# Bridge-Curriculum with Rotational Experimental Projects for Multidisciplinary Courses on Biomedical Engineering

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### ABSTRACT

A bridge-curriculum with rotational experimental projects has been designed for a sustained improvement of a curriculum in a multidisciplinary area of “Biomedical Engineering”. In the system, each course is taken by multiple teachers. A professor takes charge of the part, which should be bridged to another subject. A constant communication between courses has been guaranteed in the system. Each lecturer takes charge of an experimental project. The contents of the experimental project relates to the lecture. Each experimental project includes many elements of learning: planning, designing, instrumentation, teamwork, analyzing, modeling, explanation, and presentation. Each small group of students goes the rounds of every experimental project one by one. The contents of each course have been continuously reviewed with variation of discipline in the system. The bridge-curriculum system works well to improve the courses of Biomedical Engineering.

**Keywords:** Multidisciplinary Courses, Biomedical Engineering, Bridge-Curriculum and Rotational Experimental Project

### 1. INTORDUCTION

In a university curriculum with a credit system, each course is usually handled by one individual teacher alone. Although the university teachers have their own original specialty, most of them have not trained how to make lessons. The licensed degree like a high school teacher is not necessary to be a professor in university in Japan. In Japan, most of textbooks taken in the courses of universities have no official approval like those of high school, either. This is convenient to offer "Place of a free doctrine". The cooperation between subjects is not enough, on the other hand, when each teacher discretely takes each class by the each one's judgment. It is difficult for student to understand the relation between subjects. This kind of system cannot guarantee the sustained improvement of the entire curriculum.

Recently, every university program is required to keep guaranteed system to improve curriculum sustainably without relying on "Student's initiative" in "Optional courses". The education program should be flexibly improved in the viewpoint not only from the program offer side but also from the student side, to extend the goals of the program.

Because “Biomedical Engineering” is a multidisciplinary area [1], it has variations not only in teachers’ special fields but also in study backgrounds of students. The relation among courses might be hard to understand in the curriculum, when it consists of disorderly aggregated subject taken by each teacher of variety of the study field. A fusion of various systems and backgrounds of study, on the other hand, creates a new field of study in a multidisciplinary area such as “Biomedical Engineering”.

An interdisciplinary field is not a mere mixture of specialized fields. When several fields that extend to another area are connected to each other, they represent the academic value as an interdisciplinary field. Aggregation of professors from various special fields cannot make a multidisciplinary education program. Every professor should experience multidiscipline, and should have ability to fuse special fields. In the present study, a challenging bridge-curriculum with rotational experimental projects has been designed for a sustained improvement of a curriculum in a multidisciplinary area of “Biomedical Engineering”.

### 2. BRIDGE BETWEEN COURSES

The design of courses in the bridge curriculum is as follows:

1) Two or more professors take charge in every course at an omnibus style. A student meets two or more teachers in any class.
2) A key professor is in charge to arrange the entire syllabus and to decide the evaluation method to give students a credit for the subject, collecting the contents from the related professors.
3) Through the communication between courses by class inspection and by discussion between professors, each professor proposes the content of the contribution part to the key professor.
4) A professor takes charge of the part, which should be bridged to another subject (Figs. 1-3). For example, the professor “B” of “Introduction to Medicine” takes charge of a statistics part of “Medical Information Processing” and the electrocardiogram part of “Bio-measurement Engineering”.
5) Several lessons are taken by guest speakers from institutions or from industry for the topics or for the application part: “Selected Topics”, for example (Fig. 3).
6) To provide the multi-learning, all teachers participate with the omnibus style in the courses, which relate to every field: “Introduction to Medical Engineering”, “Ethics in Engineering“, “Technological History “, and “English for Engineering“.

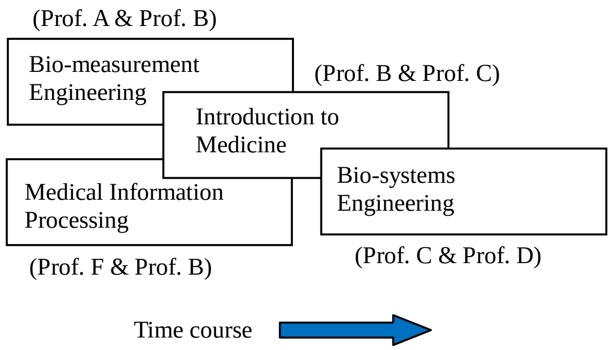


**Fig. 1:** Bridge between courses.

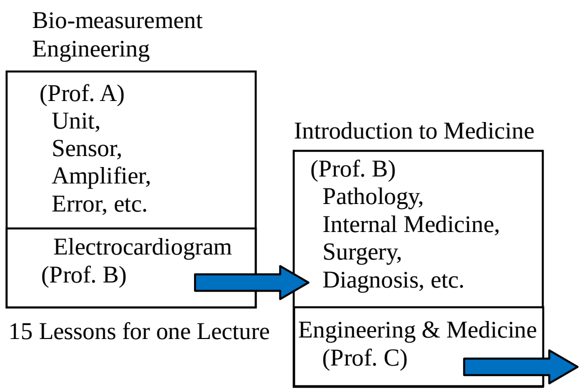


**Fig. 2:** Bridge (arrow) content between courses.

7) In projects for multiple hours, students are divided into small groups, and one professor is charged to the serial classes of several hours, while the groups sometimes amalgamate to prevent being biased according to the individual professor: "Seminar", and "Bachelor Thesis (Fig. 3)", for example.

## 3. BRIDGE BETWEEN ROTATIONAL EXPERIMENTAL PROJECT AND LECTURE

The system of "Rotational Experimental Projects" enables polishing the ability of design, communication, presentation, and teamwork, simultaneously, as well as supplying the advisory system for students' learning.

1) Each lecturer takes charge of an experimental project (Experiment of Biology, Experiment of Chemistry, Experiment of Medical engineering in Fig. 3). The contents of the experimental project relates to that of lecture.
2) Each experimental project includes many elements of learning: planning, designing, instrumentation, teamwork, analyzing, modeling, explanation, and presentation.
3) Each small group of students goes the rounds of every experimental project one by one.
4) The rotational experimental project provides a good opportunity to touch materials and to meet with application of fundamental subjects, which have been learned in the lecture.

## 4. DISCUSSION

Interviews to students, to their parents and to industry show the following advantages and disadvantages of the bridge-curriculum system.

Advantages:
1) The system gives a chance to divert motivation from one object to another, which is useful to refresh and inspire students. Compatibility between a student and the content of the subject can be distinguished from that between a student and the professor individuality. Students can select professor, when they complain to the contents of the subject. Professor can collect opinion from students about the contents charged by another professor.
2) The bridging-charge system guarantees the daily discussion among subjects.
3) A constant exchange between subjects is guaranteed. Cooperation with other subjects can be considered at any time. Scheduled lecture is requested.
4) Evaluation: discussion on student achievement level among related subjects is guaranteed. A self-righteous evaluation to students can be prevented by being checked by another professor.
5) The bias, which depends on professor individuality, can be compensated by another professor. The improvement of the content of the subject can be distinguished from that of the professor ability.
6) With the system, every subject can easily include specialized topics by a guest lecturer, which inspire students.
7) Because every professor takes part in the class of all semesters, he can always check students' achievement according to their learning history.
8) Because two or more professors recognize the outline of the class, a lecturer at any class can be easily replaced by another professor in a case of an accident. The lesson schedule becomes flexible independent of teacher's convenience.
9) The system breaks the wall between subjects, and enhances the exchange of the content between them
10) The system breaks the traditional style of "one teacher on one subject".
11) The system creates a new curriculum system, as well as a new academic system.

Disadvantages:
1) Interrupt the story of each course.
2) Students have to follow the change of the lecture style during one course.
3) Scheduled lecture is requested.
4) The management of the class schedule becomes complicated for faculties.
5) The class schedule becomes complicated for professors.
6) Alternation of professors might make it difficult for student to understand the continuousness of the content in the course.

"Plan, Do, Check, Action (PDCA)" cycle to improve a curriculum works with the class inspection and the meeting on the course content among faculties. The regular meeting, however, is not enough to support the cycle. Daily discussion among faculties is preferred to support the cycle. Before introduction of the system, the class inspection and the meeting on the course content tended to be skipped.

Although it is the best way for students to select one from two or more classes prepared for each subject, a department does not have allowance to prepare such a huge amount of classes: neither enough space, nor enough professors. Students tend to select subjects not due to the contents but due to professor's individuality. The subject does not depend too much on individuality of one professor in the bridging-charge system. Before introduction of the system, the improvement of the content of the subject can hardly be distinguished from that of the professor ability. Monotonous contents of basic subject can be changed to exciting contents by variation of professors' specialty background. It is easy for a professor to take cooperation with another university under flexible class schedule in the system. Cooperation between universities is important especially in a multidisciplinary field.

The course contents have been continuously reviewed with the designed system. Following the students' opinion about the weakness of the area in biology and in life science, fields on the biological cell technology, gene technology, and the protein technology have been added to the curriculum [2-4]. The special subjects have been categorized into two groups: "life science" and "medical engineering", which cover the wide multidisciplinary field. The basic part has been supported with natural science subjects. "Analytical Chemistry" has been added following the opinion of industry. "Ethics", "Technological History", and "Language", have been positioned as compulsory subjects, which are key subjects for every discipline. The serial subjects of small group activity (ten people or less) in "Seminars" and in "Rotational Experimental Projects" from first to last semester enable polishing the ability of design, communication, presentation, and teamwork, simultaneously, as well as supplying the advisory system for students' learning. Enough contents are kept in the courses to maintain relations to the license of the high-school teacher and of the clinical engineer, following to parents' opinion. The bridging-charge system works well to improve the curriculum of Biomedical Engineering.

## 5. CONCLUSION

A bridge-curriculum with rotational experimental projects has been designed for a sustained improvement of a curriculum in a multidisciplinary area of "Biomedical Engineering". The system works well to improve the curriculum of a multidisciplinary area.


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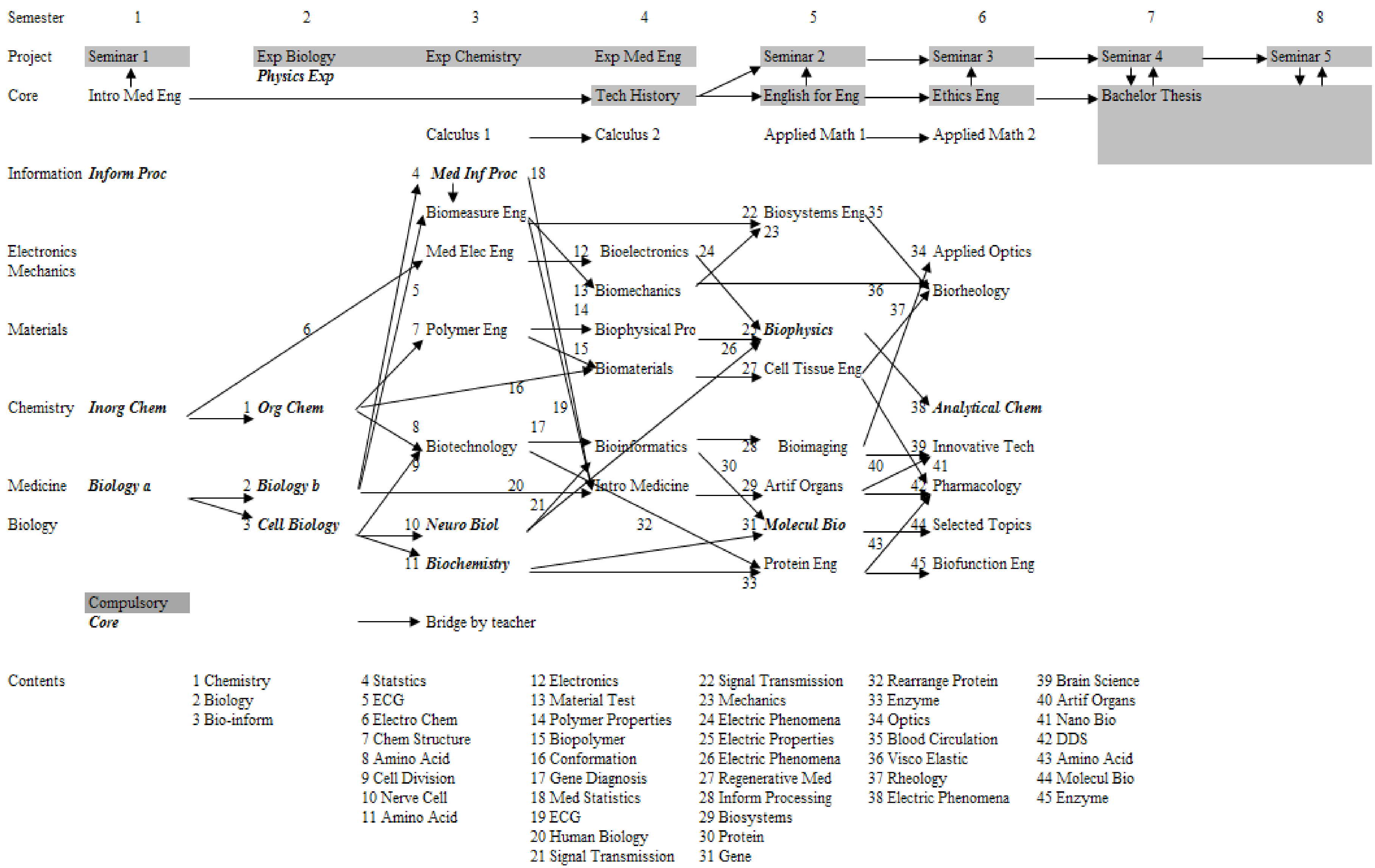


**Fig. 3:** Flowchart of courses. Bridges between experimental project (Exp. Biology, Exp. Chemistry, Exp. Medical Engineering) and lecture are not shown in the figure.