Introductory Design Project in Engineering Design Course to Freshmen at Kanazawa Institute of Technology

Masakatsu Matsuishi, Kazuya Takemata, Tetsuro Furukawa and Shigeo Matsumoto
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1. Introduction

Kanazawa Institute of Technology (KIT) is one of the first universities who are conducting Engineering Design Education (EDE) in Japan. The objectives of EDE are to provide students not only with superior technical capabilities, but also to enable them to identify and solve ill-defined and open-ended problems, to generate a set of distinct and creative concepts and to implement the Engineering Design Process, while working as a team. Furthermore, EDE is also to encourage students to acquire important skills such as those of communication and leadership[1)].

Original engineering design courses, which were introduced in 1996, were consisted of two sophomore-level classes; Engineering Design I (EDI) and Engineering Design II (EDII). EDI and EDII were taught respectively to all sophomore engineering students, composed of approximately 2,000 students every year. As part of a university-wide curriculum review, KIT decided to reform EDI and EDII during the 1998-1999 academic year. A new curriculum has been introduced in which EDI be taught in the Fall Quarter of the freshman year and EDII be taught in the Winter Quarter of the sophomore year[2)].

One of the problems caused by the new curriculum is that freshman students have to tackle with ill-defined and open-ended problems. Most of freshman students at KIT have never had chance to design and build anything, because the Japanese high school educational system emphasizes knowledge acquisition and memorization with little consideration for open-ended problem solving. Therefore, an introductory design project, which is to be completed at the beginning of EDI, has been introduced before tackling with an ill-defined and open-ended problem.

The paper presents an overview and lessons learned from the introductory design project in Engineering Design Course, which may be illuminating to engineering educators. We discuss how the introductory design project helped the freshman students to tackle with design problems while working as a team.

2. Outline of Engineering Design Education at KIT

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In our EDE, the Engineering Design Process (EDP) is defined as the process by which the following activities (stages) are performed.

(1) Design Opportunity Identification
(2) Design Project Characterization
(3) Design Concept Generation
(4) Design Concept Evaluation and Selection
(5) Detailed Design

The course objectives of EDI and EDII should be distinct but properly coupled in order to achieve a seamless transition from EDI to EDII. EDI starts with the announcement of a main theme: the definition of a broad problem area with many specific problems and needs. Each instructor selects his or her own main theme and introduces it in the class. The main theme provides a unifying element for the class. Each design team is expected to choose an appropriate project theme. The project theme is a specific design area related to the main theme. An example of main theme is “Making Winter More Comfortable”. Examples of project themes based on the preceding main theme are ”Designing a Bike for Winter Use” and “Designing Clothing for Keeping the Body Warm”.

Based on the main theme, each design team identifies a project theme and goes on applying the EDP up through Stage 4 in an effort to fully understand the problem, define it, and generate viable design concepts. Each design team is required to complete a Final File for its design project. The Final File includes a Project Summary Document, which is a brief summary of the EDP and the results of each design project. The Project Summary Document contributes to achieve a seamless transition from EDI to EDII.

In EDII, each design team reviews some of the information and design techniques presented in the Project Summary Documents of EDI. By applying the design process up through Stage 5, the team develops the details of its design solution.

3. Introductory Design Project in EDI

Each design team is assigned an introductory design project on Week 1 of EDI, which is called a “Mini Design Project”. The Mini Design Project, which is to be completed in a week, requires each team to design and build at least one chopsticks holder, i.e. a device to support a set of chopsticks on a dining table while not in use. Chopsticks holders are commonly used on every Japanese dining table. Students are asked to make use of recycled materials whenever possible. Students are asked to present the results of their Mini Design Projects on Week 2. Each team has three minutes to make an oral presentation showing its design objectives and emphasizing the strength of its proposed solution. A prototype is to be displayed during the presentation.

The Mini Design Project provides students with a first and brief experience in design. Because this project is not technically difficult, it provides an excellent opportunity for students to build their design confidence by designing chopsticks holders on their own without significant tutoring. In order to evaluate the effectiveness of the introductory design project, a questionnaire is prepared as shown in Table 1. After the oral presentation of the Mini Design Projects, every student fills in a questionnaire on the Mini Design Project.

Table 1. Questionnaire on Mini Design Project

This data you enter below will not be graded, but will be used to make a plan for future improvement of the Mini Design Project.

Question 1: How many teammates were there in your design team?

Question 2: Were there any teammates in your team, whom you have not talked with nor worked together before?

Question 3: If "YES", write down the number of teammates with whom you have not talked nor worked together before.

Question 4: Did all teammates work together to complete the Mini Design Project?

Question 5: If "YES", what part did you take to complete the Mini Design Project?

Question 6: If "YES", how long did it take to complete the Mini Design Project?

Question 7: If "YES", were you interested in your job?

Question 8: Was it easy to complete a document, which showed your design objectives and emphasized the strength of your proposed solution?

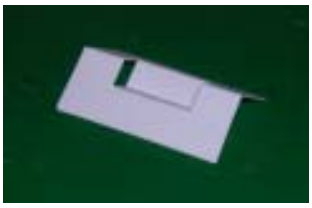
Question 9: Have your teamwork improved since the Mini Design Project?

Question 10: Was your oral presentation satisfactorily?

Question 11: Did you meet any difficulties during the Mini Design project?

Examples of prototypes are shown in Figure 1 and Figure 2, respectively.

Students of each class were asked to write articles on the Mini Design Project for their Class Newspaper, which would be published on Week 2. An example of Class Newspaper, which includes photographs of chopsticks holders, short comments on them and ratings of their qualities determined by students, is shown in Figure 3.



(a) Details of chopsticks holder

(b) Chopstick holder supporting a set of chopsticks

Figure 1. Chopsticks holder made of plastic sheet

(a) Details of chopsticks holder

(b) Chopstick holder supporting a set of chopsticks

Figure 2. Chopsticks holder made of toothpicks

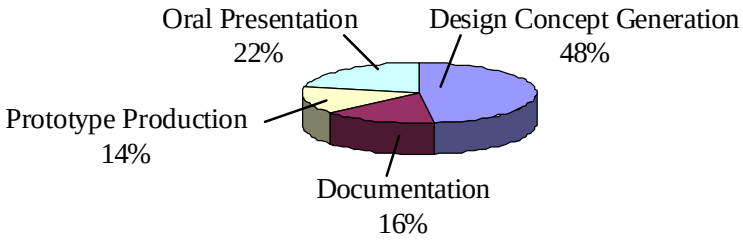


Figure 4. What kind of work did you take charge of to complete the Mini Design Project?

*Class Newspaper *Chopsticks Holder**

Sep.1,'01

picture of prototype	score
	sanitary *** handling *** beauty ****
Comment! Typically Japanese style. May be difficult to put chopsticks into the chopsticks holder.	

	sanitary *** handling *** beauty ***
Skelton appearance is fashionable. May or may not be fragile.	

	sanitary *** handling ** beauty ****
Foldable chopsticks holder is unique. May or may not be troublesome to openwhen to use.	

Figure 3. Examples of Class Newspaper

The results of the questionnaire are as follows;
1) Average number of students in one design team was six.
2) 66% of students met “strangers” first time in their team, whom they had not talked with nor worked together before.
3) Average number of “strangers” was approximately three.
Because of the time constraints imposed on the project, students have to meet their teammates and work together to develop a solution outside of class. The Mini Design Project was quite effective in getting students to work with their respective teammates right from the start of the quarter.
4) All teammates of each team worked together to complete the Mini Design Project.
5) Average hour to complete the Mini Design Project, which was spent by one student, was approximately 2.5 hours.
6) 83% of students were interested in their share of responsibility to complete the Mini Design Project.
7) 68% of students found it difficult to complete the document, which emphasizes the strength of their proposed solution, while 26% found it easy. This suggests that some subsequent measures should be added to help students to develop their design capabilities, such as finding customer needs, translating the needs into design specifications, generating quality design concepts, selecting the best concept among them, and completing quality document, in both content and format.
8) 97% of students found that their teamwork improved after completing the Mini Design Project. This suggests that the Mini Design Project was quite successful to improve their teamwork.
9) 80% of students thought that their oral presentation of their design solution was satisfactory, while 20% unsatisfactory.
10) 91% of students could manage to design and produce the chopsticks holder without serious difficulty.

An example of the results of the questionnaire is shown in Figure4.

4. Conclusions

It was found that most freshman students were very much interested in designing and building chopsticks holders of the introductory design project on their own. The results of the introductory design project seem to be conspicuously successful in improving teamwork of design teams and providing students a first and brief experience in tackling with an open-ended design problem.

Designing and building chopsticks holders enabled each team to work together on the introductory design project.
1) Students became acquainted with the other members of the team.
2) Students clearly understood their roles and tasks to complete their design projects.
3) Students developed a consensus on group behaviors.

This introductory project is not the project the design team work on throughout the quarter. It is just a very short project, which starts at the end of Week 1 and ends when students present their

achievements in class on Week 2. Students are not expected to work on it after the Week 2 presentation. However if instructors use the results of the introductory project throughout the quarter to demonstrate examples of good and/or poor design practice, students may be able to understand and implement engineering design process more successfully.

Bibliographic Information

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Biographical Information

Dr. MASAKATSU MATUISHI – Education: 1969, Doctor of Engineering, Naval Architecture, Osaka University. 1964, Bachelor of Engineering, Naval Architecture, Osaka University.
Professional Experience: 1999-Present, Professor, Kanazawa Institute of Technology. 1966-1999, Hitachi Zosen Corporation.

Dr. KAZUYA TAKEMATA – Education: 1998, Doctor of Engineering, Information and Computer Engineering, Kanazawa Institute of Technology.
Professional Experience: 2001-Present, Assistant Professor, Kanazawa Institute of Technology. 1987-2001, Assistant Professor, Kanazawa Technical College.

Mr. TETSURO FURUKAWA – Education: 1964, Master of Engineering, Mechanical Engineering, Tokyo Institute of Technology.
Professional Experience: 2002-Present, Lecturer, Kanazawa Institute of Technology. 1964-2002, Hitachi Zosen Corporation.

Dr. SHIGEO MATSUMOTO – Education: 1994, Doctor of Engineering, Material Design Engineering, Kanazawa Institute of Technology.
Professional Experience: 1996-Present, Associate Professor, Kanazawa Institute of Technology. 1995-1996, Visiting Researcher, Stanford University. 1987-1995, Instructor, Toyama Polytechnic College.