The Factory for Dreams and Ideas

Students' Projects to Enhance Professional Technical Competence

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INTRODUCTION

The world of today needs competent engineers who are able to demonstrate their professional technical competence. Professional technical competence integrates knowledge, understanding, skills, and values. According to Engineering Council of UK [1], the competence and commitment standard for incorporated engineers are;

A. Use a combination of general and specialist engineering knowledge and understanding to apply existing and emerging technology.

B. Apply appropriate theoretical and practical methods to design, develop, manufacture, construct, commission, operate, maintain, decommission and re-cycle engineering processes, systems, services and products.

C. Provide technical and commercial management.

D. Demonstrate effective interpersonal skills.

E. Demonstrate a personal commitment to professional standards, recognising obligations to society, the profession and the environment.

The formation process through which engineering professionals become competent generally involves a combination of formal education and further training and experience. In most universities, classes of regular curriculum are in session approximately 160 days a year. The remaining 205 days are spring/summer/winter vacations, holidays, Saturdays, and Sundays. The Kanazawa Institute of Technology (henceforth, KIT) developed a new strategy to have its students spend all the year including the remaining 205 days in a more productive and creative way in its campus. Therefore, KIT established an innovative facility "The Factory for Dreams and Ideas" (henceforth, "Yumekobo", which is the original Japanese name for the factory) [2]. Yumekobo is designed and managed so that any students of KIT are able to convert their engineering ideas/dreams easily and safely into reality by

designing and producing models/prototypes throughout the year. The mission of Yumekobo is to help students to enhance students' motivation and creativity, and to develop technical competence and professional skills through extracurricular activities.

Yumekobo has organized an innovative and creative students' project, "Yumekobo project", in order to accomplish its mission. The Yumekobo project is defined as a self-directed project of extracurricular activities in a team. Yumekobo presently houses fifteen Yumekobo projects. More than 500 students are working vigorously on the Yumekobo projects, although they cannot get any credits for the Yumekobo projects. All of these projects are self-directed with minimal guidance from professors. One of the ultimate goals of the Yumekobo project is to participate in regional, national, and international competitions and win championships. In order to achieve the goal, students apply sophisticated and state-of-the-art technologies to their products. Yumekobo projects recruit members with diverse characteristics (e.g., majors, special abilities and knowledge, age).

In this paper, the author discusses the details of the Yumekobo project, i.e. its objectives, how the project is managed by students, safety programs to secure students' safety, and peer instruction in each Yumekobo project. The author evaluated the progress in technical competence and professional skills of students.

1 THE FACTORY FOR DREAMS & IDEAS "YUMEKOBO"

1.1 Roll of Yumekobo

"Yumekobo" literally means "thinking workshop" in Japanese. Yumekobo is comprised of two buildings and designed to be available to all students from 8:40 a.m. until 9:00 p.m. throughout the year. More than half of KIT students (approximately 3,500 students) make at least one visit to Yumekobo each year with approximately 100,000 visits total. Yumekobo is equipped with a wide range of machines and tools, and is staffed with 14 skilled full-time technical staff and 5 skilled part-time technicians to support students' extracurricular activities. Students' activities at Yumekobo fall into the following three categories:

(1) Personal creative activities

Yumekobo is designed to be available to the entire campus population. Therefore, any KIT student with a dream can realize it, in the engineering sense, using the tools and knowledge available at Yumekobo.

(2) Yumekobo projects

The Yumekobo projects are creative team-based extracurricular activities which are financially supported by KIT. Yumekobo presently houses fifteen Yumekobo projects with participation from more than 500 students. Project examples include the Solar-Powered Car Project, Robot Project, Fuel-Efficient Car Project, and Human-Powered Airplane Project. Yumekobo projects win high esteem at various regional, national, and international competitions. Details of Yumekobo projects will be discussed in the following section.

(3) Building prototypes for engineering design courses

KIT requires three engineering design courses: Engineering Design I, II, and III. In these classes students are asked to develop innovative, viable, and ethical design solutions on paper [3]. Some students thereafter build models and prototypes at Yumekobo to see if their designs are feasible and useful, or find out what needs to be improved.

1.2 Safety Program at Yumekobo

Students are not well trained in building prototypes and are not familiar with safety control before entering KIT. The possibilities of accidents and/or injuries of inexperienced students working at Yumekobo are immeasurable without systematic and thorough safety management.

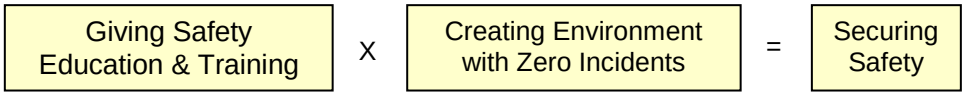

Fig. 1. Measures to secure safety at Yumekobo

Yumekobo holds paramount the safety of students. The strategy of safety management at Yumekobo is to combine the safety education & training and the environmental improvement as shown in *Fig. 1*. The safety of education is composed of technical courses on safety, accident prediction training, training to eliminate potential hazards, safety training and campaign, periodic safety patrols, human error training, etc. The environmental improvements are achieved by safety patrols to eliminate potential hazards, a warning plate showing potential hazards of each machine, and dissemination of emergency procedures and first-aid treatment, etc.

1.3 Technical Courses

Yumekobo offers twelve technical courses which are composed of three steps as shown in *Fig. 2*: Step 1 is safety guidance, Step 2 are courses on the operation of machine tools, electrical engineering & electronics courses, and woodworking courses, Step 3 are advanced courses. All technical courses start after classes and end for the day. Each of the twelve courses is offered approximately thirty times a year. Those technical courses help students to develop technology and skills so that they can design and build prototypes easily and safely by themselves.

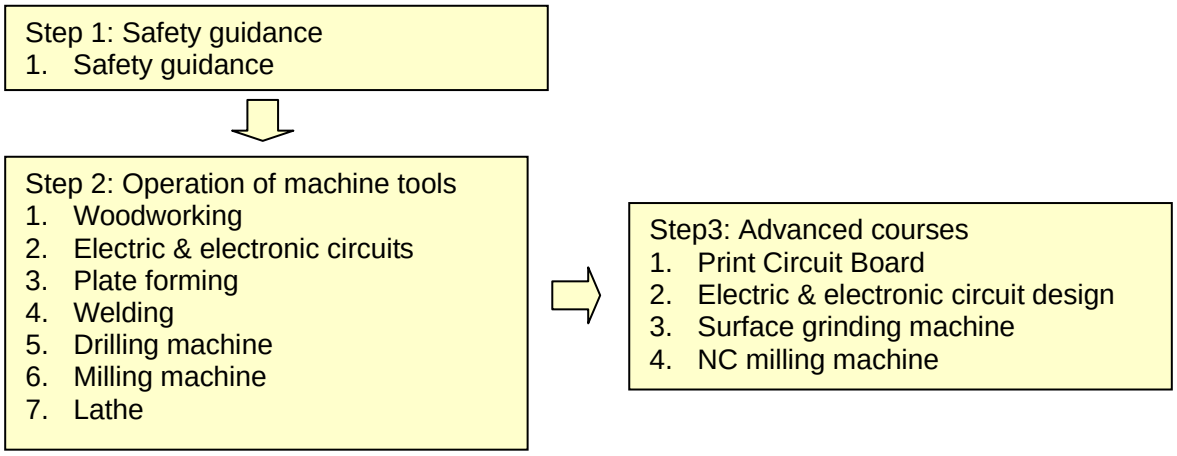

Fig. 2. Technical courses offered at Yumekobo

2 YUMEKOBO PROJECTS

2.1 Objectives

The Yumekobo project is defined as a student project in which students experience the full creative process from planning, market research, design, fabrication, and operation to analysis and evaluation of their product's performance in a team. Students control their schedule and run the organization on their own. Yumekobo

projects recruit members with diverse characteristics (e.g., majors, special abilities and knowledge, age). Project activities take up tasks that cannot be achieved by individuals' efforts alone. Project activities enable students to enhance their technical capability and personal/interpersonal skills. The Yumekobo project is conducted basically by students independently and voluntarily.

2.2 Management of Yumekobo Projects

Yumekobo presently houses fifteen Yumekobo projects that draw participation from more than 500 students. These students join projects as part of their extracurricular activities and they are free to choose the area that they would like to work in. Thus, these activities are not as structured when compared to the classes that make up the regular curriculum. All of these projects are self-directed with minimal guidance from professors. Students generally work on Yumekobo projects as a part of independent teams, only seeking help from their professors or external engineers in industry when the need arises. Yumekobo projects include the Solar-Powered Boat, Solar-Powered Car, Robot, Fuel-Efficient Car, Human-Powered Airplane, etc. *Table 1* shows examples of primary technological fields that students working in to achieve their goals.

Table 1. Examples of primary technological field of Yumekobo projects

	Solar-powered car	Fuel-efficient car	Robot
Green technology	X	X	
Energy-saving technology	X	X	
Ergonomics	X	X	X
Robotics			X
Modelling technology	X	X	X
Simulation technology	X	X	X
Electronics	X	X	X

2.3 An Example of Yumekobo Projects

As a typical example of Yumekobo projects, activities of Fuel-Efficient Car Project are discussed in this section.

The goal of Fuel-Efficient Car Project is to design and manufacture an ultimately fuel-efficient car with a fuel efficiency rate of 3,000 km/liter. Forty-one members are actively working on the project: 18 freshmen, 12 sophomores, 4 juniors, and 7 graduates. They enhance their technical capability and personal/interpersonal skills by designing and producing a fuel-efficient car.

They analyzed factors affecting fuel efficiency and found that primary factors of fuel efficiency are wind resistance, acceleration resistance, frictional resistance of mechanical parts, rolling resistance of tires, and combustion loss of an engine. They designed and produced a cowl of low wind resistance, developed a tire of low rolling resistance with a tire manufacturer, designed and fabricated a new combustion-efficient engine by themselves, and improved driving pattern.

Fig. 3. Fuel-efficient car

One of the big competitions of fuel-efficient cars in Japan is the Honda Eco-Mileage Challenge as shown in *Fig. 3*. They won a championship of the Honda Eco-Mileage Challenge in 2011 and 2012, consecutively. They achieved a record of a fuel efficiency of 2,546 km/liter.

3 EVALUATION OF PROFESSIONAL TECHNICAL COMPETENCE

We conducted a survey to evaluate if Yumekobo projects are useful for enhancing technical competencies and professional skills of students. Some of the examples of performance and progress in developing technical competencies and professional skills of Yumekobo project members are shown in *Fig.4* through *Fig. 7*. Comparison of *Fig. 4* and *Fig. 5* suggests that activity of Yumekobo project help students to enhance communication skills, capability to apply discipline knowledge to problem solving, fundamental science & math knowledge, inquiry capability, project management capability, team spirit, and design & manufacturing capability. *Fig. 6* suggests that (1) students' learning attitude changed toward more enthusiastic, (2) they coped with both Yumekobo project and their class work, and (3) they made full use of their expertise for Yumekobo project activity. *Fig. 7* shows that most students are satisfied with Yumekobo project activity.

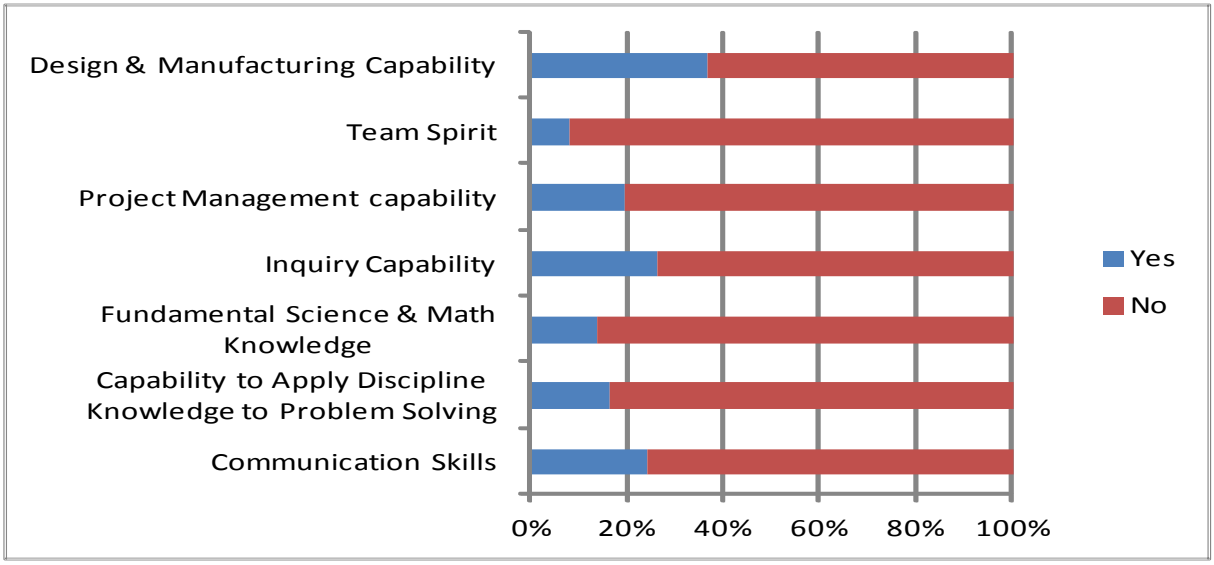

Fig.4. Percentage of students having sufficient skills when entered university

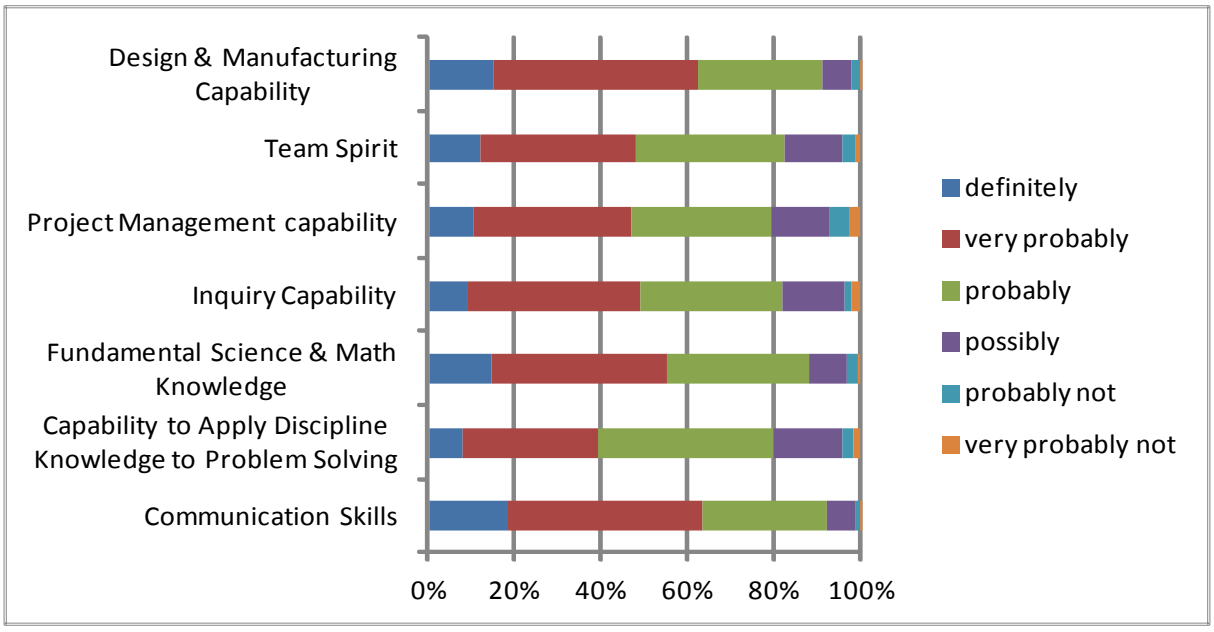

Fig.5. Is Yumekobo project activity useful for improving your capability/skills?

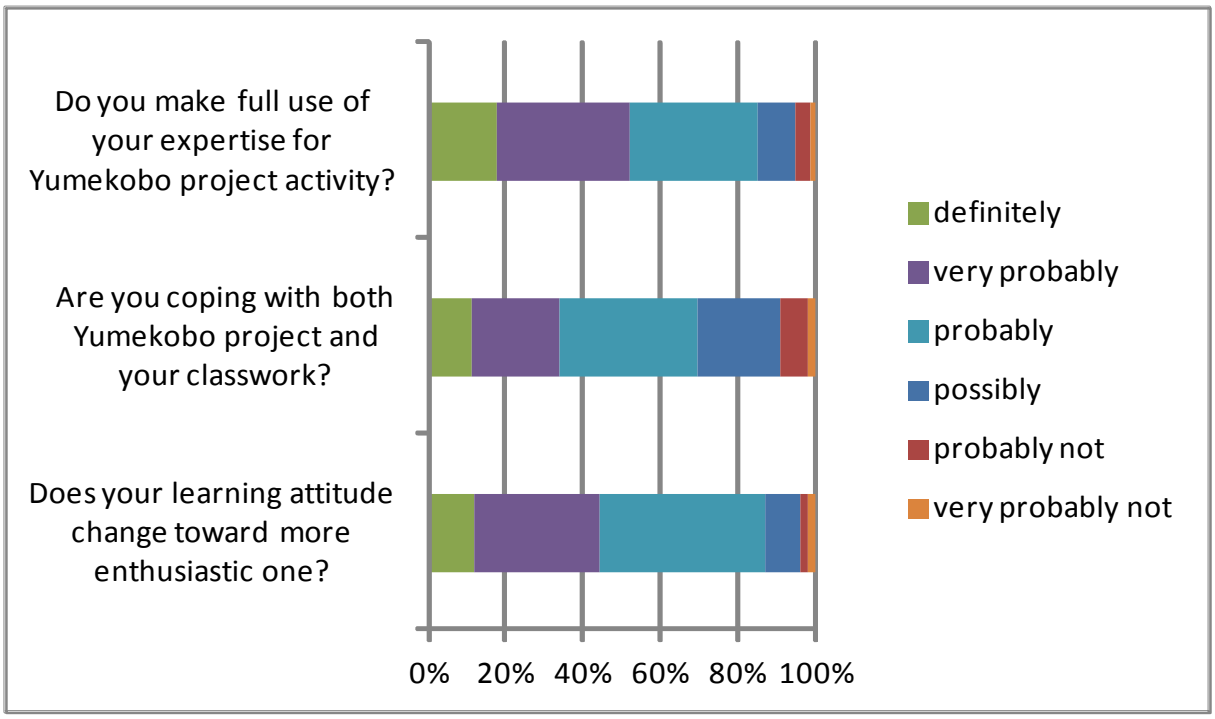

Fig.6. Evaluation of Yumekobo project activity

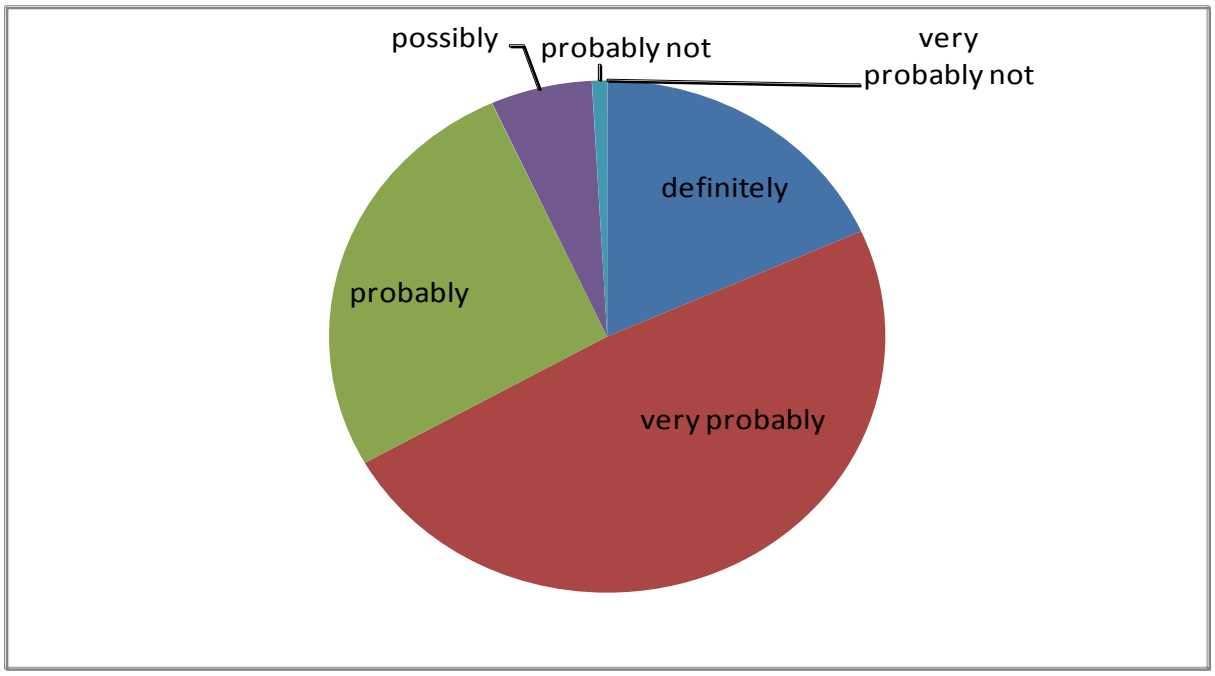

Fig. 7. Are you satisfied with Yumekobo project activity?

4 CONCLUSION

The educational goal of KIT is to develop self-directed, productive, and innovative engineers. In order to achieve its educational goal, KIT developed a new strategy to have its students spend the whole year in a productive and creative way in its campus, and established an innovative factory “Yumekobo”. The mission of Yumekobo is to enhance students’ motivation and creativity, and to develop technical competence and professional skills through extracurricular activities.

The strategy of KIT to achieve its educational goals seems successful judging from the following facts;

(1) Yumekobo projects helped students to enhance communication skills, capability to apply discipline knowledge to problem solving, fundamental science & math knowledge, inquiry capability, project management capability, team spirit, and design & manufacturing capability.

(2) Their learning attitude changed toward more enthusiastic

(3) They coped with both Yumekobo project and their class work.

(4) They made full use of their expertise for Yumekobo project activity.

(5) They are satisfied with Yumekobo project activity.

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