

International Individual Internship Based on Research Collaboration on Engineering Education and Academic Science

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Abstract—The authors have conducted the mutual exchanges of the students and professors between the universities in Japan and Germany, discussing the topics on the engineering education. On the platform, the international collaboration on the engineering education researches in assistance of the educational reform program have been carried on by the grants-in-aid of Japanese government. Since the current issues on engineering education are generally common in every country, it is beneficial for us to discuss the educational information with foreign faculty. Since the experiences of collaboration with foreign universities are profitable for students, we have been conducting the individual student exchanges on the scientific research areas with each other by the mutual contracts of MOU with German institutes. The individually-dispatched students showed us that the experiences of collaborations were will beneficial for their career-design as well as the enhancement to motivate their scientific researches. The individual internships thus processed have resulted in some academic paper publications on the collaborative researches. 21 Japanese students have studied abroad and 10 German students have studied in Niigata. 13 scientific papers co-authored by the students have been published in a decade.

Keywords— *international meeting; internship; international collaboration; student exchange*

I. INTRODUCTION

The recent circumstances of engineering education have drastically changed by general attribution of internationalization of the whole society in addition to the research areas of science and technology. During the last decade, the necessity of the educational reforms has been strongly stated even in almost of universities, as pointed by R. Miller [1]. The roles of universities were actually redefined again. The engineering education should take the important roles to attract the students toward their profession. The numerous problems have been pointed such as the elevation of applicants, the decline of the scholastic ability due to the university-applicant elevation in number [2] and the globalization of whole society [3]. Various educational configuration like the flipped classrooms, design schools, and MOOCs [4] have been proposed to promote the educational performances of various educational institutes.

The authors in Niigata University have begun various kinds of reform projects of engineering education such as interdisciplinary program in 2003 [5], the practical learn-by-doing programs [6, 7], the career-designing education [8, 9], the start-up programs for freshmen [10, 11], the leadership program [12, 13].

At first, we must refer to an outstanding international activity in this paper. Niigata University has been keeping a strong relationship to Otto-von-Guericke-University Magdeburg in Germany for more than twenty years. The faculty members and students more than five hundred have participated the summer school programs which have been biannually planned in turn [14, 15]. In 2008, we started a novel project “Global Circus” for the graduate school students for a mutual exchange the double degree program for the foreign PhD students. Afterward, the governmental fund which was called Short Stay/Short Visit Program has partially supported the activities of the mutual students/researchers exchanges with the institutes and universities in Germany. In this paper, the authors report and discuss the activities of educational reforms and the student exchange programs with Technical University of Darmstadt and Technical University of Dresden in Germany. In practical, the faculty members of TU Dresden conduct Dresden IFW (Leibniz Institute for Solid State and Materials Research Dresden). We gathered the information on the present status on engineering education. We also discuss about the collaborative forefront researches, which are assigned to the students of universities, who have individually performed their collaborative researches during several-month internship in each foreign institute.

II. INTERNATIONAL INVESTIGATIONS ON ENGINEERING EDUCATIONAL REFORM

The first opportunity for us to start the international activity on the engineering educational researches overseas was an international conference named “Fusin Technology” which was held in Niigata University in attendance with a couple of Korean and Chinese universities, respectively. At the end of 2006, this big event was followed by some meetings on the engineering education. We have invited the lecturers from foreign universities. They gave us the information on the

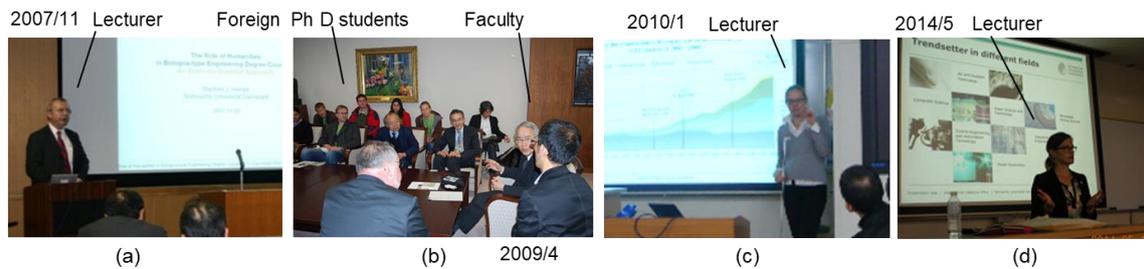


Fig. 1 Lectures by the professor, engineer and international office staff from Darmstadt

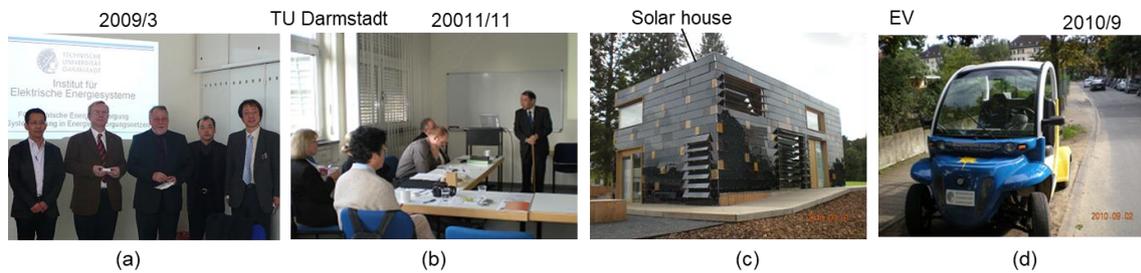


Fig. 2 International investigation on the reform activities on engineering education in TU Darmstadt

international situations of the educational reforms which have been conducted in each country. In Europe, a famous program “Bologna process” has been conducted for ten years from 1999 to enhance the mobility of university students. The story should get started with the delegation from TU Darmstadt, visiting Niigata University in 2009. As shown in Fig. 1a, the lecturer from TU Darmstadt reported us the present status of the reform activity in Germany.

As shown in Fig. 1b, we had a guest delegation of 19 PhD students of Dept. of Electric Engineering from TU Darmstadt to research the power systems in Japan. In 2010, a member of the delegation visited us again as a lecturer, giving us the present energy saving technique in Smart Grid in Germany (Fig. 1c). After the establishment of MOU on the mutual exchange contract in 2013, an international office staff of TU Darmstadt presented us the guidance for our students to study abroad to TU Darmstadt, and introduced us their educational activity for the foreign students in 2014 (Fig. 1d) [16].

Before establishing the contract, we investigated the international reform activities on engineering education in TU

Darmstadt. Figures 2a and 2b show the views of a meeting there about the educational reform activities and another information exchange on the academic research area of the information technology, respectively. Figure 2c shows the other collaboration candidates to investigate the solar house (Fig. 2c) which was designed and built by undergraduate and graduate school students in Dept. of Architect. This solar house was awarded the highest prize in the competitions called “Solar Decathlon” held in US in 2009. Figure 2d shows a photo of the electric vehicle EV under developing in Dept. of Electric Engineering (Fig. 2d). These research targets such as energy-saving houses and the energy consumption in vehicles are popular for the interdisciplinary projects which the students conduct by themselves in many universities of all the world. Since the circumstances around the engineering education are thus common to those of every country, it is effective to discuss the present status and exchange information on these issues. We have collected the information on the educational issues in this way, and recognized the differences between these instances and those in Japan.

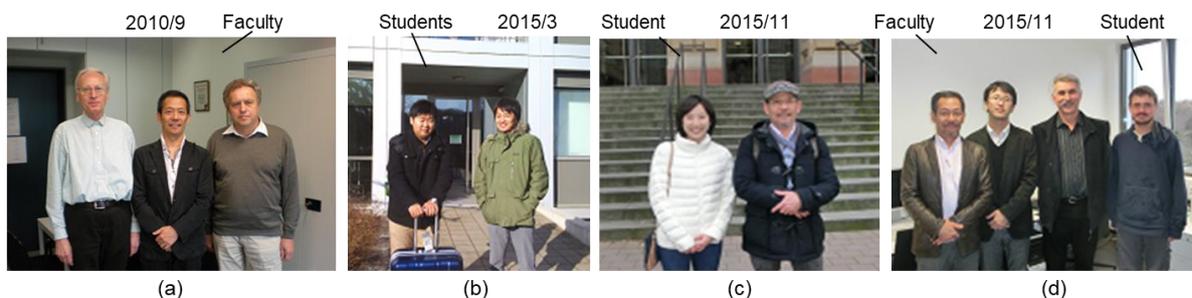


Fig. 3 Mutual students' exchanges with TU Darmstadt

III. INTERNATIONAL DISPATCH OF STUDENTS TO FOREIGN INSTITUTE/UNIVERSITY AND ACADEMIC RESEARCH COLLABORATIONS

Nowadays, the students and faculty members frequently visit each university, promoting the academically scientific collaboration as well as the educational information exchanges by faculty members. We established a MOU contract between TU Darmstadt and Niigata University with respect to the mutual exchanges of students and faculty members in 2013, and started sending and accepting the students each other. Figure 3a shows a scene of a meeting held at TU Darmstadt in 2010 to plan the mutual sending and accepting students in the collaborative researches on superconductivity and its feasible applications between the departments of Material Science in TU Darmstadt and Electrical and Electronics in Niigata University. Based on the contract, the students stayed abroad for 3-5 months at each university, as shown in Fig. 3b-d. We individually dispatched the students all alone during their stay period. Following this concept, the project has a character like an individual internship to foreign universities for several months.

Fig. 3b shows the students who stayed for 3 and 5 months, respectively. The student shown in the left-hand side has stayed for 5 months in the research laboratory in Materials Science with respect to the theme of thin film physics in 2015, whereas the other stayed for 3 months in another research laboratory on the theme of ac loss simulation. As he worked on the experimental research in Niigata, he had to study the numerical simulation software which was necessary to work in Darmstadt before his stay. In this manner, the students have joined the

research teams, and the collaborative papers were possibly published with their names as coauthors, when their contributive works would be approved [17]. The student in Fig. 3c stayed for a semester in 2015 winter. She has got the German credits for the first time in this project.

The students in Fig. 3d who has studied the ac energy loss of the superconducting tapes by numerical simulation method as a PhD candidate in Darmstadt visited Niigata University to operate the practical experiments to make his numerically-calculated results sure, because we have a lot of experimental results and know-how on ac loss measurement. After returning home after his three-month stay, he submitted a paper including both the numerical simulation and the practical measurement results. The paper was accepted and was recently published in the academic journal as a collaborative accomplishment by Darmstadt and Niigata universities in 2017 [18].

We have started a mutual exchange program with the foreign universities for graduate school students, aiming the double degree program of so-called “Global Circus” project from 2008 to 2012 fiscal years. We have conducted several collaborative research activities by accepting students from Dresden IFW from 2009, as well as the students dispatch. Since the research activity on the superconducting materials was strongly related to that driven in Niigata University, the students shown in Fig. 4 have performed some experiments on the scientific research area in the collaborative works assigned in Niigata. A few of students in the figure still work on the same topics in the relevant research institutes, the relationship must be precious to gather the information on research

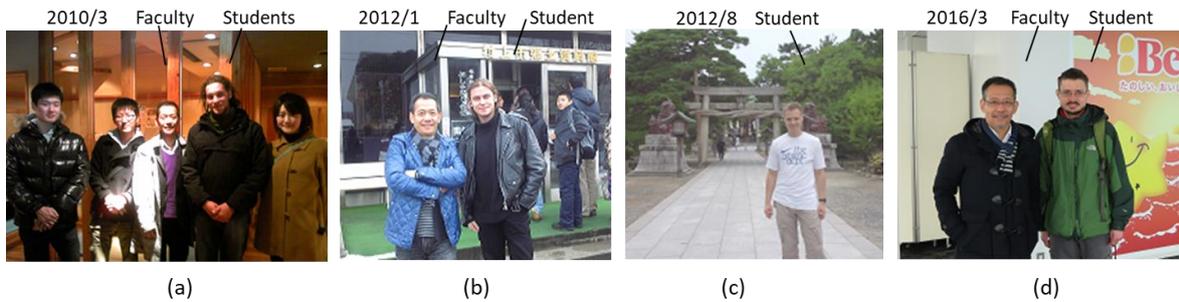


Fig. 4 Acceptance of students from TU Dresden to Niigata on collaborative scientific researches

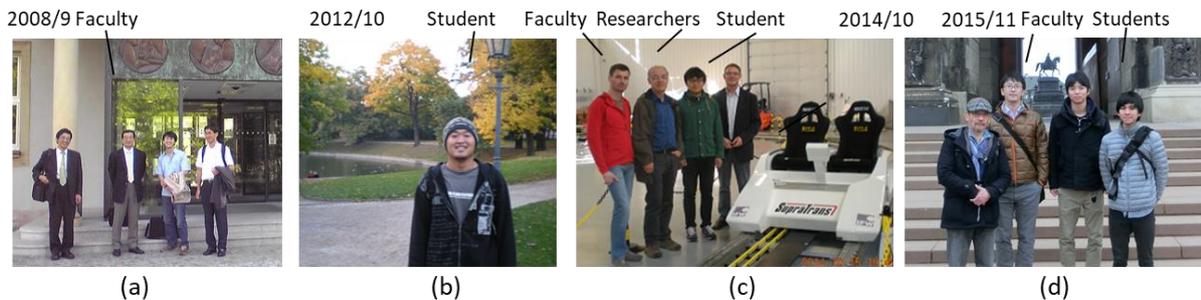


Fig. 5 Faculty and students in Dresden

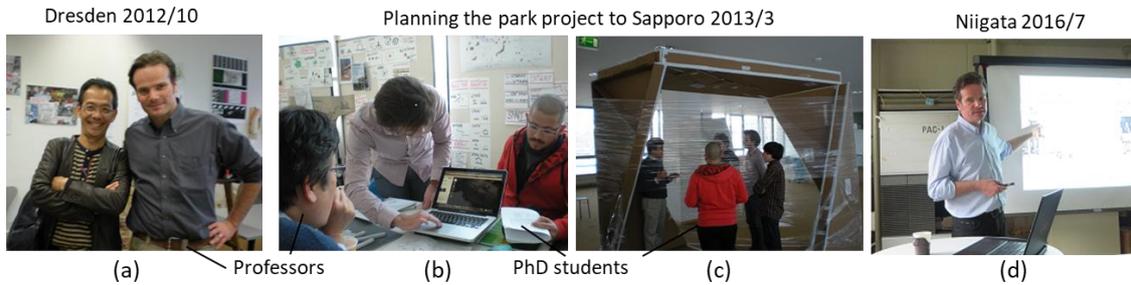


Fig. 6 Collaborative works with the architects in TU Dresden

activities. They would take care of the students dispatched from Niigata to their institutes. Nine papers were published with their names as the co-authors till now [19]. The foreign students staying in our laboratory have given the Japanese students good effects on their career-design, promoting the consciousness of the students who hesitate to study abroad. A couple of Japanese students have already studied in Darmstadt for 5 months and Dresden for 3 months in 2018, respectively. Furthermore, another student is preparing for his 3-month stay at Darmstadt, starting at next October. The project has been mainly operated by a research laboratory working on the superconductivity, and actually the major students have come from a certain research laboratory. Therefore, it may be possibly an issue to expand this activity to increase the number of dispatched students when it needed in the future.

Based on the personal relationship on the scientific research area on superconductivity and the sectional agreement between the schools, we have sent 10 undergraduate/graduate school students to Dresden IFW from Niigata University for nearly a decade, as shown in Fig. 5. The students have stayed for up to 5 months are profitable for their career designing. The students stay at the institute all alone and belong to the certain laboratory. The student shown in Fig. 5c has joined the forefront development on world-first levitation vehicle. As well as the case in Darmstadt, the collaboration results there would be published in the international collaborative paper as a co-author. Actually, the international collaborative papers were

published when the students' contribution was approved in the team they belonged [17]. The paper still contains the world-best performance in the research area of superconductivity even till now.

In addition, the collaboration has extended to another academic areas beside the material science. As shown in Fig. 6a, a novel personal relationship was introduced with the architects in TU Dresden. Fig. 6b shows a view of coaching by the professor from Niigata for the park-planning project in Germany in 2013, and Fig. 6c shows the practical park bench they designed. We invited a professor from TU Dresden to Japan for the collaborative work in 2016. We can find one student on the right-hand side in Fig. 5d, who stayed for 3 months in 2015 at Dresdner Architects Dept. Till now, two undergraduate students were dispatched to stay for three months with respect to the collaboration on the architect matter.

Tables 1 and 2 show the total number of the students dispatched and accepted to each university of Darmstadt and Dresden. 22 Japanese students have studied abroad and 10 German students have studied in Niigata. 13 international scientific papers co-authored by the students who contributed to the collaborative researches have been published in ten years. We may know how to estimate the number of papers published, and it may not be sufficient in number. But, the internationalization of universities would be accomplished well when the activity would be extended to the whole faculty.

TABLE I NUMBER OF MUTUAL STUDENTS' EXCHANGE WITH GERMAN INSTITUTES

<i>Institute</i>	<i>Style</i>	<i>Number of students</i>	<i>Stay period</i>	<i>Year</i>
IFW	Sending	11 (2)	1-6 months	2009-2018
	Acceptance	5	3 months	2009-2013
TU	Sending	9	3-5 months	2014-2018
	Acceptance	5	3-5 months	2014-2016
No. of international papers/presentations		13		

(*) Another laboratory

TABLE II NUMBER OF STUDENTS GOING ABROAD

<i>Style</i>	<i>Number of students</i>	<i>Laboratory</i>	<i>Department</i>
Sending	18 (19)	Oka	E&E
	1	Ogawa	E&E
	2	Nishimura	Architect
Acceptance	5	Oka	E&E
	1	Ogawa	E&E
	4	---	Others

(*) number of times

IV. CONCLUSION

Our international investigation on the engineering education have started in 2008 and continued till now in Faculty of Engineering in Niigata University. Although the educational circumstances are different with each university or country, the current issues on the engineering education were found to be mostly common in every country. Therefore, it is profitable for us to discuss about the present status and further developments on education programs. We have carried on the individual dispatches of students to German universities in Darmstadt and Dresden. The number of student dispatch and acceptance reached 22 and 10 with a feature of individual internship, respectively. The projects are based on the personal relationships which were established through the specific research collaborations in the past. 13 scientific papers have been published through the students' collaboration as co-authors. The active research areas of collaboration are expanding to other academic areas as well the materials science.

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