# ACTIVE LEARNING SYSTEM BASED ON COMPREHENSIVE LEARNING INITIATIVE PROCESS AT KANAZAWA INSTITUTE OF TECHNOLOGY

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## ABSTRACT

Kanazawa Institute of Technology (KIT) has conducted educational reforms since 1995 and joined the CDIO initiative at June, 2011. In the present paper, first, an overview of the KIT engineering educational program is presented, including the 2012 curriculum which was developed after joining the CDIO initiative. Second, an active learning system based on a "Comprehensive Learning Initiative Process (CLIP)" is explained. KIT tries to foster comprehensive integrated abilities based on disciplinary knowledge as well as personal and interpersonal skills through classroom learning. Third, typical practical examples of the KIT approach are shown. Rather than being limited to the traditional course objective of scholastic achievements (academic knowledge and skills), KIT aims to cultivate more practical and integrated capabilities in the students by having them engage in active learning. Finally, the objectives of the KIT educational program are summarized: students are expected to develop personal and interpersonal abilities and skills, including 1) the ability to acquire knowledge, 2) the ability to think critically and creatively, 3) skills for collaboration and leadership, and 4) the ability express, present, and communicate ideas and knowledge.

## KEYWORDS

Engineering educational program, Active and experiential learning, Program design, Comprehensive integrated abilities

## INTRODUCTION

Reforms and improvements in engineering education began from the latter half of the 20th century, especially in the 1990s around the world. Kanazawa Institute of Technology (KIT) is an engineering university in Japan which has conducted educational reforms several times since its first reform in 1995 and started a new engineering program with engineering design education as its main pillar. In the course of reform, in 2006 KIT began to focus on fostering comprehensive integrated abilities which include both academic disciplinary knowledge and KIT-defined personal and interpersonal skills, based on the preceding experience and results.

As a further step, KIT joined the CDIO initiative at the 2011 Copenhagen International Conference. The aim is to further improve engineering education through international cooperation with worldwide engineering institutions through the participation in the CDIO initiative, an international framework addressing the balance of engineering science and engineering practice in education. Actually, in its new 2012 curriculum (resulting from KIT's fifth educational reform effort started in 2010), the reinforcement of Project-Design, KIT's engineering design program and the implementation of active learning have been planned with reference to the CDIO Standards.

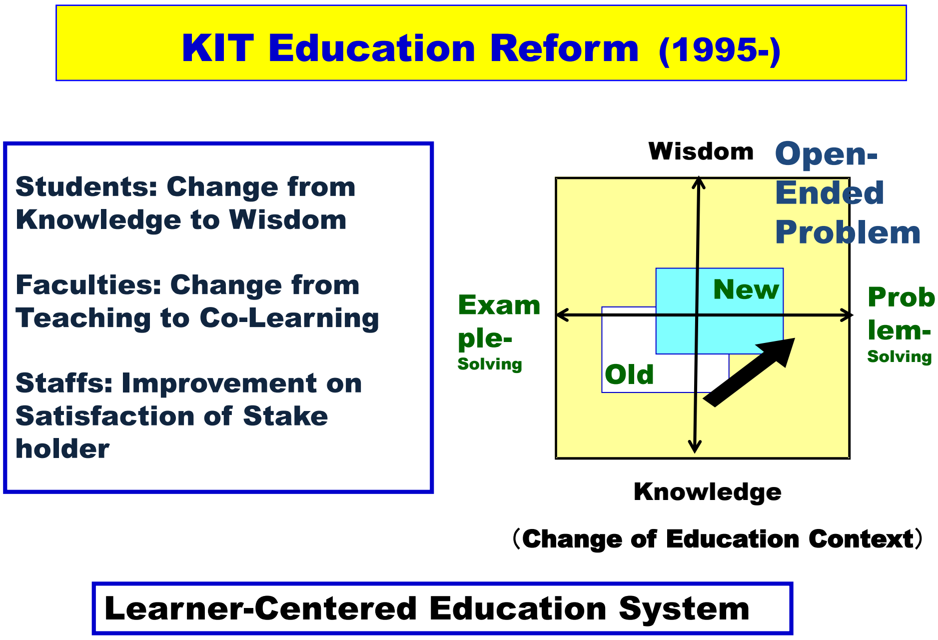


Figure 1. Context of KIT educational reform beginning at 1995

The overall objective of KIT's educational reforms begun in 1995 is to build a framework of learner-centered engineering education. As shown in Fig.1, the action guides for the students, faculty and staffs are defined as follows: "to move from knowledge to wisdom," "to move from a focus on teaching to a focus on co-learning," and "to improve stakeholder satisfaction," respectively. KIT's stated mission is to foster "engineers who can make well-thought-out decisions and act on them." To achieve this, KIT has promoted an educational system incorporating active learning based on a "Comprehensive Learning Initiative Process" (the main theme of this paper), engineering design education as the main pillar of its curriculum, and the establishment of a variety of work spaces in the KIT campus that are conducive to student-centered activities.

## THE NEW CURRICULUM AT KANAZAWA INSTITUTE OF TECHNOLOGY

KIT aims to build a campus where the students actively learn and work. At the present stage three factors are considered to be important to achieve this plan:

- (A) the Project-Design program as the main pillar of the curriculum,
- (B) an active learning system through which students can develop comprehensive integrated abilities,
- (C) provision of appropriate workspaces.

These three factors can be closely related to the CDIO Standards.

In the KIT curriculum, "engineering design" is called "Project-Design" because this required course sequence is taken by non-engineering students as well as engineering students. They experience the process of solving an open-ended problem in project- and team-based learning.

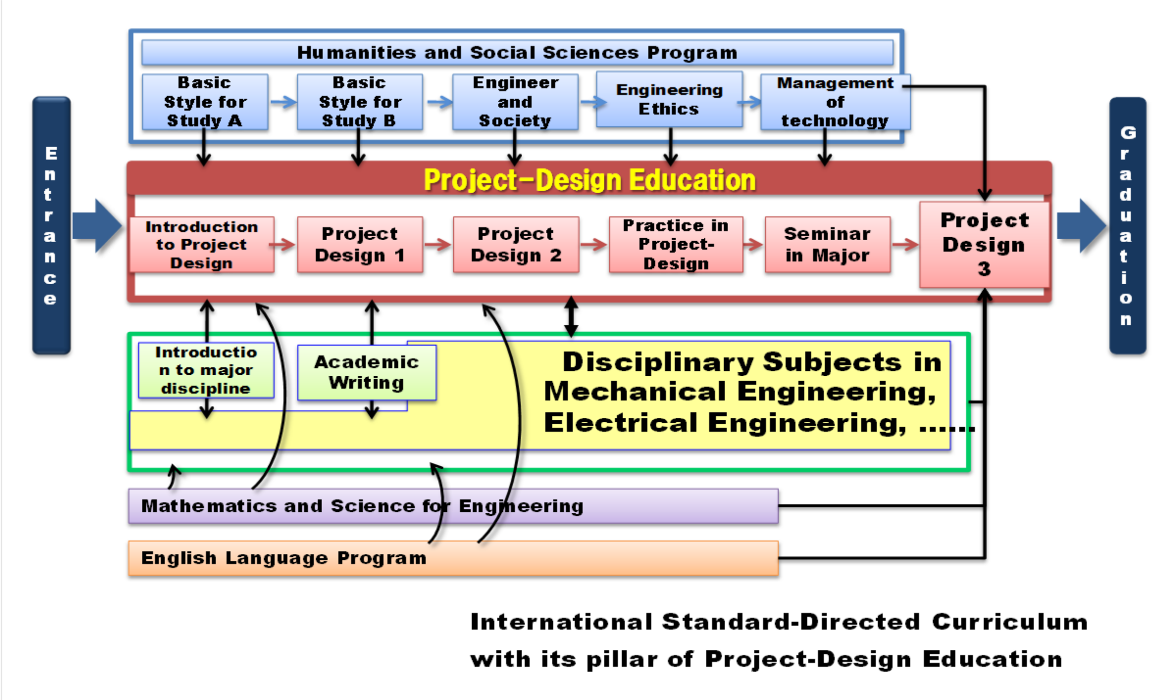


Figure 2. Outline of new KIT curriculum from 2012

Figure 2 shows an outline of KIT's new curriculum which went into effect in April, 2012. The pillar Project-Design sequence consist of five courses including "Introduction to Project-Design", "Project-Design 1", Project-Design 2", "Application of Project-Design", and "Project-Design 3". Project-Design 3 is year-long research design project which takes the place of the traditional Japanese 4th-year graduation thesis. In the course students can learn to integrate knowledge based in various disciplines, develop the ability of engineering research and solve a problem in a similar manner to a real-world engineer, through this capstone course.

The curriculum also includes a variety of other courses which introduce students to engineering practice in the real world and help to motivate students. Such courses include "Overview of Engineering", "Engineers and Society", "Management in Technology" as well as "Engineering Ethics".

## WHAT SORT OF ENGINEER AND HOW DOES KIT FOSTER HIM or HER?

What are the desired attributes of a successful engineer? What attributes are our students expected to possess when they leave KIT? In this respect we agree with the approach of the CDIO initiative, which calls for a curriculum organized around mutually supporting technical disciplines with personal and interpersonal skills, and product, process, and system building skills highly interwoven [1].

In the case of KIT, the corresponding approach is an education based on "comprehensive integrated abilities" defined by KIT as shown in Fig. 3. The comprehensive integrated abilities consist of a combination of academic knowledge with KIT-defined personal and interpersonal skills. The latter skills are defined as those learned by college education, including five elements:

(1) independence and autonomy,
(2) leadership,
(3) collaboration,
(4) presentation skills
(5) communication skills.

Thus the framework of the KIT educational system is the teaching and learning of the comprehensive integrated abilities, namely the personal and interpersonal skills together with disciplinary knowledge, through the KIT educational program.

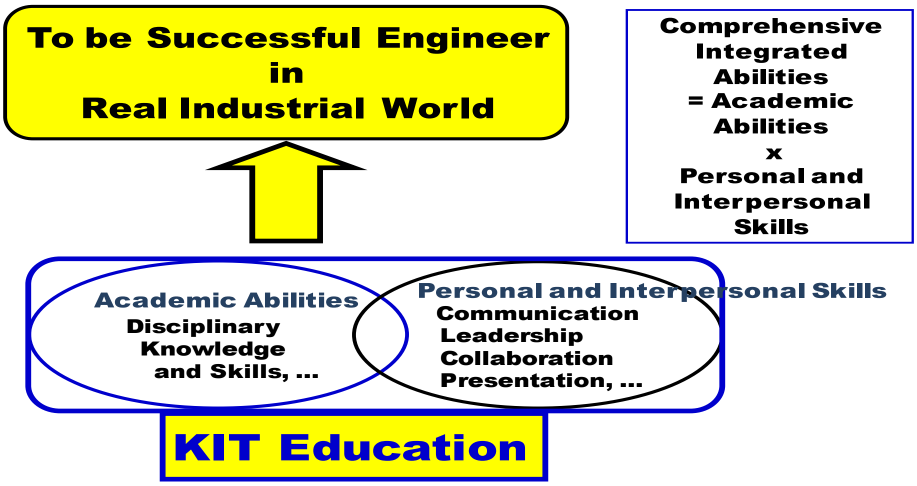


Figure 3. Two important elements in KIT education

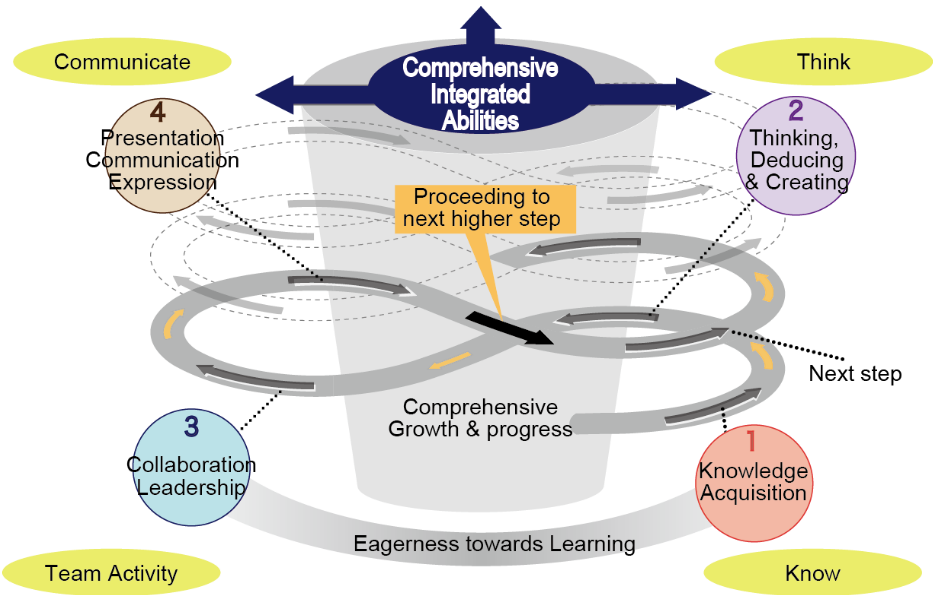


Figure 4. CLIP learning process to foster "comprehensive integrated abilities" in KIT

In order to teach the comprehensive integrated abilities in the classroom, it is important to design an appropriate curriculum as well as to consider how to administer the curriculum and how to teach and learn in the class. As shown in Fig. 4, the KIT learning model is called the CLIP learning process, where CLIP means Comprehensive Learning Initiative Process. Classes fostering "comprehensive integrated abilities" based on the CLIP learning process will be called CLIP learning classes. In such classes it is necessary not only to teach the disciplinary knowledge and skills, but to include some or all of the following items in order to teach the academic discipline and personal and interpersonal skills at the same time.

(1) Time for thinking
(2) Time for practice
(3) Communication and discussion between students, between students and teacher, and between students and other people, etc.
(4) In-class and/or open presentations
(5) Team-based activities

The basis of the CLIP learning class is an earnest and active attitude for learning, so that the course should provide active and experiential learning (the CDIO Standards 8). In short, the CLIP learning process transforms knowledge obtained in class- and homework into comprehensive integrated abilities through active learning.

Through the CLIP learning process, as shown in Fig. 4, students can gain the comprehensive integrated abilities by which they can be successful engineers in a real society. The process consists of 1) Acquisition of Knowledge, 2) Thought, Deduction and Creation, 3) Leadership and Collaboration in team activity and 4) Communication, Presentation and Expression. In many cases they can obtain the comprehensive integrated abilities through spiral-up growth by repeating the CLIP-cycle of 1) to 4).

Further work is still needed to develop specific methods for 1) active learning appropriate to the KIT engineering program, 2) active learning appropriate to the content of each subject and 3) active learning appropriate to the character of each teacher.

## TYPICAL EXAMPLES OF CLIP LEARNING-TYPE CLASS IN KIT

As mentioned in the previous chapter, the CLIP learning class at KIT involves active learning based on the CLIP learning process in order to foster the comprehensive integrated abilities defined by KIT. The Project-Design education which is a central subject in the KIT curriculum is considered to be a model CLIP learning course founded on team-based activity. In this paper, two other examples will be introduced: a course in liberal arts and a course in mechanical engineering.


Figure 5. Profile of "Japanology" class in liberal arts

### *Example 1: Japanology*

Japanology, a liberal arts course, has the objective of deepening understanding about Japan and the Japanese people through consideration of various aspects of the society. In the nature of the subject, there is usually no single correct interpretation of a given phenomenon, so that the students have to solve open-ended problems. Therefore, the class is based on the CLIP learning process. The teacher tries to make the students think of the subject and present the opinions, while avoiding one-way teaching. As shown in Fig. 5, the students in the class carry out the following activities:

(1) Acquire the knowledge in lecture class and make lecture notes,
(2) Consider the topic from various aspects and try to apply, expand and create on the basis of the knowledge,
(3) Conduct team-based discussion and investigation of the topic,
(4) Make a presentation of the final result.

Sometimes there is a danger that student-centered analysis will be superficial, but with a careful input from the instructor this problem can be overcome.

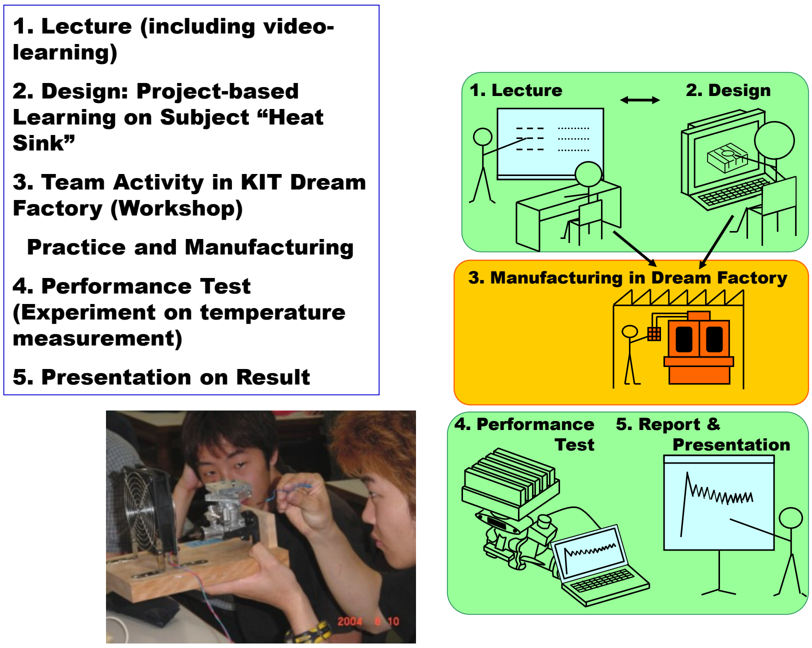


Figure 6. Profile of “Mechanical Technology and Practice” class in mechanical engineering

### *Example 2: Mechanical Technology and Practical Training*

This course is considerably different from a traditional technology training course. Figure 6 shows the flow chart of the class work [2]. First, the students study the structure and function of machine tools, then design a heat sink for a model engine, make it using real machine tools, and finally measure the temperature distribution to evaluate the cooling performance under air flow. Thus, they can experience directly the process of manufacturing which consists of design, production and evaluation. This practice-based class is motivating for the students and helps them recognize the necessity of technical knowledge. The course seems to have a fairly good reputation among students.

## SUMMARY

The KIT engineering education program was explained mainly from viewpoints of the CLIP learning class and the comprehensive integrated abilities, with their relation with the CDIO standards.

As stated above, KIT aims to build an active campus for students from three standpoints: A) Project-Design education as the main pillar of the curriculum, B) active learning as the attitude of students, and C) appropriate workspaces as the field of action for students.

The main points of the present paper can be summarized as follows.
(1) The CLIP learning process is the system through which KIT students can transform knowledge obtained in class-work or home-work into comprehensive integrated abilities.
(2) In order to graduate engineers with the comprehensive integrated abilities, both the academic abilities and the personal and interpersonal skills need to be addressed in courses.
(3) The learning process for the present purpose is the CLIP learning process. The learning way appropriate to this process is considered to be active learning.
(4) Typical examples of KIT CLIP learning courses were presented. In such courses the comprehensive integrated abilities are fostered on the basis of the CLIP learning process as well as the active learning.

We are planning to present further practical examples and results at CDIO international meetings. For some previous results, refer to the existing papers [3-5].

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