaborative nature of the senior project will reinforce, enhance and assess the fundamental concepts being taught in the traditional classroom but in an interactive, 3D e-learning environment. Those engineers would be ready to embrace such interdisciplinary projects, which will not only save time and improve accuracy but they will also have a significant business advantage over their competitors.

Bibliography

1. Konchar, M. and V. Sanvido (1998). Comparison of U.S. Project Delivery Systems. J. Constr. Eng. Manage., Vol. 124, No. 6, pp. 435-444.
2. Design Build Institute of America (DBIA). History of DBIA State Advocacy. Available at: http://www.dbia.org/advocacy/state/Pages/default.aspx, n.d. Accessed September 2014.
3. Yates, J. K., and J. A. Smith. Global legal issues for engineers and constructors. *Journal of Professional Issues in Engineering Education and Practice*, Vol. 133, No. 3, 2007, pp. 199-209
4. Devier, C. J. (2007). Designers' and Contractors' Perceptions of Each Other. Thesis presented in partial fulfillment of the requirements for the Degree of Master of Science in Building Construction, University of Florida.
5. Tran, Anh L. H., Mills, Julie, Morris, David, and Phillips, Michael (2012). All hands on deck: Collaborative building design education for architects and engineers. EE 2012 - International Conference on Innovation, Practice and Research in Engineering Education, Conference Proceedings, International Conference on Innovation, Practice and Research in Engineering Education, Conference Proceedings; ISBN-13: 9781907632167; September 18, 2012 - September 20, 2012; Loughborough University
6. Lopez Del Puerto, Carla and Strong, Kelly (2015). Lessons learned from co-developing and co-implementing a design-build course with the construction industry. ASEE Annual Conference and Exposition, Conference Proceedings, 122nd ASEE Annual Conference and Exposition: Making Value for Society, June 14, 2015 - June 17, 2015; American Society for Engineering Education
7. Masi, Barbara A; Hosoi, A.E.; and Go, Shanette A. (2011). Re-engineering engineering education: A comparison of student motivation, ability development and career paths in traditional and cross-disciplinary engineering degree programs. 118th ASEE Annual Conference and Exposition; Conference, June 26, 2011 - June 29, 2011; American Society for Engineering Education