"Developing an Inter-School Internet Design/Build Class"

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Abstract

At a time when the design and construction industries are aware of the increasing use of the Design/Build project delivery strategy, there is little attention to its implementation in architectural or construction management programs as a classroom experiment. East Carolina University Department of Construction Management and the University of Oklahoma Department of Architecture began the investigation for such programs in their curricula. This research presents the development strategies created to instigate an Internet Design/Build class for the two schools. The paper relates the positive and negative components confronted during the development and implementation of the overall class. Using available computer information technology resources, such as NetMeeting and MIRC32, the Design/Build class approach of study emphasizes the management of design, construction, planning, finance, and marketing, as well the absolute need for communication between the team members. Rather than face the traditional confrontation of the parties, this class is intended to strengthen the professional bonds, complementing each partners' strengths and thereby creating a strong TEAM approach to design and construction. The implications derived in developing this program show the need for such investigations in other schools of construction and architecture interested in pursuing a relevant and emerging domain of education. This study recognizes the need for the existence of Design/Build and its integration and acceptance into professional programs.

(Key Words: Design/Build, Internet Learning Environments)

I. Introduction

For over the past 100 years, the primary method of Project Delivery for construction projects has been the Design/Bid/Build method. This cumbersome system does not allow an Owner to avoid conflicts between the A/E and Contractor during the project, while still attempting to meet his/her needs of a cost-effective, well designed structure built in a reasonable time frame.

In response to these needs, the Design/Build method of delivery was developed as a single-source procurement for the Owner. Design and construction are provided to the Owner for a "Guaranteed-Maximum Price" (GMP) from the Design/Build firm. By employing this project delivery framework, adversarial relationships between A/E's and Contractors have the probability of being significantly reduced. The Design/Build firm acts as the facilitator for the two entities so that they are working for the Owner's objectives. Design/Build shares the responsibility for product delivery between the historically adversarial groups of builders and designers. With this shared responsibility, there is no finger pointing to shirk the responsibility of a non-performing product or team member [11].

At a time when architects and construction managers may scoff at Design/Build and wish it would go away, a greater need for owners to obtain design/build services has increased [4]. It is this need that this classroom setting attempts to enhance. Although there are a variety of company configurations for Design/Build firms, the project was centered on the method of a total Design/Build firm that encompasses both design and construction within their organization (See Fig. 1). It is the most advantageous method for maximizing the strengths and minimizing the weaknesses of the A/E and Construction components.

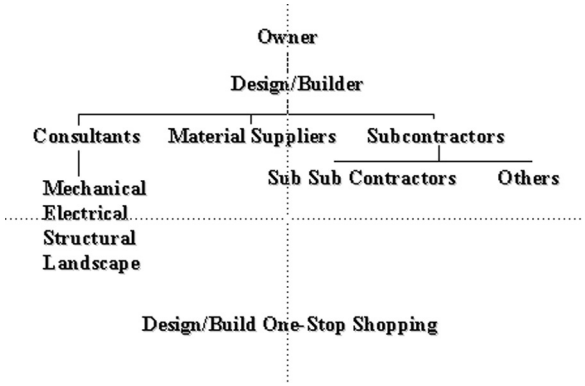

Figure 1 Design/Build Project Delivery System

Schools have previously provided classes in Design/Build at some construction-focused architectural programs [6], however these classes have dealt primarily with creating a hands-on clinics to teach students about sites, structures, materials, and joinery. Research did not uncover any true Design/Build courses directed towards the complete development of such a project delivery course. With this need to expose graduates to the reality of the fastest growing method of project delivery in the design and construction industries, the course was developed.

II. Class Organization

The initial Internet Design/Build class (http://www.sit.ecu.edu/cm-dept/D_Bhome.htm), for the Spring 1998 semester, provided the researchers the opportunity to investigate the Design/Build project delivery system. The Internet class permitted the enhancement of the learning experiences for both disciplines, and the interaction between remote universities, specifically East Carolina University (ECU) and the University of Oklahoma (OU).

The class organization was composed of six (6) teams created with one ECU Construction Management student and one OU Architecture student. Communication between all parties and teams was required to be totally through the Internet. The communication software programs available to students, as well as those that they have discovered on their own initiative, allowed for this form of interaction. In order to maintain written records of the communication, formal communication records were required by all teams. This obligation allowed the research team the opportunity to study the dynamics of the decision making process through the semester. The necessity of these records was reinforced to instill in the students the need for complete written

documentation in the working environment.

Each team created homepages that were maintained throughout the duration of the semester. The professional homepage became the marketing showcase for each team's Design/Build firm. Because of the special character of this class, a number of programs, alumni and interested individuals were watching the development and progress of this project.

In addition, all semester course presentations were accomplished via the Internet. This allowed each team to display their designs to many individuals and groups simultaneously and thereby enrich the learning experience. This method of project presentation delivery was used to experiment with the given software technology to verify its viable use for design and construction firms.

III. Class Project

The project for the Design/Build Internet Class was a Fire Substation located in Las Vegas, NV. The building type was selected because of its relative complexity in design elements for the time constraints of the new learning environment of the electronic studio/classroom. In addition, the facility type was a design and constructability level that enabled a more complete investigation by the teams.

The project site was the actual location of a recently constructed fire station designed by Carpenter Sellers Architects. Project photographs and topographic surveys were provided for the teams. Based on preliminary project programming requirements and cost constraints, teams were instructed to develop full programming studies, site development studies, preliminary and final materials research, code analysis, schematic designs preliminary designs, structural designs, preliminary cost and scheduling, value engineering, and final design development. During the semester intermediate assignments were given to provide needed direction.

Weekly presentations enabled the teams to update their project development to other class members and to the professors and visiting critics. Final presentations were given at the end of the semester to a combined critique of academics, architects, and contractors at both university sites.

IV. Expected Outcomes from the Class

Because of the multiple issues relative to the combined disciplines of Architecture and Construction Management, and the inaugural Internet learning environment, there were a variety of expected outcomes of interest to the research team. Not only was the issue of the success of a Design/Build teamwork program important, we are also interested in the role and implications of using Internet technology to enable effective collaboration. Specifically we were addressing:

1. Communication, Communication, Communication

Communication was the primary goal of the research. Not only were we interested in the dynamics of two distinct disciplines and how they would interact, but also the significance of

how Internet collaboration would influence or hamper the team process. Two specific modes of communication were utilized: *asynchronous and synchronous*.

The *asynchronous* mode allowed team members to work at different times on different components of the Design/Build project without the simultaneous presence of their partner. Therefore they were not required to be electronically connected in a common environment, however were united through e-mail and FTP software. This allowed directed research by individuals based on prescribed duties negotiated by each team.

The *synchronous* mode allowed necessary multi-task interactions with partners. When it was critical to discuss findings, as well as evaluate changes or needed changes during the project, members were linked simultaneously in a common electronic workspace. Group presentations, where the electronic classroom simulated the traditional classroom, were convened in this communication mode.

2. Exposure and Appreciation to the Strengths of Both Parties

The understanding and appreciation of both disciplines were issues that too often have been overlooked by programs in construction management and architecture. In many instances, as programs have become more exclusive, the potential for continued adversarial relationships increases. New technologies and practices trends requires reassessment of the long held attitudes of the two disciplines of architecture and construction management [8]. Contributions by both partners to the design, development, management, constructablity, and building use, all determine the outcome of design decisions. Therefore, by engaging the students in the framework of TEAM, the class experience presented them with the opportunity to experience the strengths and weaknesses of the current learning environment. The TEAM organization made the researchers aware of the different values inculcated by the two disciplines of Architecture and Construction Management.

3. Understanding the Building Process

It was essential that both parties gain a firm understanding of the "building process." This was defined as the comprehensive nature of a structure being constructed, from idea, to drawing, to design, to refinement, to cost refinement, to buildability refinement, and ultimately the implementation into its final constructed form. A successful experience would elevate this project to a higher level of learning for all students.

4. Internet Communication Skills

With the requirement that all communication for this project take place via the Internet, students were confronted with the difficulties of current Internet video software. Based on the technical hardware and software capabilities created for graduate coursework at ECU, existing mainstream communication software was employed. This level of interaction allowed the students to experiment with NetMeeting communication software, in conjunction with standard chat rooms, e-mail, and FTP software.

5. AutoCAD and Construction Management Computer program enhancement

Because of the differences in curriculum between Construction Management and Architecture, exposure to differing software and the needs of documentation and information required for their successful implementation, became a strategic issue to address. Specific hurdles were required by all teams to explore. Specifically, Architecture students realized the pragmatic issues that construction management students must address in utilizing Primavera and Timberline software, and Construction Management students were required to manipulate AutoCAD drawings to obtain necessary information for estimating. The project also allowed both members to enhance their working knowledge of the programs on a realistic project, thereby enforcing their decision making skills during the design phase.

V. Educational and Technical Requirements of the Class

Based on the following general requirements for both disciplines, students were selected for the initial Design/Build Internet class:

Construction Management

- Senior status
- Working knowledge of Primavera and Timberline software.
- Internet experience (Preferable WWW design knowledge).
- High communication skills, both verbal and written.
- Enthusiasm for the challenge.

Architecture

- Junior/Senior status.
- Working knowledge of AutoCAD and 3D Studio or appropriate compatible CAD software.
- Internet experience (Preferable WWW design knowledge).
- High communication skills, both verbal and written.
- Enthusiasm for the challenge.

From this baseline of knowledge, twelve (12) students were selected. A primary concern was in the understanding of the Design/Build project delivery format of the class. Two Internet class sessions were held to discuss the dynamics of the process to provide a better understanding of the roles of the partners. This was deemed insufficient and a more thorough discussion was required.

Students were introduced to Microsoft NetMeeting (See Fig. 2) as the primary method of communication. This software allows for one-to-one video and audio communication, with the ability to share applications and to collaborate electronically. These applications allowed team partners to discuss issues at length over the Internet and share software applications when

required. Whiteboards were used as a standard method of discussing design ideas prior to their development in CAD documents. Chat boards became the primary method of retaining the required written documentation of all discussions during the design development phase. In addition, when the need arose for other teams to come together as a group, NetMeeting provided the capability of six individuals communicating via the Chat Room application. The software additionally allowed maximum flexibility for teams to discuss day-to-day problems.

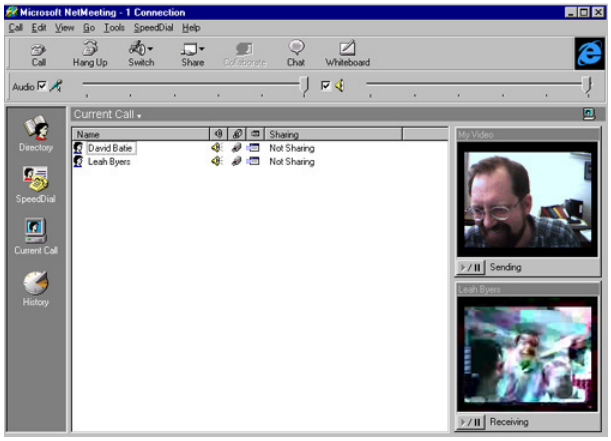

Figure 2 NetMeeting Video Conferencing

Both universities utilized established labs for use of the software, maintaining 200 Pentium PCs computers with all relevant software installed, including Cu-See-Me cameras, speakers, and microphones. Students were also given the option to download the NetMeeting software for their home computers. Because no specific university-governed time was established for the class, teams had the option to set their own meeting times and schedules. This allowed for a great deal of freedom for the students, but also required self-directed discipline to maintain the required time schedule. Presentation meeting times with the professors were established for every Friday afternoon.

VI. Implications of the Project

What we learned, what students learned from the experience.

Because the researchers were dealing with a program arrangement that had no known prior examples, there was no specific basis of comparing the results of this project against previous work. The program schedule and content expectations were established from each professor's previous teaching experiences in their specific disciplines. In addition, the pragmatic requirements for course credit dictated a variable observance of requirements. Since ECU students were using the course as a three (3) credit hour special problems course and OU architecture students were involved in a five (5) credit hour design course, a disparity of required work existed. Because of the complexities of work taking place at different times during the term, it was not possible to simply accumulate both content areas hours to assign hourly work requirements. Ultimately the decision was made to evaluate the outcomes based on observations of group dynamics, completeness of intermediate goals, completeness of

intermediate requirements, individual research, and final project completeness and holistic quality of the entire project achievement.

The learning requirements were compounded by the realities of having a partner with a different perspective and interest, causing delays for consideration, coordination, collaboration, and communication that are not required of the content material of any course by themselves. There were clear differences in "values" pertinent to the particular disciplines. Architecture strongly valued issues concerning originality whereas construction management strongly valued issues concerning buildability, i.e., cost and the precedence of building. The Design/Build Studio process was slower than expected; however we believe it was also more refined and resolved. Professors and students were required to be more flexible in scheduling their time.

Electronic contact versus human contact had certain results that were not anticipated. One major issue confronted involved the situation when students were physically out of touch with their typical studio context classroom. There was greater potential for students to "wander" into areas of the work process that would not occur in the traditionally structured classroom or studio. It was discovered that students were taking advice from technical experts through Internet discussions where the information, although possibly being correct, was in direct opposition to the educational intentions of the project. By limiting some building requirements, the instructors chose to direct the program to simulate a complete building process. While the instructors intentionally shaped some issues simply for the sake of moving the learning experience to meet educational goals, technical advisors provided advice that sidetracked the work process and thus students are not clear whom they should have taken the advice.

Secondly, students had the potential to stray into directions of design that would not go unnoticed by a typical classroom instructor. There would normally be immediate feedback to design decisions. However when using the Internet to converse with the teams, the comments would come to the students via e-mail or chatboard. The asynchronous process was deemed to be much slower and required that students be diligent in checking their e-mail regularly. Frequently messages were received by the students but not responded back to the professors. This asynchronous communication led to confusion and there was doubt if the comments were understood or even received. This had the effect of eroding confidence in the communication process and the loss of control over the studio/classroom learning environment.

With communication being the primary learning goal of the project, the lack of control contributed to a breakdown in the TEAM concept. There were instances when instructors received comments from team members that indicated team partners were not contributing equitably in the Design/Build process. Until both professors investigated the situation, the perception caused dissension among some teams. Part of the misunderstanding can be attributed to the Internet communication environment. This was caused by the fact that their partner did not witness their work. In addition, understanding the nature of each partners discipline was another contributing factor. We believe a more thorough understanding of the process and actual witnessing of the work process would have eliminated this perception immediately. The issue of trust was at stake in the virtual environment.

Other factors that do not have direct implications on the project were also observed.

Impressions over the Internet involve the "TV" image of the screen used for Videoconferences. Individuals not comfortable or familiar with being in front of a camera have a tendency to look away from the camera that translates in body language as a lack of certainty about the subject being presented. Uneasiness with being on the screen caused persons to desire a speedy presentation, thereby providing false signals to the receiver of impatience, lack of interest, or indifference. Therefore, a certain level of "On Screen" skills are necessary for effective communications.

The quality of interactions can be compared with a previous Internet Studio conducted in 1994 [3]. The Design/Build studio clearly proved to be more effective. As a form of comparison, the 1994 studio lost nearly 2/3 of the class participation by the end of the semester. In the current situation, full participation was maintained in spite of unforeseeable technical problems, shortcomings with electronic communications, misunderstandings, and discipline differences. This is attributed to technology-literate and interested students, more active involvement of the instructors, and having the benefit of previous experience in such a teaching/learning environment. Collaborations could clearly have been better and one would expect that such a situation would occur if additional pre-class preparation had been expanded as post-evaluation of student perceptions of the course indicated. This pre-preparation is vital for a successful "Internet Learning Environment" (ILE).

Additionally, students explored and adapted new software during the semester that proved more effective to the needs of the Internet Studio. The heuristic process applied to software use in the course experience was a natural outcome of the educational endeavor. Accordingly, research has shown that tool usage influences the manner that individuals learn and how they learn, both positively and negatively. These ideas can be viewed positively as paradigm shifts in learning and negatively as an "analogue takeover" [1].

The quality of the design product of the Internet collaborations proved to be clearly superior to a typical design studio that does not have a Design/Build Construction Management team member. If one were to compare the work of a same design project in a traditional architectural studio to the products that were derived from this collaboration, the differences are significant. The Design/Build teams referenced (1) performance specifications for the design, (2) material options with explanations for the choices made, (3) detail drawings of various types of design conditions with specific manufacturers, (4) cost estimates for all decisions, and (5) an overall decision making process grounded in real current context experience. Student homepages showcased the development stages of their designs in a variety of professional designs (See Figs. 3 & 4).

Teams experienced the complexity of the "building process" first hand, thus meeting one of the initial goals for the class. The members also displayed the stereotypical responses to each others discipline; examples being 1) designing at the last minute without regard for or understanding the consequences of such decisions, 2) seemingly always focusing on cost as a primary form constraint, 3) taking on the role of the design lead rather than a position of equity, 4) teams at times had self perceptions of difference when they were expected to have coalesced as partners. This is not completely without justification if one considers that they only were partners as they interacted, while the rest of their daily time was spent in other activities not related to their

working relationship.

Figure 3 Student Project

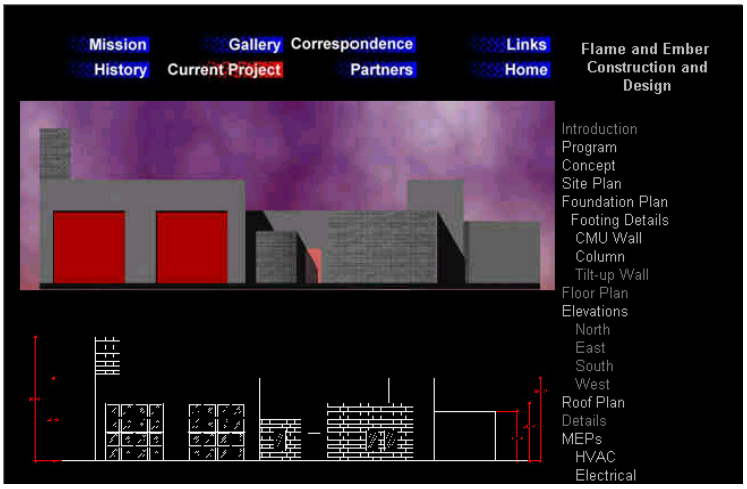

Figure 4 Student Project

VII. Observations for Future Development

From the initial teaching endeavor, areas of development and improvement are required for future Design/Build classes. Specific areas include the understanding that students with field experience (architectural or construction related) will fare better in such a collaboration. Specifically architectural students should have a strong technical understanding of construction in conjunction with design expertise. It is equally important to understand that in scheduling or allotting time for design, the process has an unruly nature; this is attributed to the design process being conceived as "continuous and on-going" [2]. Additionally, construction management students are deficient in their CAD capabilities, which led to frustration when working out original budgets. By not being familiar with the capabilities of CAD, and expecting

dimensioned drawings to work from, students were confused and delays developed in compiling the cost figures. Future classes should provide an initial short-term class in CAD for the construction students.

Structured communications with specific goals per interaction will streamline the decision making process between teams. For example, when making formal presentations, each individual must identify himself or herself, explain the purpose of the meeting (what is going to be discussed), then conclude with what just transpired (repeating the instructions of the introduction). This assists to make communication explicit [7]. Otherwise team members have the tendency to avoid speaking about their accomplishments by internalizing the information and considered it common knowledge.

Organization and documentation of information for the Internet environment requires special attention to how an audience will interact with the data [10]. This applies to home page design and how one is able to understand the whole working process and presentation of graphic and verbal information concerning the design/build process. It is clearly a communication exercise at a sophisticated level. Whether the intent is to work over the Internet or in a close collaboration of same-location disciplines, the results of a design/build endeavor will provide a greater appreciation, a better understanding and a more informed student body for the effort. However, communication remains essential.

Dedicated computing facilities would make the process more reliable and would help to create a learning space for students when requiring help. Conditions of sound and light can be improved in a dedicated space, thereby helping link the distant interactions. Information could be distributed via a bulletin board in the dedicated space for improved communications that occur naturally in a non-Internet environment. This can be thought of as a workplace or studio for distance learning. It does not have to be exclusive for the singular class but should be for Internet activities.

Finally, exit interviews with the participants provided needed documentation for the development of future Design/Build classes. A one-year post evaluation of student status in the industry is underway. The researchers hypothesize that many of the members will be leaders in the technological/communications areas of their companies, due in large part to this experience.

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