Teaching Design Integration through a Hands-on Approach

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Abstract

The Pavilion Project is a teaching/learning activity in which first year architectural students are engaged in building wooden pavilions. This is one of a series of studio problems the students have to tackle in an introductory design course in order to learn the fundamentals of architectural design. Unlike previous hands-on problems conducted under the same course framework, designing and building full size building objects raises the essential question about the role of the hands-on approach within the introductory design curriculum. In this study we have contributed to this question in two ways. First, the design/build project has been seen as an integral part of the overall design curriculum. The central concept of design integration is strengthened by the closure of the course with a design/build project. Second, the installation of an individual design development into the project provides a means of evaluation, through which an individual student's mastery of practical knowledge can be visually demonstrated. The project has succeeded in achieving a unity between theoretical exploration and practical experience, between team effort and individual design development.

The Hands-on Approach in Introductory Design Training

The basic component of a school of architecture is the design studio. It is the place where students learn how to design architecture. A small group of 10 to 15 students work on a given design problem under the guidance of a studio instructor with the students producing drawings and models to develop their design concepts. They meet with their instructor two or three times a week to discuss their problems and receive comments for further improvement, the duration for a studio project varying from between one week to one term. At the end of a project, students usually make considerable effort to produce pleasing drawings and models which they then present to a group of design juries. The strength of the design studio is that students learn design through doing it - a 'learning by doing' approach. Similar approaches can be found in business schools and are known as 'the case method' or in the 'problem-based learning' employed in medical schools. Recently, the teaching and learning method of the design studio has attracted much attentions from other disciplines, largely as a result of the work of Donald Schön. He recognised it as an exemplary model for reflection-in-action and the best place for acquiring tacit knowledge (Schön, 1985). However, in our daily practice we were able to identify some shortcomings in the design studio method. For instance, studio work is concerned mainly with drawings and models and students have no direct contact with the actual building process. Their designs always remain as attractive pictures or models and without the students knowing if these designs can actually be built or not. The hands-on approach within a design curriculum attempts to bridge the gap between theoretical exploration and practical experience.

Hands-on experience in beginning design training has been always an important component in the first year design course: The Introduction to Design I and II in the Department of Architecture at the Chinese University of Hong Kong. It entails the students being involved in projects where they

are challenged to design and make full size objects. This is quite different from what they usually do in the design studio. Figure 1 (below) demonstrates a variety of hands-on problems which were undertaken in the past. This is the starting point for this Action Learning Project.

Figure 1: Past experiences: From bamboo structure to wooden bridge

Top row left: The bamboo tree house and corrugated cardboard cave (1991-93).
This was inspired by bamboo scaffolding structures found in Hong Kong. The project adopted a special type of local material for simple structures which have minimum functional use. The cave house project (not shown in this picture), together with the bamboo tree house, emphasised the formation of interior space with corrugated cardboard.

Top row centre: The entry mark (1994).
Using the same types of material as the previous project, this project put more emphasis on the visual form of entry marks derived from materials and structures employed.

Top row, right: The sitting object (1994-98).
This was the first design problem tackled by the students in the course. They made objects for sitting using corrugated cardboard. The project introduced basic concepts of design with an emphasis on human scale (i.e. body dimension).

Bottom row left: The mast and landmark (1993-96).
This was a joint project of the studio and the structure course. The students built six-metre high structures with various kinds of material. The innovative use of material was one of the criteria, the other being the visual quality of structures.

Bottom row, centre: The concrete post and chair (1994-95).
The post project addressed the visual and tactile exploration of concrete material using different surface treatments in the making of sculptural forms. The chair project attempted to design and build useful objects on the campus.

Bottom row, right: The vertical project (1996).
This was a joint project of the whole undergraduate programme. Each design team was made up of

students from year 1 to year 3. The task was to build bridges with wood, bamboo, PVC pipe, and other appropriate materials.

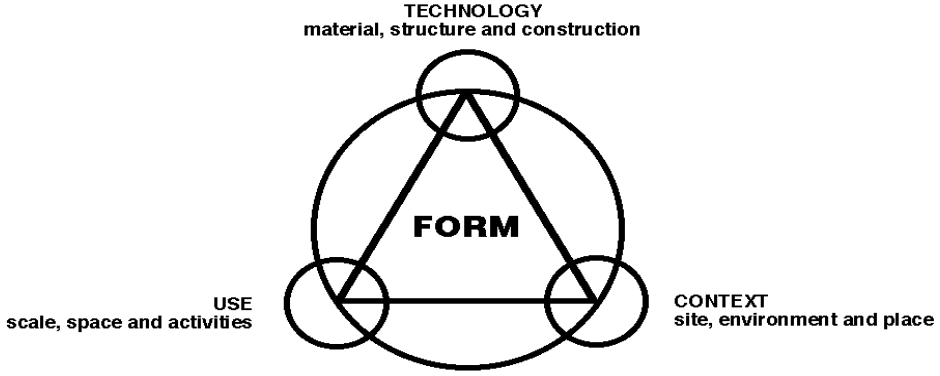
These hands-on projects serve many pedagogic purposes. They provide opportunities for the students to work with actual materials and to learn methods of construction, with the students not only designing but also making objects. The act of making proves their design. Another positive feature is that they also learn to work as a team. Above all, we think that the hands-on approach is especially valuable for Hong Kong students who grow up in a cultural environment in which the emphasis of pre-university education is placed solely on intellectual learning. The lack of life experience and hands-on knowledge are two obstacles which Hong Kong students must overcome in the learning of architectural design. This introductory course takes these two issues as its primary challenge.

So far, our exploration of the hands-on approach has been confined to small scale objects using mainly cardboard and bamboo. The concrete chair project was the first project aimed at exposing the students to real building material and complex design issues. However, the essence of architectural design cannot be tackled fully unless we work on real buildings, and so such work became the primary focus for this Action Learning Project. To design and build real buildings in an academic context raises very different challenges from the small size objects because of the complexity of work involved in the process. In spite of the value of this type of experience for architectural students, very few schools of architecture use the design and build projects on a regular basis. Carpenter (1997, p. 8), the author of 'Learning by Building' pointed out that "There are over one hundred schools of architecture in the U.S.; and less than ten have design / build programs."

Design Integration

An introductory course in architectural design contains different levels of objectives, namely: skill learning, concept learning, and design learning. First, the students have to learn the basic skills of drawing, drafting and model-making. Second, they have to learn the language of architecture: the vocabulary of design, concepts, and related knowledge. Third, they have to develop an ability to design, and apply design concepts to explore a problem, to employ appropriate tools to develop and test an idea, and to communicate the design to others. In our introductory course, these three levels of learning objectives are not treated independently, or in a sequential order. They are handled as a whole. This is based upon the concept of design integration expressed in the following diagram (Figure 2).

Figure 2: Diagram of architectural design

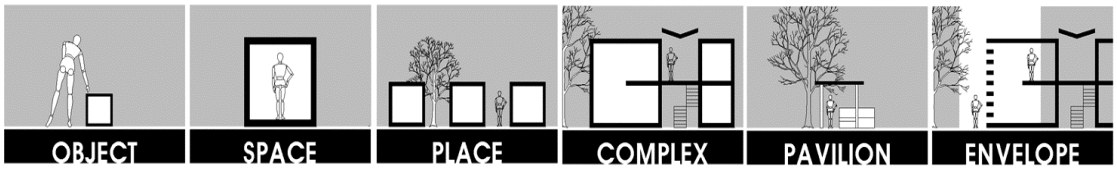


- A building has a *purpose* - the arrangement of spaces facilitating various human activities such as living, working and studying.
- A building is situated at a *place* - the impact of site conditions, climate, historical, cultural and social contexts, etc. on the form of a building.
- A building is a *built object* - the adoption of appropriate materials, structural systems and construction methods to achieve stability.
- A building is a *form-space object* - the organisation of form and space according to formal principles such as figure and ground, solid and void, symmetry and dynamics, etc.

The difficulty of teaching and learning architectural design lies in the fact that we cannot fully explain the thinking process involved in designing. How these design parameters result in a piece of architecture through the process of designing remains a mystery to the students. We believe that the ability to design cannot be taught directly by teachers through lectures but can be learned by students themselves working on design problems in the design studio.

The first year introductory design training consists of two courses taught across two terms. There are about six projects altogether including the design / build project. Each project is devoted to a particular pedagogic goal as captured in project titles: Object, Space, Place, Complex, Pavilion, and Envelope (Figure 3). It is an accumulative learning process with increasing complexity of design issues and skills. Projects relate to each other in sequence, the result of one project being the input to the next project. In this way, they form a rather complicated didactic model.

Figure 3: Sequence of studio projects



In this curriculum structure, the first project OBJECT and the fifth project PAVILION are hands-on problems. The latter is a typical design / build problem. As a building type, the pavilion is perceived as a structure-form object, its form being mainly determined by its structural characteristics. It is also perceived as space-form object providing shelter in which people can hold activities. The Pavilion Project is scheduled for the second term, around the Chinese New Year period, so that it can be completed before the rainy season. When considering the curriculum as a whole, with the central concept being design integration, the design / build project becomes a crucial stage in the development of the students' design abilities. At this time, students have already undertaken four studio projects: Object, Space, Place, and Complex. They have learned basic design skills and fundamental design concepts. They are able to tackle complex issues involved in designing pavilions. The design / build project introduced at this point could serve as a testing ground for the students to apply what they have learned to a real problem. With this understanding, we were able to develop the programme for the Pavilion Project.

Development of the Programme

The Pavilion Project was first introduced in Spring 1997 and has run for three consecutive years. The problem issued at each year was slightly different. However, the programme has been developed under the same pedagogic concept (Figure 4 below). The development of the programme includes three tasks: to define learning objectives, to invent a design scenario and to layout an instructional process.

Objectives

We have reached agreement that the essential learning objective of the Pavilion Project is to consolidate and further develop the design capability. To elaborate further, the students are expected to demonstrate through the project their understanding of basic design issues in terms of use, context, technology and form; their ability to apply design knowledge to a real design problem; and their mastery of design skills. There also exists a set of codified learning objectives for design / build projects, such as integration of design and construction, direct experimentation with properties of construction materials, involvement of students in collaborative efforts, and introduction to management skills (Hardin, 1996).

Design Scenario

The scenario is to design and build pavilions on the Chung Chi Campus to improve the quality of the campus environment. The Chung Chi College has been extremely supportive not only by allowing us to use campus land as building sites but also by sponsoring the project each year to the sum of $10,000.00 (HK). The number of pavilions built is determined by the organisation of the design studio. Considering the amount of work involved in the project, it is appropriate for a studio section of 12 students to be engaged in building one pavilion. These pavilions are meant to be temporary structures that must be dismantled within a certain time of their completion.

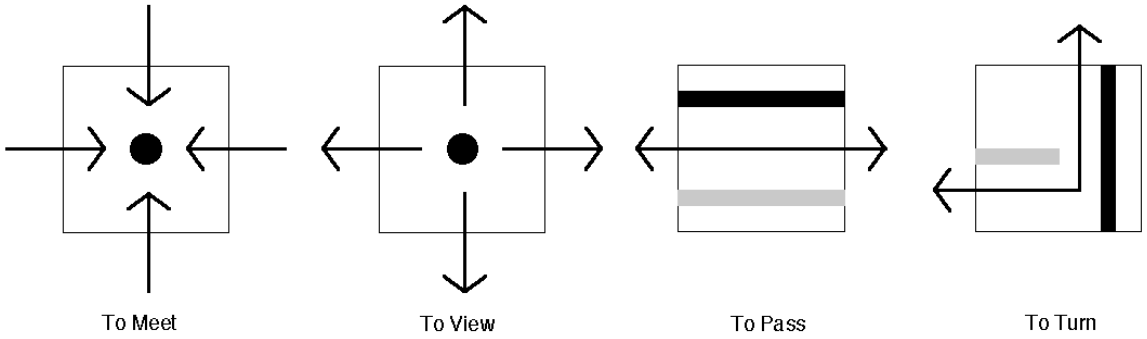
Figure 4: The Pavilion Project from 1997-99

The problem given to the students in the first trial in 1997, was straightforward and identical for the whole class - three wooden pavilions for people to meet and rest (a total of three studio sections). We were more concerned about the running of the project and so intended to prepare all the materials in advance. However, this was impossible to achieve before the design was completed. The students asked that we allocate a budget instead of giving prepared materials to each section. This unplanned decision became a wonderful learning opportunity for the students. The cost of a pavilion, which was considered to be a problem for us, became a driving force in the design process. We also noticed that the site where the pavilions were located, had little impact on the whole process. The pavilions were placed on the site, but there was no thoughtful decision made about an overall site plan.

In 1998, the problem was modified. First, the students were informed explicitly that they should design and construct pavilions within a limited budget. The issue of the budget should be considered at an early stage of the design development. Second, each section was to design a pavilion with a particular function as shown in the following diagram (Figure 5). The Meet refers to a pavilion that accommodates people in a defined space. The View refers to a pavilion that allows people to look at a particular direction from inside. The Pass refers to a pavilion that allows people to pass through it and points in a certain direction. The Turn refers to a pavilion that allows people to pass through it by turning in a different direction. These four pavilions on

the site should form a logical sequence of activities. Formal structures among pavilions should also be defined. By doing so, the issue of site became an important design parameter and the concept of use was strengthened.

Figure 5: The Design scenario for 1998: Four pavilions with four functions



There was a change of focus in 1999's problem. Students were asked to design and build four pavilions that provided shade for people inside the pavilion at particular times of the day within the year while still maintaining views to a landmark on the campus. The interesting issue of four pavilions forming a site developed in the previous year was left aside. In exchange, we could integrate some of the issues tackled in the Climate course, a required course in term two.

Instructional Model

The design / build project has its focus on the act of construction. This type of project allows people to develop teamwork skills in contrast to the normal studio's focus on individual learning. The instructional process is usually structured in a linear sequence: Design, Build and Celebrate. Figure 6, shows that the instructional model for the Pavilion Project contains two lines of development: individual and teamwork. It indicates that each design team starts by exploring the design process, then a team design is developed and finally the building takes place. Parallel to the teamwork, each team member continues his or her own initial design with continuous input from the process of construction. At the end of the project, each team has built a pavilion and each team member has presented his or her developed design proposal. These proposals should reach the level where they are ready for construction as if they can be funded. The essential idea behind this particular instructional structure is to develop a mechanism through which a student's learning from hands-on experience can be demonstrated through his or her individual design proposal.

Figure 6: The Instructional model

Process of Design, Build and Celebrate

The project in 1998 illustrates how the programme is executed in three phases: design, build and celebrate. Four design teams designed and built four pavilions with four distinct functions: Pass, Meet, View and Turn. The site was a piece of open land at the back of the student canteen (Figure 7).

Figure 7: The process of design, build and celebrate

Design

In this case study, the section was assigned to the problem of creating the Pass, which suggested a smooth movement from one end of the pavilion to the other. Within the team, each student first developed his or her initial design proposal through a 1:20 scale model and sketches. The task was to search for a proper wooden structure system and a form that expressed the idea of the Pass. Then the section met together to discuss all the design proposals from the team members and to work out a group design based on consensus. This process can be smooth or painful depending upon the particular atmosphere within the team. The process was conducted by the students without the instructor's involvement. The group solution could be one of the initial ideas from the team members, or a combination of several design ideas. Once the team came to a conclusion for a design proposal, sub-teams were organised for different tasks. The design team continued to explore the design concept, to finalise the proposal, to test joints, and to prepare working drawings for construction. The material team began to contact wood suppliers for quotation, delivery time and specifications. Two teams had to work closely to keep the schedule and the budget.

Before construction took place, four design teams had to make a site plan for four pavilions. An ad hoc design team was formed with the representatives from each section. Models of four pavilions were placed on a 1:20 scale site plan in order to define a logical sequence between the Pass, Turn, Meet and View. Site conditions were also considered carefully.

Build

While the ad hoc design team was working on the site planning, materials ordered were delivered to the school and each team started to prepare timber elements in the workshop under the supervision of workshop masters - cutting them to the correct size, drilling holes and lacquering them. Then materials were transported to the site and the final construction work began. Four teams worked together to set up positions for each pavilion on the site. The pavilion for the Pass was based on a repetitive frame system where students first assembled frame pieces and then erected them on location. Floor elements, wall and roof panels were added to hold the structure together.

Celebrate

The whole project was completed with a Celebration. This was an important moment when students could share their success amongst themselves and with others. Teachers and students from the whole department were invited to an opening ceremony held by the students. The representatives from the Chung Chi College, our clients, also attended the event. At this time, students not only presented to the public their four built pavilions but also 48 models of pavilions as well as design documents which included working drawings, material lists and budgets. The initial design idea from each student was not abandoned after the teamwork started. They were worked on alongside the construction process. They were improved with the input from the practice. In this way, it was hoped that the individual design creativity could be balanced with the team design efforts. The practical knowledge could be reflected in the individual student's design thinking.

Erected pavilions stand at the rear of the student canteen, used by students, teachers and visitors. The abandoned piece of land was turned into a meaningful place. Though the students wished to keep these structures, they had to be dismantled and the site cleared. Usually, it should be done after a few weeks. However, these pavilions remained on the site until the beginning of the new academic year. The class of students has been promoted to the second year, and they were responsible for organising the orientation camp for incoming architectural students. Dismantling these structures became a part of the camp programme for new students. Before they learned any

thing about architectural design, the first challenge the new students encountered was in the dismantling of the pavilions.

Conclusion

In this study, we contributed to the hands-on approach in two ways. First, the project has developed a new pedagogic strategy for the hands-on project. The design / build project has been seen as an integral part of the overall design curriculum. The central concept of design integration has been strengthened by the closure of the course with a design / build project. The theoretical exploration (the design studio training) and practical experiment (hands-on experience) form an integrated approach to introductory design training. As shown in these three Pavilion Projects, we could have different focuses and contents of design integration based upon learning objectives. The definition of four different types of pavilion creates a learning situation within which a positive response to site and the interrelationship between pavilions is expected. In addition, the definition of pavilions as shading devices allows us to integrate environmental concerns into the design. There are other possibilities for future exploration.

Second, the installation of an individual design development into the project provides a means of evaluation through which an individual student's mastery of practical knowledge can be visually demonstrated. We have observed that much of the research into action learning is actually spent on the assessment of learning. It is of course very important to know what students have learned through accomplishing assignments. Traditional methods of evaluation of learning, such as questionnaires, as we understand, are devised for those learning situations in which a student's accomplishment cannot be seen directly. The Pavilion Project is quite different because actual built pavilions could serve as the evidence of learning. We could clearly recognise the success or failure of a pavilion based upon a set of pre-defined design criteria. However, it only reflects the team effort. A problem arises when attempting to measure the learning of an individual in the team. One solution is to consider individual design development in parallel with the teamwork. We all have an interest in knowing the difference in learning between a regular studio project and a design / build project. A regular studio project culminates in a set of drawings and models. It is often criticised as 'paper architecture' because it is created without a firm knowledge of building construction. We believe that students will respond to technological issues better through the design / build project because as they understand clearly the potential and constraints of wood material and construction method when designing, they produce better architecture.

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