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Innovative Form Generation Training for Bridging Product Design Practice

Shih-Hung Cheng[1*], Yung-Chuan Ma[2], Winger Sei-Wo Tseng[2]

[1]National United University
[2]National Yunlin University of Science and Technology
[1]1, Lienda, Miaoli, Taiwan, R.O.C
[2]123 University Road, Section 3, Douliou, Yunlin, Taiwan, R.O.C
achille@nuu.edu.tw*, mayc@yuntech.edu.tw, tsengws@yuntech.edu.tw

Abstract

This research wants to develop and test innovative modular courses of form generation. There were four modular projects in the course "Form Theory," and twenty-two students completed all assignments of the twenty-eight students originally enrolled. After analyzing the data of student self-assessment and reflection, we found that students are more proficient in proportion and volume than contours and surfaces. We hope that our finding is conducive to follow-up improvement of modular courses and syllabus design.

Key words: Form Generation, Product Design, Industrial Design, Modular Courses, Innovative Training

Introduction

In the field of design practice and education, the concept and the maxim of "form follows function" coined by the architect Louis Sullivan [1] is deeply rooted in the basic education. In the pursuit of diverse creative solutions, it is better for students in the department of design to have a good command of product form. However, the rational analysis of product function is the necessary condition. It is more important to improve the sensitive ability (sufficient condition) of integrating form generation, as well as to increase the flexibility of the problem-solving process for avoiding the dull design expression. In the course "Form Theory," we tried to divide shape into five levels, including proportion, contour, volume, surface, and detail. We proposed these five levels to develop new modular training projects for bridging student's ability of form generation to product design core course. Students who took this course were guided to complete four modular assignments for enhancing their skill and knowledge of form generation. We hope that students will acquire proper skill and knowledge of form generation through the assignments introduced in this module course.

Literature Review of Form Theory

In the form generation of industrial products, "form follows function" has deeply influenced students learning especially since their basic design education. Students of product design have been systematically educated and trained to rationally explore the relation between product functions and user needs, as well as then to develop appropriate product forms. However, Taiwanese students who are really able to comprehend and apply this design maxim in time are not the majority. We guess that such learning outcomes may be influenced by two factors. One is that student's exploration of functions and needs is not precise enough, and the other is that student's ability to construct simple form is not enough either. The latter is the focus of this study. Therefore, in the following paragraphs, we will review the literature on Kostellow's foundation studies, the gestalt principle and the concept of archetype.

A. Kostellow's Foundation Studies

Professor Rowena Kostellow was the driving force of foundation program at Pratt Institute and deeply influenced the design education, especially on industrial design program. She believed that beauty and the thoughtful manipulation of form are at the core of designer's role in product development [2]. She insisted always on the designer's primary role as form giver. She introduced students to an ordered sequence of visual experiences by which artists may develop their understanding and recognition of the abstract elements. All her teaching was focused on the abstract elements that made her class very regimented [3]. Rectilinear volume (as Fig. 1), the first work of Kostellow's form exercises, plays the role of cornerstone in the sequenced training programs. It is composed of only three rectilinear blocks. Kostellow had ever said "at first working with 3-dimensional forms in this way is difficult. You really have to make these beautiful. That sounds pretentious. How can you make three blocks beautiful? …But I know that you can." [3] Students are encouraged to make three volumes different in shape and volume (e.g., long cuboid, and thin rectangular board) as much as possible. By going through this form exercise, students will learn to experience and establish the relationships between volumes by choosing the dominant, subdominant, and subordinate forms. They also are asked to be aware of proportions within a form (including length to width to thickness), among forms (e.g., thin block vs. long cuboid), and of overall contour that are influenced by positioning the axes of the volumes.

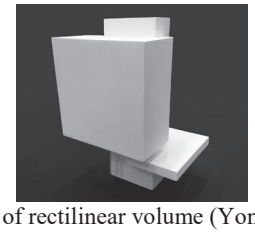

Fig. 1 Student's work of rectilinear volume (Yong-Yi Cai, 2016).

According to the above description of Kostellow's design teaching, we can understand that her foundation studies has transcended mere the mechanical measurement of form elements, and been able to lead students to focus more on

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experiencing and comprehending the structure of abstract elements. We believe that this kind of sequenced training is helpful for students of product design [4]. In order to enable students to have a good command of form generation, we believe that it is necessary to teach students to follow the characteristics of elements to choose an appropriate method to complete the shape [5]. Therefore, students need to be able to comprehend extra ways to arrive at a unity of multiplicity by applying proportion, balance, harmony, rhythm, etc.

B. Gestalt Principle

Gestalt psychology, is an important basic theory for learning form generation. From the beginning, Gestalt psychology has a very close relationship with artistic expression [4]. "Gestalt" cannot be translated into an equivalent single English term and encompasses a wide variety of concepts: a shape, and a whole form [6]. Gestalt psychologist proposed that people senses external shape as whole rather than the sum of the parts. The visual stimuli can be designed and structured by using Gestalt laws of grouping. Gestalt laws of grouping deal with the sensory modality of vision, auditory, tactile, and others. The visual modality is the most widely used principles including law of proximity, similarity, closure, symmetry, common fate, etc. [7]. Gestalt psychologist Rudolf Anheim had tried to apply Gestalt psychology to art, and deeply influenced the design practice [8]. For example, in Kostellow's studies, students must bear in mind the proportion of the structure while at the same time paying attention to contours, volumes, and surfaces [4].

C. Archetype

The perception of basic form is the result of experiencing its edge and contour. Every element has its own essence and attributes; for example, the essence of sphere is its most simply and complete shape, while the characteristic of a rectangle relies on its straight edge and planes perpendicular to each other. When an experience of a basic element repeats many times, the archetype of this element may emerge out.

Archetype, a psychological theory, is proposed to illustrate repetitive images, symbols, themes, or structures in the field of art, literature, and religious beliefs that emphasize instinct, emotion, and creativity of people [9]. The analysis of the archetype is to explore the regular structure of the work and its repetitive symbolic pattern [10]. In some design researches, archetypal theory has been introduced to illustrate the various characteristics of archetypal icons and the related applications [11], even applied to explore the attributes of metaphorical design [12]. In addition, the paradigm is used to refer to the design entity, which is equivalent to the role played by the metaphor in the language. The main difference between them is that metaphor is based on verbal analogy, while paradigms are used to more deeply visually and functionally analogize, even covers the understanding and interpretation of the basic principles of the operation, and interaction [13]. Thus, the paradigm has a considerable conceptual overlap with the prototype or archetype.

Innovative Course and Student's Work

For developing an innovative course of form generation, four projects were chosen or designed for second-year design students. These projects were including rectilinear volume, superposition of three objects, bionic speed form, and speed form of mirrored Project 1, respectively corresponding to five levels of form generation. Moreover, product design thinking about archetype and Gestalt principle were also brought into this modular course (as Fig. 2).

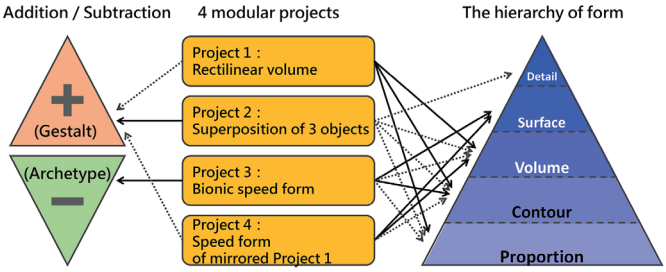

Fig. 2 The hierarchy of the course "Form Theory." Solid arrows signify what students are primarily trained through four projects; dotted arrows delineate the secondary training goals.

In the spring and summer of 2018, twenty-eight Taiwanese students enrolled this innovative course at the beginning of the semester. However, there were only twenty-two students completed all four assignments. During the semester, there were three students withdrawn the course before proceeding with Project 2 and three other students given up completing the Project 4. Each project period is about five weeks. In the following, we introduce these four course assignments and related student works.

A. Project 1: Rectilinear volume

In the first project, students were guided to go through choosing the dominant, subdominant, and subordinate forms, followed by adjusting the (inherent and overall) proportions, reviewing the contour of the façade, and pursuing changes in the volume (as Fig. 3 & Fig.4).

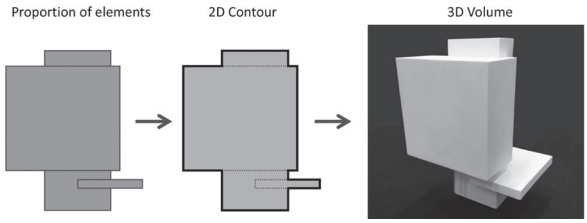

Fig. 3 The recommended design process of Project 1.

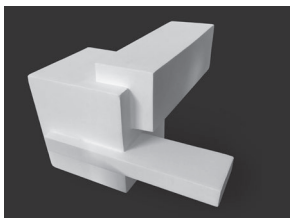

Fig. 4 Student's work of rectilinear volume (Kai Lin Hsiao, 2018).

B. Project 2: Superposition of three objects

The second assignment would deliberately force the students to reorganize and deal with the integration of three objects with different functions. First of all, students randomly selected three objects from six tools they were familiar with, including mechanical pencil, compass, caliper, utility knife, needle nose pliers, and screwdriver. Then, they were led to think about how people operates the three tools and how to integrate them

together by Gestalt laws of grouping. During the project period, students also needed to choose one tool as the dominant part, and to adjust proportions, contour, and the details to complete the works (as Fig. 5).

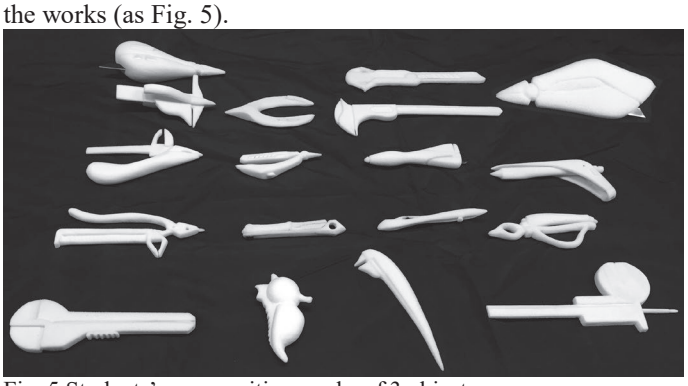

Fig. 5 Students' superposition works of 3 objects.

C. Project 3: Bionic speed form

The purpose of this assignment was to guide students to construct bionic speed forms. First, each student selected one creature, that he or she wanted to express. Each of them anatomized the structure into three parts as the dominant, subdominant, and subordinate part by using the theory of archetype or paradigm. Then, each student continued to adjust the proportion, contour, and surface of the rough archetype. Finally, every student would complete a simplified bionic speed form (as Fig. 6 & Fig.7) by optimizing the dominant part, modulating the subdominant part, and controlling the subordinate part. During the project period, students would be led to think about how to express the simplified archetype of the function (to move in high speed). Therefore, the main goal of Project 3 is to learn how to express the visual archetype of the function as well as to control the contour and surface.

Fig. 6 Student's work of bionic speed form (Kai Lin Hsiao, 2018).

Fig. 7 Student's work of bionic speed form (Yu Xiang Lin, 2018).

D. Project 4: Speed form of mirrored Project 1

The fourth and final project was to extend the results of Project 1 to go through advanced training. Because visual concepts of many objects are characterized by structural symmetries [4], students were led to select one side of their first works as the mirror planes for getting the symmetrical forms. They continued to modify contours and volumes with appropriate rounded corners and curved surfaces. Finally, each of them created a new shape with the aerodynamic characteristic (as Fig. 8 & Fig.9). During the project period, students would experience morphological variability under a specific framework.

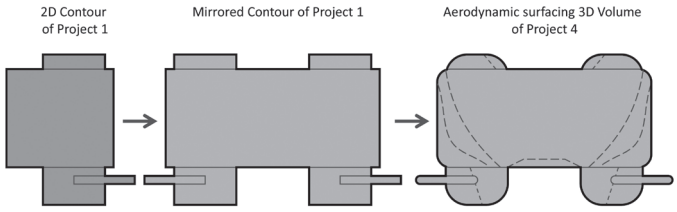

Fig. 8 The recommended design process of Project 4

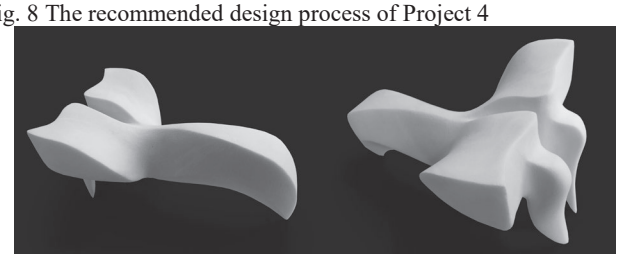

Fig. 9 Student's work of Project 4 (Yu Xiang Lin, 2018).

Interview and Student Self-Assessment

After each assignment, student self-assessment of learning performance and learning response was conducted to explore the relevance with other assignments. In addition, we interviewed five students individually who withdrew from the course "Form Theory" after the end of the semester for finding out why they gave up. The initial analysis and findings are described in the following sections.

A. The responses from students withdrawing from the course

On average, five students spent about 5.5 minutes on describing why they withdrew from the course. Most reasons were heavy workloads in all courses they enrolled (as Table 1).

TABLE 1
Basic data of students withdrawing from the course.

No./ Gender	Reason of withdrawal (Number of completed works)
S1/F	Too busy in the end of the semester (3)
S2/F	Too busy in the end of the semester (3)
S3/F	Too busy and dissatisfied with her concept for Project 4 (3)
S4/M	Busy in another course (1)
S5/M	Transfer student; without confidence in modeling (1)
S6 /F	N/A; she didn't participate the interview. (1)

About the responses for Project 1, four students thought that it was much easier (S1, S2, & S4), while a student felt that it was more difficult because Project 1 was intuitive and quite different from most products (S3). As to Project 2, they all expressed that it was more difficult than Project 1 (S1, S2, S3, & S4). The first interviewed student explained that there was low context correlation between some tools that took a long time to think how to combine them and decrease confidence to deal with it (S1). In addition, the second interviewee expounded that she was more inclined to make a design meet a demand (S2), while some students mentioned that the training of Project 2 was helpful to achieve a sense of beauty, reasonable and easy to use. About Project 3, students said that it was helpful to simplify a bionic appearance into a reasonable and fluent form.

B. The results of student self-assessment

After the semester, twenty-two students completed all four self-assessments. Each self-assessment was designed to display the context correlation between assignments and the levels of form, on a seven-point Likert scale (as Table 2).

TABLE 2
The questions for each form level in each self-assessment.

No.	Question content
1	My understanding of "Level" has been deeper than before.
2	I am confident to deal with "Level" better than before.
3	The training of "Level" is helpful for my core course.

In general analysis, the initial outcome shown that students most understood Project 1 followed by Project 3, Project 2, and Project 4 (as Table 3). Then, students' most confident assignment was Project 3 followed by Project 1, Project 2, and Project 4 (as Table 4). The project most helpful for design core course was Project 2 followed by Project 3, Project 1, and Project 4 (as Table 5).

TABLE 3
The result of the paired t-test for students' understanding (2-tailed).

Project	Number	Subset	
		1	2
1	88	5.659*	
3	88	5.636**	
2	88	5.432	5.432
4	88		5.352*,**

*The p-value between Project 1 and Project 4 is 0.00.
**The p-value between Project 3 and Project 4 is 0.00.

TABLE 4
The result of the paired t-test for students' confidence (2-tailed).

Project	Number	Subset	
		1	2
3	88	5.397*	
1	88	5.352**	
2	88	5.170	5.170
4	88		5.080*,**

*The p-value between Project 3 and Project 4 is 0.00.
**The p-value between Project 1 and Project 4 is 0.01

TABLE 5
The result of the paired t-test for being helpful (2-tailed).

Project	Number	Subset	
		1	2
2	88	5.727*	
3	88	5.625**	
1	88	5.561	5.170
4	88		5.364*,**

*The p-value between Project 2 and Project 4 is 0.00.
**The p-value between Project 3 and Project 4 is 0.01

The data of Project 1 shown that "understand the contour deeper" scored highest (5.773), and "confident to deal with volume better" scored lowest (5.318). Further, "understand the whole levels of form deeper" was weakly correlated to "proportion is helpful for core course" (the correlation coefficient (r) was 0.081), "contour is helpful for core course" (r= -0.027), and "understand the contour deeper" (r=0.035). As to Project 2, "proportion/contour is helpful for core course" scored highest (both 5.773), and "confident to deal with volume better" scored lowest (5.045). In addition, "contour is helpful for core course" was weakly correlated to "understand the whole levels of form deeper" (r=0.017), and "confident to deal with the whole levels of form better" (r= 0.042). The data of Project 3 explored that "proportion is helpful for core course" and "understand the contour deeper" scored highest (both 5.773), and "confident to deal with volume better" scored lowest (5.136). Further, "understand the whole levels of form deeper" was uncorrelated to "understand the contour deeper" (r= -0.004); "confident to deal with the whole levels of form better" was weakly correlated to "confident to deal with contour better" (r=0.085), and "confident to deal with surface better" (r= 0.091). Finally, in Project 4, "proportion is helpful for core course" and "understand the volume deeper" scored highest (both 5.773), and "confident to deal with contour better" scored lowest (5.136).

Conclusion and Discussion

This study mainly developed four modular projects for design students and tested them in the course "Form Theory." From the perspective of design education, design students should have a really good command of form generation. By going through all four assignments, students responded that they had understood the contour deeper than before but still been not confident to deal with volume better. Furthermore, the score of Project 4 was lower than Project 1 and Project 3 in many aspects. It revealed that Taiwanese design students were still not used to deal with surface under the existing limitation of structure or volume. Therefore, we will innovate and improve modular courses as soon as possible.

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