

The Engineering Design I and II at Kanazawa Institute of Technology

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IEEE JSEE/JSME ASEE/JSEE

1. Introduction

Engineering Design Education (EDE) was introduced in 1995 as a primary focus of educational reform at Kanazawa Institute of Technology (KIT). It consists of two introductory courses: Engineering Design (ED) I and II. Starting in the Fall and Winter Quarters of 1996, ED I and ED II are taught respectively to all sophomore engineering students, comprised of about 2,000 students every year.

To expose the students to a variety of ideas, backgrounds and different ways of thinking, the classes are taught not only by Japanese professors, but also by foreign professors with experience working for U.S. universities and with the assistance of American teaching liaisons. EDE is based entirely on a new concept in Japan, hence it is also the first time the Japanese professors have taught these kinds of classes.

2. Objective¹

Within the exam-based educational system of Japan, students naturally tend to regard as important the “question and answer system” within which there is only one correct and precise answer. In the ED classes we are determined to reform the students’ perspectives such that they are able to tackle engineering design problems which may have innumerable solutions or for which a solution may not exist.

The goal of EDE, which is derived from KIT’s motto ‘From Knowledge to Wisdom’, is to allow students to acquire actual engineering design experience through working on real-life projects in class. In the problem solving activities (projects) that engineers face in society, there are many cases in which the problem is not clearly defined, the problem domain is ambiguous, or the problem does not possess a unique correct answer. Additionally, real-world projects are seldom undertaken by individuals. Most projects are tackled by teams, teams which may be composed of workers from different countries.

In an effort to prepare engineering students for their future professional careers, we think it is important to provide them with experience in discovering and solving problems similar to those they will face in society. It is crucial that the students be allowed to develop the skills and abilities for tackling problems independently, rather than following the directions of others. Engineering Design I and II are courses founded on these basic principles.

3. Course Management

3.1 Engineering Design Process¹

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

1. Clarification of the Problem Domain: Clarification of the specific themes (main theme, project theme and sub-themes) which should be tackled.
2. Collection and Analysis of Information: Collection of information related to the theme and performance of analysis on that information.
3. Solution Proposal Design: Within the problem constraints, formulation and evaluation of solution proposals for the theme.
4. Preparation of a Written Report: Arrangement of the solution proposal into the form of a written report of the definitive results.
5. Presentation of Results: Effective communication of the achieved results in a manner in which even a third party can understand.

We are presenting these activities as the minimal process by which the students may comprehend the necessity and importance of engineering design methods for the sake of tackling open-ended problems. Furthermore, this definition of the Engineering Design Process was derived from referring to innumerable real world processes, such as product or system development in various engineering fields, and is a collection of what is commonly thought of in all fields of engineering as the Engineering Design Process.

3.2 Class Structure and Management

The main difference between the class structure of ED I and ED II is that a poster session is held for ED II during the last week (10th week) of the quarter. There are 60 classes each in ED I and II. Each class is divided into 5 to 7 teams and each team is composed of 5 to 7 students, depending on the class size. Since the EDE places enormous emphasis on developing independent thinking and leadership, each member of the team is assigned a responsibility, such as team leader, presenter, report writer, and so forth.

The ED classes are divided into two consecutive periods of 75 minutes each. The classes are very interactive. A lecture, a class exercise and a discussion can take place all in one period. It is not just professors telling the students something and the students repeating it verbatim. Even though the main theme given by the professor is the same for the entire class, each team is required to come up with its own project theme to tackle. The students are required to determine, clarify and analyze problems and solutions on their own, both independently and as teams. All relevant information such as design objectives, requirements, specifications and possible concept designs are determined by the students. The main job of the professor is to provide the students with tools and guidance in order to help them analyze and utilize the information that they gather more effectively.

All teams are required to meet with their professor once a week to discuss about their activities' progress, results and problems. They are required to submit a weekly report detailing their activities, assignments and progress report for one week. They are also required to speak about their progress by giving oral presentations periodically. Finally at the end of the quarter, all teams are required to submit a final report and to give a final presentation. Both items are based on the team's activities from week one until the end of the quarter.

All ED students own laptop computers. They all have access to an electronics bonanza of multimedia equipment, digital cameras, scanners, color printers, color copiers, television sets, VCRs and computer stations. All ED classrooms are equipped with state-of-the-art presentation devices, and every professor and student is encouraged to use these devices during les-

and presentations. All KIT students also have access to *Yumekobo*, a workshop type facility where some of our students have constructed prototypes or models of their final designs.

4. Achievements

The results are tangible. After taking ED I and II, most students have become more proficient in utilizing different resources such as the Internet, technical journals and scientific publications to gather information about their projects. Furthermore, the usually aloof and timid Japanese students are now willingly contacting and interviewing prospective customers, other KIT professors, industry and public officials to gather relevant data and statistics concerning their projects.

Besides ED professors, other KIT professors have noticed that the students who have taken ED I and II are asking more questions in class. They are also better at communicating; that is, they are more skillful in giving presentations and writing professional reports. Before attending KIT, most of our students have never used a computer, let alone the Internet. After taking the ED classes, they are more adept in using their computers and their various pieces of software as tools to create attractive graphics and professional reports and presentations.

By encouraging the students to utilize not only computer resources but also human resources to gather, analyze and evaluate information independently and in teams, we have cultivated students who are computer-literate and who also possess problem-solving and interpersonal skills.

5. Problem Points

The main problem that we faced in teaching both ED I and ED II is that a standardized structured way of teaching these courses was not set up. While some professors prefer that the students come up with possible solutions for a project at the early stage of the course and work on improving those solutions throughout the rest of the quarter, other professors prefer that the students tackle the project theme first without considering what the solutions might be. Instead of generating solution first and then later trying to improve the solution so that it will meet the specifications that are set after the solution is generated, other professors prefer to clarify the goals and requirements before generating solutions that will satisfy these specifications. Hence even though the outcome of both processes are basically the same, generating solution(s) for problem(s) or need(s), the steps that were undertaken to generate the solution(s) were somewhat reversed. At times, this has created some confusion because the students are not sure whether or not to use the process they have learned in ED I from a different professor, in their ED II class, which is taught by a different professor. However, one advantage of having the students learn different steps for accomplishing the same task is that they are exposed to different ways of thinking and different ways of implementing the design process.

Most Japanese students have never been exposed to a non-Japanese instructor before. Hence at the beginning, they are rather timid and hesitant in communicating with a foreign faculty. However, we have noticed that as time goes by, they become more confident and ask more questions. By exposing them to foreign faculty, we hope that they will get accustomed to interacting with non-Japanese. Since most projects are tackled by teams, which may be com-

posed of workers from different countries, being accustomed to foreigners will help them develop a better working relationship with their future non-Japanese coworkers.

Lastly, at the present most design projects are geared towards designing a concrete artifact rather than a system or software. However, since the engineering design process that we teach to the students is applicable regardless of the type of design, our students are still able to utilize the process to tackle different types of projects that they might encounter in their future work.

6. Conclusion

We are now in the second year of teaching ED I and II. Along with the students, the instructors as well are learning how to tackle obstacles that might arise. We are working in teams also to continually improve the way we conduct the classes in order to prepare our students, as future engineers, to meet the challenges that they will face in this ever changing world. The foreign professors, with the assistance of the American teaching liaisons and the Japanese professors, are learning to customize the class so that it can accommodate the differences in the Japanese culture and best benefit the Japanese students. Conversely, the Japanese professors, through directly working with the teaching liaisons and collaborating with the foreign professors, are also learning new tools and methods, in addition to the ones they already know, for implementing the engineering design process.

Bibliographic Information

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Biographical Information

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