Developing New Frameworks of Art-Physics-Design Pedagogy for Future Engineers

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Abstract

The study aims to investigate Art teaching ideas and activities enhancing pre-engineering students’ prospects for their forthcoming career path. The designed approach embraces the integration between fundamental structural forces and applied art as to facilitate learners’ developing of abstract, unsophisticated features. The samples of model conversion from 2D illustrations to abstract, tangible 3D engineering configurations incorporate the representation of glass and steel low-rise and high-rise building structures, as well as long span bridges being generated from compression and tension principles. Concisely, students’ fabricated models feature the balanced combination of engineering conceptual design coupled with the aesthetics aspect of artwork. Materials for structural design cover normal items such as paper, plaster, rubber, cloth waste and yarn. Ninety pre-engineering in the first year were classified into 3 classes, each of which contained 6 groups of 5 members. Subsequent to the developed instructional approach, the samples could create 7 pieces of model representation in one semester. The performance evaluation, measured from fundamental implementation toward advanced application reveals that a quarter of samples fulfilled the progression of planning-to-shape integration as well as model production. Furthermore, half of them were able to apply practical knowledge about directions (real physics) into innovative and artistry creations.

Keywords: Art-Physics-Design Pedagogy, pre-engineering students;

1. Introduction

The study was conducted with pre-engineering (high vocational certificate) students, Civil Engineering program, King Mongkut’s University of Technology North Bangkok (KMUTNB). Ninety students were assigned into a fundamental Fine Art course “Fundamental Art Design Composition” to enhance engineering design process, bridging the gap between the design concept and the detailed design phase. The principal objective is to introduce pre-engineering students the combination of art and engineering concept formulation to meet the challenges of professional civil engineering arena. Typically, these vocational students do not have a keen interest in the world of art and design education, the stage giving them the practical preparation by developing their design skills. On the other hand, their special attention is

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given to the fields of science, technology and innovation. These students are assumed to have a keen interest in expanding their knowledge into the area of engineering rather than imagination and aesthetic skill, the philosophy dealing with the nature of art, beauty, and taste, with the creation and appreciation of beauty.

1.1 Proposal
1.1.1 Some basic aesthetic concepts and aesthetic elements should be thought to pre-engineering students for further application into their work.
1.1.2. The ratio of each knowledge should depend on each application.
1.1.3. The overview of engineering design should be presented with aesthetic appearances/feature.

1.2 Two Problems
1.2.1. How can the instructor integrate basic aesthetic components into civil engineering courses?
1.2.2. How can the instructor make students aware of aesthetic aspects so they can incorporate them into engineering design work pieces?

2. Methodology

2.1 The first solution
As engineering students prefer science over art creativity, physics/science should be involved into their art lessons and activity assignments. All physics theories, especially the domains of force, vector, and moment efficiency can be transformed into a variety of 3D models. Therefore, the students were encouraged to develop skills embracing the basic of art composition along with civil engineering design, i.e. building up conceptual mass models based on physics principles. The course procedure incorporated 4 learning stages:

Firstly, the instructor gave a lecture on the basic of art composition with a wide range of examples of engineering design applications. Secondly, the techniques of architectural model making was illustrated. Then, students were assigned to design their own 2D works of art, which were likely to be similar to the abstract shapes; however, the images had an aesthetically pleasing impression. Next, students created 3D abstract sculptures through geometric mass models. Lastly, 3D pieces of civil engineering conceptual models were carried out.

2.2 The second solution
After the student completed preliminary design for their assignments, they were assigned to build up 3D mass models including both engineering and aesthetic design concepts in compliance with the design criteria for each

Figure 1. Practical experiment of paper cantilever.
assignment. Then, the 3D models would be contested in class. The winning decision was derived from instructor’s judgment and students’ votes. The standard criteria principally entailed the balanced combination of visual art composition and engineering design that produced an outstanding arrangement.

Figure 2. Efficiency evaluation of bridge structure.

Figure 3. Compression and Tension bridges.

By nature, pre-engineering students were excited with the contest. They were devoted participants, eager to contribute and attempted to do their best for the competition success.

2.3 Scope of judgment: Methodology for students’ assignment
Guidelines for judgment are based on the following criteria, i.e. the designed model must:

2.3.1 Be based on the principles of physics and civil construction notions
2.3.2 Reflect its own function as being set up by students’ ideas
2.3.3 Be completed with accuracy and keenness in details of assembly at all scales
2.3.4 Illustrate appropriate structure with low cost, local materials
2.3.5 Be either an original or a traditional but modified project
2.3.6 Never be a replication

2.4 Concept / Philosophy of assignments
The assignment instruction was coached step by step as to motivate students into actual work. Students were encouraged to demonstrate their imagination and present their creative ideas enthusiastically.

All students set up their own group to manage assignments. Every 2 - 3 week phase, the lecturer would assign the 2D and 3D model making projects. The introduction of overview design and main issues in relation to space dimensions reflect the shape design were discussed. In the following week, students needed to submit their preliminary idea and drawing for beneficial suggestions of techniques for model formulation.

2.5 Tentative schedule
2.5.1 Week 1-3
- A lecture on elements of art composition and application in the real world. Students practice on 2D works, e.g. with dot, line, shape, space, and colour involvement. They work on the composition of abstract texture by means of low cost materials.

2.5.2 Week 4-7
- A lecture on the general appearance of 3D abstract sculptures. Practice on the construction of a sculpture model of reinforced plaster.

2.5.3 Week 8-10
- A lecture about long-span bridge shape and construction principles. Practice on the design of a ‘long-span bridge shape’ by a scaled model.

2.5.4 Week 11-13
- A lecture about the design concept and structure of the wide span roof. Design assignment on a ‘wide-span roof shape’.

2.5.5 Week 14-16
- A lecture about architectural concept and structure to formulate a skyscraper shape. A practice on a ‘high-rise building shape’ by a scaled model.

2.6 Criteria of evaluation

2.6.1 Assignment 1. “Geometric Abstract Sculpture forming”
A. Design ability to produce an outstanding shape
B. Structural design ability C. Carefully construction

2.6.2 Assignment 2. “A long-span bridge shape”
A. Creative ideas to apply physics principles into bridge’s shape
B. Correct ideas matching up structural form and function
C. Accurate model part assemblage D. Impressive shape of a civil sculpture

2.6.3 Assignment 3. “A wide-span roof shape”
A. Appropriate structure to create unobstructed space under the shape
B. Right and proper model assembling C. Suitable overview of roof design to its space and function

2.6.4 Assignment 4. “High-rise building’s shape”
A. Proper model part assembling
B. Impressive building shape proportion as municipal landmark C. Outstanding structural design

3. Conclusion
The pedagogical approach has been operated since 2005 while the course description is subject to the improvement every 4 year in compliance with learners’ civil work experience. The course adjustment was carried out through random interviews from former students. The significant data were gathered from previous in-class scores, design quality classification, a number of enthusiastic participants and students attitude, gained from interviews right after the course completion. Lastly, the feedback of students’ work was collected for further improvement of the of the course structure.
Figure 4. 2D Abstract texture  

Figure 5. 3D Geometric Abstract Sculpture forming  

Figure 6. A long-span bridge shape.  

Figure 7. A wide-span roof shape.  

Figure 8. High-rise building’s shape  

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