The Interdisciplinary Design Studio – Identifying Collaboration

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Intuitively designers know that teamwork is necessary to produce a cohesive project. Collaborative teamwork, or teamwork across disciplines, is a fundamental basis for firms such as Arups and Buro Happold among others and these firms are known for producing innovative work as a result of their collaborative efforts. Studies have shown that collaborative efforts can produce new and original ideas not possible in a uni-disciplinary setting. The potential to develop intriguing design solutions while requiring students to work in multi-disciplinary teams is one of the primary goals for an ongoing studio course at Cal Poly San Luis Obispo.

1 BREAKING DOWN SILOS: WHY COLLABORATION

Historically, the typical culture or condition of the university is the separation of disciplines into stand-alone curricula. There is no overlap of studies between disciplines, even if common topics exist. The colloquial term of “silo” is used to describe this condition. This separation of disciplines also extends to the professions of the built environment. As the complexity of buildings increase, so does the information needed by the design team to manage the design and building process. What is happening in the profession is mirrored by what is happening in the university. The increase in complexity of problems, is recognized by Warren Weaver in a 1948 paper entitled “Science and Complexity”. Weaver observed that (scientific) problems developed from “problems of simplicity,” in the 17th, 18th and 19th centuries, to “problems of disorganized complexity” in the first half of the 20th century, and “problems of organized complexity” post-World War II. As the complexity of problems increases to our present day, so does the need to be interdisciplinary in our research. It is not possible to be stand-alone, single disciplinary and engage the full complexity of current problems.

The added complexity of making 21st century buildings has also influenced how multidisciplinary teams are now required to design and build many buildings. These teams are formed at the early stages of projects to maximize the influence of various disciplines through the entire design and building process. The collaborative process of developing the interdisciplinary team is at the leading edge of our professions, and is becoming ever more necessary in our increasingly complex world.

Recognizing these developments of collaborative teams crossing boundaries in both the academy and industry has influenced our thinking on the need to explore interdisciplinary teams in an academic setting. Collaborative teams allow for new combinations of skills and hybrid disciplines, a better problem solving toolbox and an increased potential for innovation. These are im-
portant concepts to introduce to the students while in school and better prepare them for the near future of their professions.

The ideal situation to explore integrative and interdisciplinary teams is through a design studio. The focus of the studio can be a complex project that requires a team to provide a solution. For the interdisciplinary structure sought, we brought architecture and engineering students together to provide a collaborative design for a steel design competition, sponsored by the American Institute of Steel Construction. Each discipline contributed their expertise to the project from the first day of the quarter. This allowed for a deep exploration into program, performance and constructability. It also forced each team to develop a strategy that was compatible with the challenges of collaborating across disciplines, while at the same time developing team strategies that accomplished project milestones in an integrative work environment. It was critical that the team work together to form the team’s conceptual framework, regardless of discipline, so that the design process and project goals were consistent for all. This mutual understanding of positions; what each profession brought to the table were integrated into the team. It was a goal to support the integrated team as a unified group and reduce the separation of disciplines. We wished to emulate the best collaborative practices of the profession and explore how you create effective interdisciplinary teams in an academic environment.

2 THE INTERDISCIPLINARY STUDIO: THE COLLABORATORY

The premise of the studio is integration, collaboration, and holistic design – hallmarks of breaking down the “silos”. The fundamentals of the studio are embodied in Ove Arup’s Key Speech (1), where Arup proposes the notion of “Total Architecture”. The idea of the design Collaboratory is to expose students to an environment that promotes collaboration across disciplines, the same fundamental models embodied in Design-Build and Integrated Project Delivery. The one caveat to the studio offered at Cal Poly when compared to similar courses offered elsewhere, is the lecture topics mimic the composition of the project delivery models mentioned previously. Topics presented by faculty and design professionals cover topics related to structural systems, siting, massing, adjacency, materiality, occupancy, natural ventilation, daylighting, computer generation and modeling, and constructability. All of these topics are relevant to the built environment and all of these topics are embodied in the concept of Total Architecture.

2.1 Getting Started – Building a New Vocabulary

The studio begins with a number of activities to help both the students and faculty better understand each other. One of the first activities is a short presentation by the students in which they articulate why they participated in the studio, what their background and interests are, and what they hope to gain from the Collaboratory experience. Additionally the students complete a short questionnaire regarding their technical expertise in digital media and working in groups. Based on the presentations and the questionnaire responses, the students are grouped such that their interests align and the skill sets required to complete the course objectives are fulfilled as a team. Additionally, the faculty identify who they think can lead the team in addition to their technical contributions and who works best when given an idea and can explore it in more detail, and who has strong technical skills, but not necessarily strong leadership skills. The “match-making” isn’t always successful, but it’s an attempt at producing well balanced teams in terms of technical skills and team chemistry which is an important part of working collaboratively. (2)

Over the duration of the program, the instructors have acknowledged the fact that the students need an impulse that helps kick start the group work mentality. Over the years, the faculty have used short activities to promote collaboration. In the beginning, the activities were skewed to-
wards either engineering or architectural design and the only real outcome was the solidification of team work. Although the students were engaged and enthused about the activities used in the early years, the faculty sought to explore activities which promoted exploration of new building forms, modularity and patterning, and forms which could be implemented into their design proposals for the competition. In the latest studio, form finding activities were implemented which required teams to work collaboratively and were forms which each team member could contribute to the final submission and take ownership in the presentation. In the past year, the ice breaking activity used tensile, fabric, balloon, and bubbles as forms to create space. Although these forms and media are not new systematically, they are new to the students at our institution. This means that when the teams select a given system or design typology, all of the team members are exploring systems which are new. The students are out of their comfort zone and as a group are forced to explore the systems and possible formations as a group in order to optimize the expertise of every individual and form a cohesive solution rather than rely on the individual with the strongest voice. The team evaluates each design decision and determines which design proposal best fits the program and is the best fit for the type of work the group wants to be reflected as its own.

Inspired by the work of Frei Otto and Bodo Rasch, the instructor set the framework for an initial form finding exercise. The teams were each given a concept to work with, net with weights, soap bubbles, weaving, balloons and plaster and tensile fabric. From this the teams were asked to explore the qualities of their concepts. As the exercise went forward, the teams were given a little more information about proportion, spatial enclosure, size and scale, which related to the main project. The teams were primarily asked to work with physical models, and the models were the deliverables.

We saw the value of this being twofold. The first being, architects and engineers were both removed from familiar ground. By having the freedom to explore and very little specific project information, the exercise was very abstract and promoted design exploration on all fronts. Therefore, it was a project each discipline was equally prepared for. The second was the use of physical models, it reduced the tool set that was being used by the teams. This put both disciplines on equal footing as model builders, learning the freedom and constraints of the system and materials they were studying.

As noted previously, the groups were required to explore structural patterning using tension elements, or bubbles, or weaving, or fabric, or balloons and plaster. The idea was to explore a new frontier and to posture the students for new systems that could be integrated into their competition proposals. The introduction to the exercise started with an overview of each typology and its application, such as diagrids used in the Pompidou Metz for weaving, Ethylene Tetra Fluoro Ethylene (ETFE) pillows used in the Watercube at the Beijing Olympic Park. The groups were given two days to complete an open program in which the only requirement was to create a 50,000 square feet space. The students were encouraged to create forms that conceptually addressed massing and stability, but also addressed construct-ability through the use of modularity or patterning. An additional objective was to force the students to work together since the only way to finish the assignment was to develop a scheme collectively. Each group presented their first iteration and described the premise for the form, inspirations, and technological principles. This is standard protocol for most studios, but as jurors, faculty also inquired about their problem solving processes. When did you work on the project – during the day or during the night, who thought of the initial design concept – the architect or the engineer? And how did the design progress. The goal was to not only have the students meet each other and form a partnership, but also have the students identify how the team functioned. The form finding activities went through three iterations leading into the main competition program. And as a requirement, the student teams documented the progression of their form finding activities and how it eventually related to their project, these images are shown in figure 1.
2.2 *Introducing the Collaborative Model*

The concept of Total Architecture is an underlying theme for the studio. As the building industry in the United States transforms itself into something that resembles the master builder model of the past, it should be remembered that the current delivery models put collaboration at the forefront, but the true strength of these models, Integrated Project Delivery and Design Build, is that they harness the ideas of a cohort working towards a common goal using the same set of design constraints or rules. In essence, the concept is like the old saying “the whole is greater than the sum of the parts”. To that end, the students were also engaged in a short course version of the Arup Design School to learn the value, and the trials and tribulations, of collaboration.

Over one and one-half days, student teams participated in two collaboration exercises and were exposed to a group lecture on Collaboration and Integrated Design by practicing mechanical and structural engineers. In the first exercise, the students were given a set of 24 images in random order, but when pieced together formed a story. To make the exercise interesting, the students were timed and a competition was staged. At the end of the exercise, the students were asked how they arrived at the “solution”. To this question, the groups noted commonality between images was a starting point. The students were also asked about how were the images placed in order – as a group or individually as someone spotted the next image sequence. They were also asked to identify how the group functioned, did someone assume a role, such as placing the images, but not contributing as much to deciphering the story. The objective being to better understand the different “delivery” models that exist in such a simple exercise as arranging pictures and the importance of roles on a team. This was a segue into a short discussion on team dynamics and negotiation and how the collaborative design model is implemented.

The main exercise was to design a small studio apartment for their design team. The space would need to function not only as a living space, but a place for work and collaboration as well. The students were allowed six hours to complete the study and to emulate real world practice; the program was given a slight twist after the fourth hour. The students were assigned a site and given a limit on programmable space, in this case 800 square feet or approximately 80 square meters. The students presented their work twice during the day, similar to a 50% schematic phase and a 100% schematic phase submittal process. At the end of the day, the students presented their work and described passive energy, structural, and architectural strategies, but the thrust of the exercise was to understand team dynamics. At the end of the presentations, the groups were asked how did they approach the initial design, how did they divide the work, how did the initial design evolve over the course of the day and how were design issues resolved, and most importantly, how did the group address change to the program. By bringing these issues to the forefront of the discussion students were able to identify how their group currently worked,
compare working models within the studio, and identify working methods that did not work for them and propose new ways for working through obstacles. Common comments from the students were:

- we worked as a group to create a list of design issues, then worked separately
- since everyone was familiar with the subject, we could all contribute
- it took longer to complete than if I did it myself

Figure 2: Collaboration Exercises

### 2.3 A Case in Point: Exploring a Precedent

The next exercise was a precedent study. The precedent buildings were selected by the faculty and demonstrated a unique way of solving a problem similar to the project program for the design competition. As an example, in the first year the design competition included public housing in an urban area as part of the program. To better prepare the students for the competition, successful and innovative housing projects were selected for research. Example projects included high density solutions as well as low rise urban renewal examples. The student teams were required to analyze the site context, the space organization and program, and the structural system. The projects concluded with a presentation. (5)

This exercise is not new to architecture students, but for the engineering students this was their first exposure to researching a building as a means to expand their horizons. Typical engineering curriculum focuses on engineering principles and the design of basic structural systems, so exploring architecturally expressive structures that utilize structure as part of the design and that push the structural envelope were invaluable. It allowed the students to see what can be achieved structurally and how to push the envelope of structural design. (5)

As with past iterations of the Collaboratory, the students were required to complete precedent or case studies of projects that related to their project program. This year, students were also required to research a second project which was published in journal articles because it is known for structural imagination as well as architectural context. The same requirements were involved for each building, but there was an added benefit with this approach because the focus for each was different. In the case of the engineering inspired buildings, students were exposed to the engineer’s perspective in more detail and were exposed to structural patterning that was not present in some of the architecturally based precedents. The blending of design and technical content allowed students to better understand the influence of one discipline on another and the dependency that exists when designing spaces.

### 2.4 A Field Trip; The Site Visit

A key aspect to the class and a big enticement for the students is the site visit. Each year the faculty team selects a city to match the program. One year it was Seattle, Washington and the next Phoenix, Arizona. (5) The idea is to expose students to environments and cultures different
than those they are familiar with – another common theme of the studio. The site visits are typically scheduled in the sixth or seventh week of the term. This allows students time to solidify themselves as a team, investigate the competition program, and conduct preliminary site analysis before seeing the proposed building location. Students and faculty explore the city to complete a number of things: conduct an in depth site analysis, become aware of current practices in the region by visiting with local architects and engineers, and touring prominent buildings in the region to better understand solutions that work in that region. Over the years, the instructors have discovered that the site visit is pivotal in the students understanding the environmental and spatial constraints of the site, the building vocabulary used in the city, and the nuances presented when designing in a particular city, and probably most of all allowing a medium for the students to bond outside of the classroom setting.

![Figure 3: Seattle, WA. Field Trip: Seattle Library, Gates Foundation, Office Tour](image)

### 2.5 *Friends from Industry and Design Review*

Design reviews with an outside juries are a critical component of the learning experience in studio. For engineering students at our institution, this form of review is dramatically different from turning in calculations on a sheet of green engineering paper and having it returned with red check marks. In some respects, the passive nature of the engineering review maybe linked to the passive nature of engineers, regardless these models are the ones the Collaboratory is trying to redefine. In the ID studio, engineers and architects present their proposals as a team and often find themselves talking seamlessly about both architecture and structures. The most telling comment about the success of the studio is when someone from the jury asks “which one of you is an architect and which one of you is an engineer”, after the presentation has finished.

An added feature is the inclusion of design professionals on the jury and conducting reviews at design firms. The inclusion of design professionals who specialize in the building forms and systems which are incorporated into the competition have proved to be invaluable. The students tend to accept the constructive responses from working professionals with expertise in areas such as fabric structures or ETFE or high rise construction. The juries are typically one-half architects and one-half engineers and ideally from firms that have a multi-disciplinary approach such as Arup, Buro Happold, or Skidmore, Owings and Merrill.

Over the course of the 20 week design period the students make six or seven presentations. For one of the reviews the students are given a twist in the process. The students switch roles where the architecture students describe the structural system and the engineers describe the architectural design as a way for the teams to self monitor that they are on the same page. This allows the teams to verify for themselves that they understand the design approaches of the other discipline. It’s common for the architects to use the computer analysis output provided by the engineers to describe where the stresses are greatest or to describe the problems associated deflection. It also gives the engineers a chance to relate the building form to the precedent study or how building orientation was used to maximize views or encourage circulation on the site. The role reversals have helped teams reveal to themselves their ability to collaborate effectively.
3 THE FUTURE: IDEAS TO BE EXPLORED

Since the Architecture Department and the Architectural Engineering Department reside in a college which includes landscape architecture, city and regional planning, and construction management, the goal is to someday include all departments in a singular studio. The instructors have reached out to their colleagues in these departments and the hope is that in the near future landscape architecture of city and regional planning join the studio, at least on an experimental basis. We have started to advertise the studio to incoming freshman with the hope that a few inspired students will decide to become part of the studio and bring faculty along as advisors to their work. Currently, we invite professors from those departments to reviews so they are aware of the project scope and possibly become participants in the course.

4 REFLECTIONS

It’s been eight years since the first interdisciplinary studio was offered at Cal Poly through the Architectural Engineering department. For the first three years the department offered a joint studio in conjunction with the architecture department at Iowa State University. The studio has been expanded upon and refined over the last five years as the result of collaboration with the Architecture Department at Cal Poly. During this time, the studio has seen a growth in diversity, attracting exchange students, as well as, students from outside the college, it has provided a forum for students to understand the intricacies of human interaction through the use of team based design exercises, and provided an opportunity for integrating students with varied backgrounds and personalities through the use of interviews and questionnaires. The Interdisciplinary Design studio has been a unique learning experience for not only the students, but for the faculty as well. The students and faculty have coined the term “Collaboratory” to best describe this eight year exploratory and experimental studio.

More importantly, it exposed the students to the nuances and subtle differences in “building” vocabulary. When one speaks of materials or materiality it means one thing to an engineer and another to an architectural designer. When one expresses the need for bracing or support, it relates to the load path and stability to the engineer, but planning and circulation to the architect. This was the starting point for the engineers and architects to understand each other. But the Collaboratory has become more refined as the instructors synthesize what has worked and how it can be improved upon and reflect upon what hasn’t worked and how does it needs to be changed. A prime example is the “icebreaker” activities that now incorporate form finding and a one and one-half day course on collaboration. It is the instructor’s intent to offer this studio every year and build upon the successes and reflect upon its shortcomings.

5 CONCLUSIONS

Establishing interdisciplinary design teams in a design studio environment and providing ex-
experiences that include working with leading professionals in industry provides an important learning experience for students while still in school. The lessons students learn from this experience are multifaceted:

1. Collaboration in general is a challenge, but when students are asked to work with a different discipline in order to accomplish a specific task, valuable lessons are learned regarding these challenges, such as the interdependency of allied professions upon each other. Students come away from this studio with life experiences that are applicable to their future in the building industry and are better prepared to contribute in multidisciplinary teams upon graduation.

2. Students learn what a multidisciplinary team can accomplish versus a single discipline team working on the same project, and it is “eye opening” for students. While the design process is initially slower when compared to the pace for that of a unidisciplinary team, most students begin to understand and appreciate the benefits of having a multidisciplinary integrated design team approach as a project is developed. Typically, students do not understand these benefits until close to the end of project design when they can trace their process and chart their critical design decisions.

3. The reflective essay that each student prepares at the end of the 20-week course, provides an opportunity to document their learning and provides an assessment of the group’s process. This assessment provides an opportunity to connect the dots between the interactions of team, lectures, and workshops from visiting professionals, periodic team reviews from practitioners, connections to case study building projects, and field trip visits to a range of successful practitioner’s offices. Below is a sample of typical comments regarding their experience in the design Collaboratory:

As an ARCE, the interaction of professionals was an unexpected and appreciated addition to this project. I enjoyed the experience because it was the first time I had a member of industry actively change/interact/critique my school work. This was possibly because of the models the architects created – visually critiquing is far easier then critiquing structural calculations (but this only occurred at the much later stages of the project).

I have never learned more about what it takes to make a building stand up until this studio. The second thing I learned is about how much a design can change when collaborating with other disciplines. I learned that there are many facets of design, and design (at least the way our major sees it), is just a part of the many things that have to happen in order to make a building work.

Bringing in professionals was by far the most important experience that took place in this studio. Not only were they forward thinking in terms of design ideas, but they knew what it took to get things built. This information helped us to realize our designs in a more realistic light.

The advantages of the interdisciplinary studio are: (1) You learn how important it is to be on the same page as the engineers and that requires a large amount of communication and discussion. (2) You learn that there are real constraints on the project and that not everything is possible. (3) You learn that engineering students are very different that architecture students.
6 REFERENCES