BRIDGING THE GAP: BUILDING INDUSTRY-UNIVERSITY LONG-TERM COOPERATION THROUGH CO-OP PROGRAM AND PROJECT COURSE

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Abstract—Engineering Schools in Colleges and Universities play vital roles as knowledge sources and innovation creators. Engineering curricula are well-designed to prepare the student with knowledge, skill and attitude for entering real-life work environment. Though, employers of new engineers have higher expectations. Therefore, an industry - university collaboration can increase opportunity and benefits to both organizations to involve in the process of producing qualified engineers. This paper discusses long-term industry-university cooperation by encouraging continuous cooperative activities through Co-Op program, Pre-project and Project courses. This research shows the cooperation between an industry and university with longer term with one to one and a half year. A data collection and a satisfaction survey show a higher trend in numbers of participative industrial companies and a high satisfaction on senior engineering students' competencies in both activities.

Keywords—Engineering Education, Industry – university cooperation, Collaboration, Qualification, Curriculum design and improvement

1. INTRODUCTION

The new paradigm of engineering education shows more expectations. The engineering graduates should have

- Ability to apply knowledge of *math, sciences, and engineering*
- Ability to *design and conduct experiments*, analyze and interpret data
- Ability to *design a system component*
- Ability to function on *multi-disciplinary* teams
- Ability to identify, formulate, and *solve engineering problems*
- Understanding of professional and *ethical responsibility*
- Ability to *communicate* effectively
- Ability to engage in *life-long learning*
- Ability to *use techniques, skills, and tools.*

Industrial needs studies and surveys have been done for more than 20 years according to new engineering graduates qualifications entering workplace including knowledge, skills, technical skill and attitudes [1], [2], [3], [4], [5], [6]. The qualifications required the most from industries are Teamwork skill, Communication skill, and Ethic. Moreover, new engineers are expected to understand Engineering profession role impacting society, economics and environment. Engineering education all over the world places most important in preparing engineering students for entering workplace environment after graduation. These preparations are attraction potential students from K-12 or a vocational certificate graduates, curriculum improvement, systematic and integrated teaching-learning process, as well as higher investment in updated technology.

2. INDUSTRY-UNIVERSITY COOPERATION

Kimmel [7] shows two type of relationship between industry and university as shown in Figure 1. At graduate level, industry usually grants research and development for university. Research and development results are then sent to implement at the research sponsor company. At undergraduate level, university is a key human resource input into the industry. Therefore, the industry impacts on engineering student qualifications and performances.

Faculty of Engineering at RMUTT focuses on industrial cooperation as part of curriculum development and study plan set up with Co-op program, Pre-project course and project course. These co-operations lay good background for higher collaborations through graduate level research and development.

2.1 Cooperative Education Program

Cooperative Education has been developed in England and United States from 1903 to 1909 which combined classroom lecture with hands-on training at cooperative industrial companies. This program has high growth in the US during 1960 due to government and industrial supports. At the present, 33% of universities all over the world put cooperative program as part of curricula. Some universities achieve an international cooperative program and a training period extends from 1-2 months to 3-4 months [11, 12, 13, 14]

At RMUTT, there are two types of study plan, a 3-

year program for vocational diploma graduates and a 4-year program designed for vocational certificate and high school graduates. Figure 2 shows a 3-year study plan of 6 semesters with 1 summer session and Figure 3 shows a 4-year study plan of 8 semesters with 1 summer session. The sequences of industrial-related courses are different between these 2 programs. For 3-year program, the student takes Pre-project course in the 4th semester, then takes co-op training program in the 5th semester and returns for a Project course in the 6th semester. For 4-year program, the student has a co-op training program at a participative industry in the 6th semester, and returns to take Pre-project and Project courses in the 7th and 8th semesters. Advantage of a 4-year plan is the student has his/her own connection with the industry during the co-op training program. Therefore, an industrial-based project has high possibility. On the other hand, a 3-year plan student needs support from project advisor's connection with the industrial company to set up a project topic at the time of taking Pre-project course. The advantage of this plan is the student can collect data for working on his/her own project at the time of co-op training.

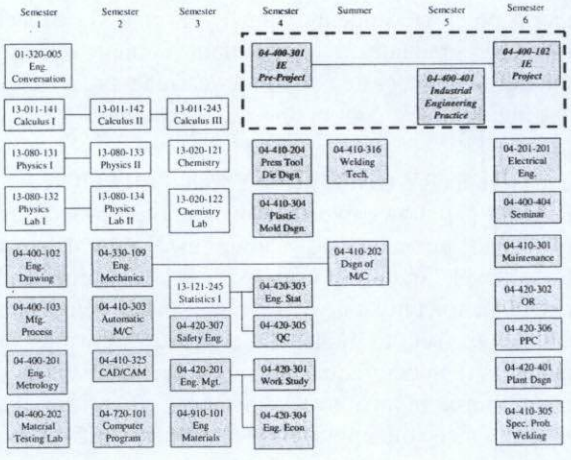

Fig. 2 Three-year Study Plan

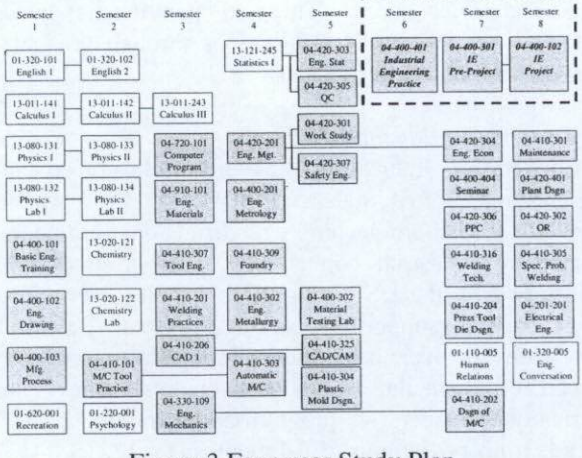

Figure 3 Four-year Study Plan

2.2 Project Course

The term of "project" is widely understood in engineering filed as a unit of task. Mostly engineering work involves with project with varying time scale depending on project type and complexity of project activities. Every project, no matter how complex it is, always relates to fundamental theories and technique. [8] Perrent et al. [9] has compared problem-based learning and project-based learning. The similarities are they need student's self direction and cooperation. A multidisciplinary oriented can be achieved with both learning techniques. The differences are project-based tasks are closer to real-life work environment requiring knowledge and skill applications. Project management skill is very important. The student should be able to manage project resource and assign job to members efficiently.

At the present, senior project course is in most engineering curricula covering all engineering majors. At the Industrial department at RMUTT, a project operation committee of 5 department staffs oversees a 1-credit Pre-project course and a 3-credit Industrial Project course. The Pre-project course objective is to help the students choose project topics and set projects scopes. At the end of semester, each project group takes an oral examination for project proposal presentation. The proposal evaluation includes topic suitability, achievement possibility and number of students per project. After passed a Pre-project course, the students can register an Industrial Engineering Project course. The project presentation and a complete report are used to evaluate and grade the project. Figure 4 shows a whole process of Pre-project and Project courses.

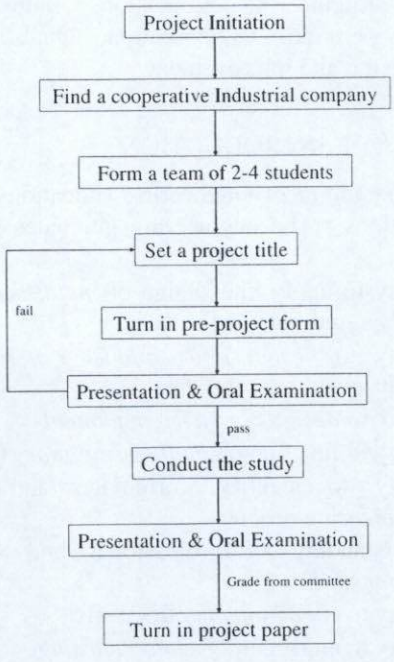

Figure 4 IE Project Process

The industrial engineering department has categorized project into hardware and software. The hardware means a manufacturing of machine, jig and fixture, material handling devices or equipment to be given to the industry after the project finishes. Project methodology starts from a design phase to a machine or equipment procurement phase. This type of project usually receives some financial support from the industry. The participative industrial companies are generally small and medium sized enterprises (SMEs). Software projects open more for the student as shown in figure 5. The main objectives are to analyze the problem occurred in the company and propose some solutions. The project scopes are operation analysis, productivity improvement, method improvement, standard time setting, production line-balancing, quality control, defect reduction, waste reduction, quality management system, plant/facility design, energy conservation, preventive maintenance and feasibility study.

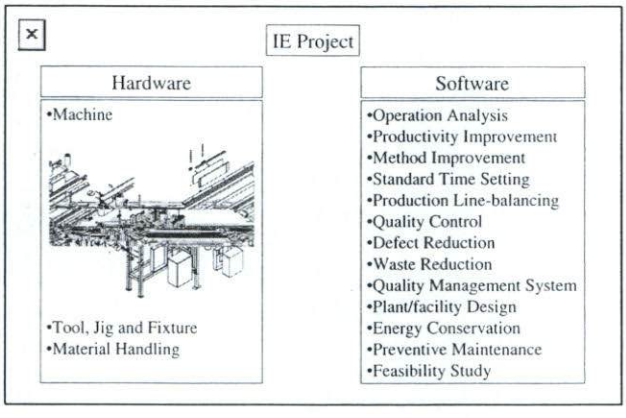

Fig. 5 IE Project Categories

In 2006, there were 29 project groups (90 students) which were 15 hardware-related and 14 software-related. Ten of them were industrial-based projects, but there were no projects from a co-op training program. A good sign happened in 2007, when 80 students with 27 project groups of 13 hardware-related and 14 software-related. Nine of them were industrial-based with two from co-op training program. In 2nd semester of academic year 2007, out of 28 groups, 3 project proposals were industrial-based with co-op program. In 1st semester of year 2008, the students in these 3 groups take a 4-month training in the participative industry. There is an opportunity for the student to gather some data to be used when work on project in the next semester.

The sequence of Pre-project course – Co-op training program – Project course has extended industry-university cooperation from 1 year to 1.5 year. Figure 6 shows increasing numbers of industrial-based project with co-op training companies.

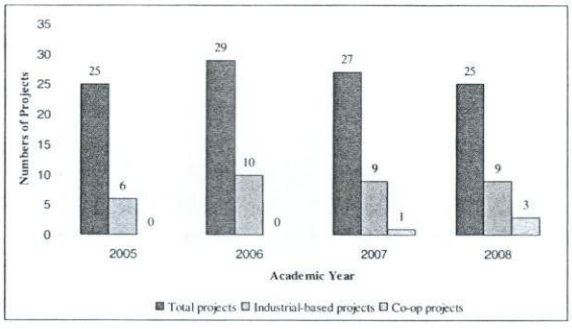

Fig. 6 Numbers of Projects

3. A SATISFACTION SURVEY

A satisfaction survey was sent to the participative companies to evaluate students' abilities at the beginning and ending of co-op training as well as at the end of project. The survey topics included student self adjustment and development, human relation skill, attitude, participative in organization, ethics, and basic knowledge and skills to achieve specific assignments. The survey outcome of average scores shows in the 1st table. The students were evaluated of tremendous improvement in all aspects. The participative industries were satisfied with the students' knowledge and skill background as well as ability to work on their assignments.

Table 1 Average Score from Satisfaction Survey (1 = Poor, 5 = Excellent)

Topics	Before	After
Self Development	3.2	4.5
Learning Ability	2.7	4.0
Human Relation	2.8	3.9
Attitudes	3.5	4.4
Participation	2.5	4.0
Ethics	3.9	4.5
Basic Knowledge	3.8	4.0
Basic Skills	4.0	4.5

4. IMPORTANT ISSUES FOR LONG-TERM INDUSTRY-UNIVERSITY COOPERATION

To achieve in long-term cooperation between industry and university through co-op training program and industrial-base project, some factors need to be concern:

4.1 A Sequence of study

Since a co-op training program take a whole semester, two different sequences of study yield different advantage. A training – Pre-project – Project sequence provides more collaboration possibility due to the industry's acquainted with students. On the other hand, a Pre-project – training – Project sequence provides preliminary data gathering while students are at the company.

4.2 Project Advisor

For co-op training program, a department staff will be assigned to each specific cooperative company. He/she visits the company three times to check on students training progress. An achievement of long-term cooperation needs both a co-op department staff and a project advisor to be the same person for a consistent connection with the industry. Moreover, a personal connection between a departmental staff and the company can enhance more cooperation.

4.3 Total Timeline

A total period of one year or even one and a half year connection delivers a bond building between industry and university. Therefore, it is an opportunity for an upper level of collaboration such as graduate research.

5. SUMMARY

To produce qualified engineers that meet industrial needs can be viewed as a process of customer satisfaction. In this case, an industry can be part of the process by providing training and allowing access to industrial problems as well as supporting students' proposal for problem solving process. The benefits from this long-term cooperation contribute to 1) engineering students who improve teamwork and communication skills throughout the training, 2) an industrial company has a new way of engineer recruitment opportunity and be part of making a good engineer process 3) university gets feedback from the industries and the students as an input to curriculum development and improvement.

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