Systematization of the Method to Improve a Quality of Project Activity for Education in University

Masahisa Shinoda

Abstract—**Improvement and investigation about a quality of both product and process of project in university is introduced. Project subjects are proposed and proceeded by students. The progress of each project is checked and managed regularly by teaching staff. The method of project management well known as PMBOK (Project Management Body Of Knowledge) in business world is applied into these projects proceeded by students to improve them. From these activities, the attempt to construct the method of project management that is optimum for education in university is described.**

Index Terms— **Design, educational materials, manufacturing, project activity in university, project management.**

I. Introduction

Professors and lecturers belonging to the Mathematics and Science Education Research Center in Kanazawa Institute of Technology (KIT) are making various efforts to improve students' understandings in fundamental subjects [1]–[6]. Besides class works, students with various grades and courses of study are working in group on their interested project activities. In order to support these project activities, KIT has a wide variety of facilities and unique environment. Total number of project activities that are recognized officially at KIT is over 80. Manufacturing a robot and a hand aircraft aiming at contests are the typical examples. Similar project activities and these analysis as research subjects are also performed in other universities [7].

The project based on fundamental science and engineering, which is one of the officially recognized projects at KIT is managed by the author. In this project, the students propose project subjects individually. Next, the students and the teaching staff verify the principle of the proposed subjects from the standpoints of mathematics, physics, engineering, electronics, software programing, production, and so on. After the above process, the students start to manufacture their products of project subjects.

The author moved to KIT from the electric company in 2015. He has a wide variety of experiences about designing and manufacturing electric appliances, for examples, DVD player/recorder, Blu-ray player/recorder, and liquid crystal displays. He has been also certified as the PMP (Project Management Professional) by the Project Management Institute (PMI) since 2007. With these points as backgrounds, the author is tackling with the projects based on fundamental science and engineering to improve the quality of both the product and the process of each project by applying the well-known method of project management [8]. This method was established and published as "A guide to the project management body of knowledge", so called as "PMBOK GUIDE".

The author had the chance of an open class to lecture on "technology of digital audio" to high school students in July 2016. He planned that the students belonging to the author's project in KIT manufacture an educational material about "digital audio" as his presentation material for high school students. In this project of manufacturing the educational material, he applied the method of project management.

The author's final goal on his current research is to systematize the method of the project management that is optimum to improve the quality of both product and process of each project subject for education in university by 2019.

In this paper, the attempt to construct and systematize the above method through the project for the open class performed at KIT in 2016 is introduced.

II. Brief Introduction about Project Management Body of Knowledge (PMBOK)

PMBOK GUIDE describes the method how to proceed with projects to success, and is recognized practically as the world standard for a wide variety of projects in the business world. The first edition was published in 1996 and the current version is the fifth edition published in 2013 [8]. PMBOK GUIDE defines 47 processes of the project, here, the process means a procedure or a treatment which is a necessary action in the project activities. All processes are divided into five process groups and ten knowledge areas.

Five process groups are as follows:

- Initiating process group,
- Planning process group,
- Executing process group,
- Monitoring and Controlling process group, and
- Closing process group.

Ten knowledge areas are as follows:

- Project integration management,
- Project scope management,
- Project time management,
- Project cost management,
- Project quality management,
- Project human resource management,
- Project communications management,
- Project risk management,
- Project procurement management, and
- Project stakeholder management.

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M. Shinoda is with the Mathematics and Science Education Research Center, Kanazawa Institute of Technology, Nonoichi, Ishikawa 921-8501, Japan (e-mail: shinoda@neptune.kanazawa-it.ac.jp).

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Using the above process groups and knowledge areas, a two-dimensional map, in which the process groups are placed on the horizontal columns and the knowledge areas are placed on the vertical ones, is defined as shown in Fig. 1. All of 47 processes are defined at cells somewhere on this map. There are some cells which are not defined in PMBOK GUIDE. In this paper, we do not mention detail contents of 47 processes.

Management of Knowledge Area	Processes				
	Initiating	Planning	Executing	Monitoring & Controlong	Closing
Project Integration					
Project Scope					
Project Time					
Project Cost					
Project Quarity					
Project Human Resource					
Project Communications					
Project Risk					
Project Procurement					
Project Stakeholder					

Not defined in PMBOK GUIDE

Fig. 1. Two dimensional map with process groups and knowledge areas.

In order to systematize the method of the project management for education, the author's policy is that 47 processes defined by PMBOK GUIDE will not be always necessary from an educational standpoint. The reasons of this policy are the followings.

(1)The students involved in the project are beginners.

(2)The students should be conscious of necessary processes, because they cannot be involved the whole project activities within the limited project term. This means that some processes should be treated by only teaching staff instead of the students.

III. Education Material for Open Class

The author proceeded the project to manufacture the educational material about "digital audio" as his presentation material for high school students at the open class [9]. This educational material explains the principle of a digital audio set such as a compact disc (CD) player. This material consists of a mechanical unit and an electrical circuit. The mechanical unit works so that coded scales painted on surface of a printable type CD-R on a turn table rotates by a hand through rubber belts. The electric circuit consists of an optical detecting unit and a signal processing unit. The optical detecting unit detects the coded scales which are marked by white and black colors as three-bit digital codes. These codes are optically detected by using light emitting diodes (LEDs) instead of a laser diode in the real CD player, and photo diodes. The signal processing unit transforms three-bit digital signals to octal numbers which represent eight sounds, "C", "D", "E", ... , as the music scale. This unit also drives a speaker to generate these sounds. Fig. 2 shows a whole appearance of the educational material. Fig. 3 shows a whole appearance of the mechanical unit.

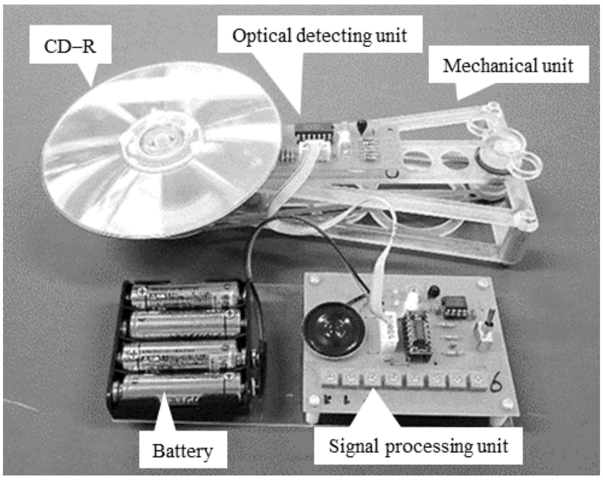

Fig. 2. Whole appearance of the educational material. CD–R is set the surface with painted marks downwards.

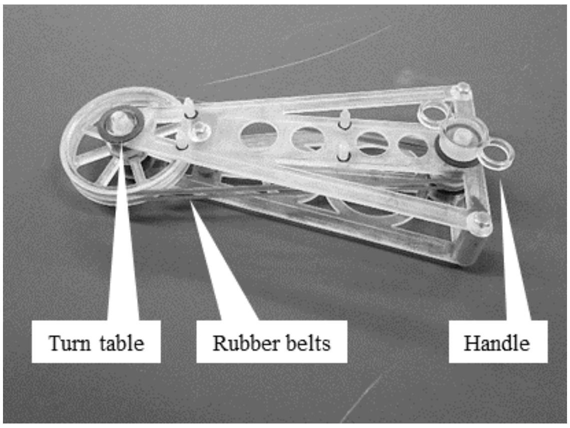

Fig. 3. Whole appearance of the mechanical unit.

16 KIT students joined this project and 11 students were in charge of the mechanical unit.

In this paper, the project activity and a trial to systematize the method of the project management about the mechanical unit are introduced.

IV. Project Activity of the Mechanical Unit

Table I shows the details of number of students.

TABLE I: Details of Students

Team	Course of Study	Number of Students		
		First-year	Second-year	Third-year
Mechanica l Unit	Mechanical Engineering	0	0	2
	Robotics	8	1	0
Electric Circuit	Electrical Engineering	1	1	0
	Robotics	2	1	0

At first, the author appointed a student leader for each unit. The appointed leader of the mechanical unit was the three-year student of the mechanical engineering course. He was so suitable that he had various experiences about manufacturing products and had great skill in dealing a 3D printer.

Next, the author directed two leaders to report progress, problems if happened, and plans of the next week every week. The author checked technical subject, schedule, and cost according to students' reports mainly, instead of the strict management based on the method of project management, because they were beginners for these managed project.

As for the mechanical unit, the author showed three special orders to its team, as follows:

(1) a structure of the mechanical unit must be confirmed visually so that high school students understand the structure of the apparatus and the mechanism of disk rotating,

(2) the mechanical unit must be able to manufactured easily by hands without any tools within ten minutes, and

(3) the mechanical unit must be disassemble easily without damage and can be re-assemble for reuse.

The leader of the mechanical unit team understood the above orders and broke down the total design into sub blocks for each team members. Each student took charge of the sub block given by the leader. They frequently gathered to verify the designs of sub blocks and checked for the existence of problems. Most of the parts except screws and nuts were designed by 3D CAD software and were molded by the 3D printer.

The planned term to complete this project was eight weeks. The students completed their missions until the deadline. In the process of this project, several problems happened. Here, two major problems are introduced.

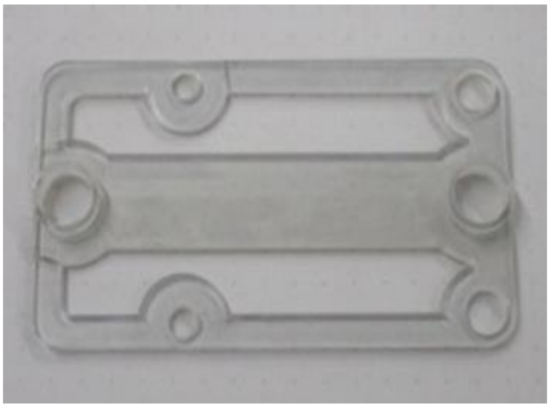

Fig. 4. The primarily designed plate.

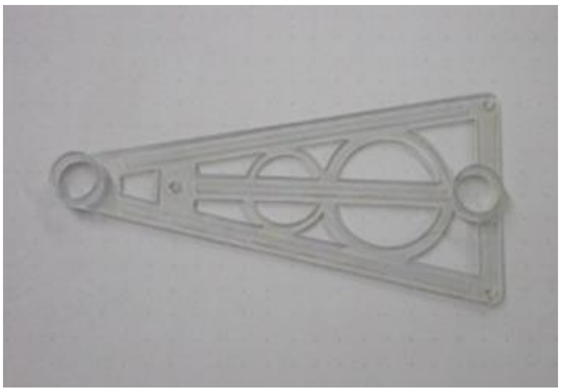

Fig. 5. The finally designed plate.

The first problem was the cost of molding using the 3D printer. The cost is almost proportional to the amount of resin. Fig. 4 shows the plate which was primarily designed and molded. This shape actually needed a large amount of resin for 3D molding and resulted in a high cost. Therefore, the team member examined necessary function of this plate and redesigned repeatedly to reduce the amount of resin by cutting unnecessary structures. Fig. 5 shows the appearance of the final plate. The cost of the final design was reduced by almost 30% against the primary design.

The second major problem was mismatching in dimensions among the mechanical parts. This problem was mainly caused by insufficient communication among the team members.

Experiencing these problems, the students were able to understand the importance about the cost in the product, and information interchange among not only team members but also all persons concerned in the same project during the process of the project.

Fig. 6 shows the final parts molded by the 3D printer.

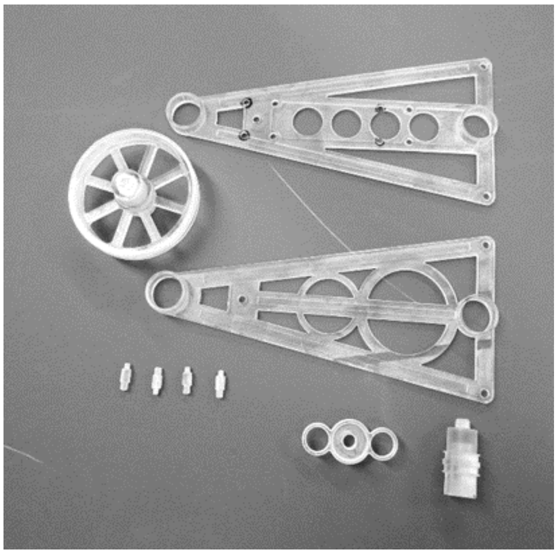

Fig. 6. All parts molded by the 3D printer.

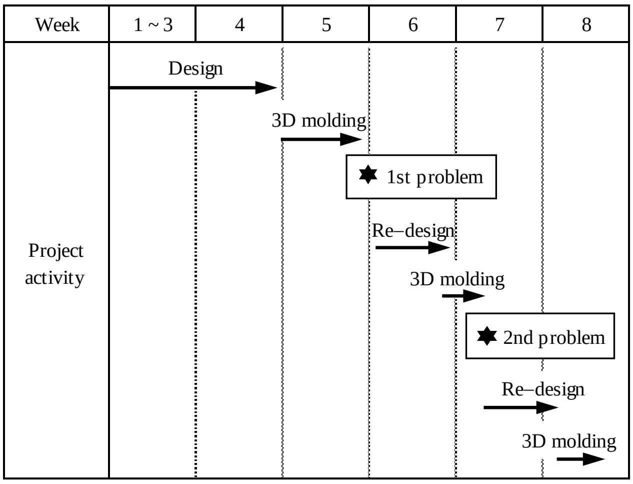

Fig. 7. Project activity for the mechanical unit.

The project activity for the mechanical unit was proceeded such as the reviewed schedule shown in Fig. 7. Two major problems were happened, however, appropriate actions of re-design and 3D molding were performed according to the directions by the author and the student leader. As a result, the mechanical unit team could keep the deadline.

After the open class, the author reviewed all project activities contributed to this project. This will be evaluated as one way to systematize the method to improve the quality of the project activities. The author analyzed that who proceeded each action. In this step, the following four types of actions were introduced:

(1) proceeded mainly by teaching staff,

(2) supported as necessary by teaching staff,

(3) proceeded mainly by students, and

(4) proceeded by students after problems happened.

Fig. 8 shows the two dimensional map introduced in Fig. 1 in which the above four types of actions are marked in the appropriate cells.

Management of Knowledge Area	Processes				
	Initiating	Planning	Executing	Monitoring & Controlong	Closing
Project Integration	Staff	Staff	Staff	Staff	
Project Scope		Studentt Staff		Staff Student	
Project Time		Student Staff		Staff	
Project Cost		Student		Staff Student	
Project Quarity		Student Staff	Student	Staff Student	
Project Human Resource		Staff	Student		
Project Communications		Staff	Student	Student	
Project Risk				Staff Student	
Project Procurement		Student	Student	Student	
Project Stakeholder					

Not defined in PMBOK GUIDE

Not defined in this study

Staff — Proceeded mainly by teaching staff.

Staff — Supported as necessary by teaching staff.

Student — Proceeded mainly by students.

Student — Proceeded by students after problems happened.

Fig. 8. Two dimensional map with four types of actions at appropriate cells.

Regarding the process groups, the project activities were performed as follows.

- The initiating processes was conducted by only teaching staff, because this process was very important so that the purpose and significance of the project for the open class was officially declared. After this process, each project was started by the project students.
- As for the planning and executing processes, the project students proceeded with each management items mainly by themselves.
- As for the monitoring and controlling processes, teaching staff basically proceeded with these processes. Since all project students were beginners for projects, teaching staff should propose corrective actions if there was a problem.
- The closing process was omitted. The open class for the high school students was performed and ended successfully by using the educational material manufactured by this project.

In the same manner, the project activities were performed regarding the management of knowledge areas as follows.

- The project integration was proceeded by only teaching staff in all process groups except the closing process.
- As for the project scope and project quality, the project students proceeded mainly with their subjects first and teaching staff supported as necessary in the planning process. In the monitoring and controlling processes, once problem happened, students redesigned by themselves, or according to ideas of teaching staff, or other students.
- As for the project time, this means the schedule. The project students planed their projects in the planning process and performed according to their plans. Teaching staff checked their progress every week.
- As for the project cost, teaching staff managed strictly in the monitoring and controlling processes. In fact, some parts had to be re-designed to reduce 3D molding cost.
- As for the project human resource and project communications, teaching staff managed these areas in planning process, because the author appointed the student leader and directed the guideline to design the mechanical unit. However, the project students managed in other processes by themselves.
- As for the project risk, teaching staff and the students jointly managed if problems happened.

As a result, almost cells of the two dimensional map were filled by four types of actions. This method would be one way to systematize the project activities as the follows:

- What is the appropriate actions proceeded by the teaching staff,
- What is the appropriate actions proceeded by the students,
- What is the appropriate actions collaborated by both teaching staff and the students.

V. Conclusion

The author planed the project that the project team students manufactured the educational materials at the open class for high school students. The project team students pursued their missions with enthusiasm. As the result of their activities, the optimum educational materials were realized, and high school students enjoyed and studied “digital audio” using the educational materials at the open class.

The author applied partially the method of project management [8] to this project. This method was established so that projects on business must be managed to succeed, but a method for education in universities does not exist. Therefore the author strengthens his idea that a method of project management for education must be established. This is his motivation to proceed his current research.

The author analyzed the process and the product of each project, and investigated the relationship between the two-dimensional map and the project members' actions. As the results, it became clear that the most of the cells on the map were filled up completely with actions by teaching staff and the project team students. It is supposed that this map described by PMBOK GUIDE is very suitable and applicable for education in university as well as business in company.

The author has studied this research for one year. In future work, he will continue to systematize of the method of project management for education in university. He will also investigate the relationship between 47 processes defined by PMBOK and actual processes which will be performed by teaching staff and the project team students.

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Masahisa Shinoda is a professor of the Mathematics and Science Research Center of Academic Foundations Programs in Kanazawa Institute of Technology, Japan. He received his B.S and M.S degrees in physics from Osaka University in 1979 and 1981, respectively. He worked for mitsubishi electric corporation from 1981 to 2015. He was a researcher and an engineer on optical engineering, and was in charge of developing DVD and Blu-ray equipment at Mitsubishi. He received his Dr. degree in optical engineering from Osaka Prefecture University in 2001. He was certified as Project Management Professional (PMP) by Project Management Institute (PMI) in 2007. Then, he moved to Kanazawa Institute of Technology (KIT) in 2015. His current research interests are educational engineering and project management.

Prof. M. Shinoda is a member of The Japan Society of Applied Physics, The Optical Society of Japan, Japanese Society for Engineering Education, and Project Management Institute (USA). He is a senior member of The Institute of Electronics, Information and Communication Engineers (Japan).