

## International Engineering and Science Research Exchange Program Enhancements through Innovations

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### Abstract

Tokyo Tech created a four year multi-lateral international research university mobility program that began in 2011 to promote internationalization and to develop student leadership skills based upon carrying out a summer research project. The 10 week inbound summer exchange program served as a test bead for new program activities and administrative innovations that resulted in a more sustainable, broader-based and more efficient program than when it began. It also resulted in the formation of an international network of university faculty contacts and students. Feedback from the inbound exchange students noted the program greatly strengthened their research ability, personal development as well as raised their cross-cultural awareness and competency.

*Keywords: summer program, engineering, research exchange, project based learning*

### 1. Introduction

In the fall of 2011, Tokyo Institute of Technology (Tokyo Tech) received a JSPS grant to establish an academic international mobility network entitled, “World-Class University Alliance for Educating Techno-Scientific Leaders”, with 17 top American/European/Asian research university partners under the “Re-inventing Japan Project” [1][2] with Tokyo Tech serving as the academic hub. The grant in-part funded the establishment of the Tokyo Tech International Research Opportunities Program (TiROP), a 10 week summer research exchange program from 2012 to 2015 for undergraduate and graduate science and engineering students. The program intent was to promote greater internationalization of Tokyo Tech and engagement with overseas partner university faculty, staff and students and nucleate long-term relationships. In addition to supporting the creation of a summer program, it also supported Tokyo Tech faculty mobility/development, doctoral student research stays, short-term overseas’ university visits by junior faculty and undergraduate students, outbound student research mobility and various other activities such as coursework, Japanese language classes and cultural activities. This paper summarizes challenges and highlights in coordinating an exchange program with 17 universities and innovations that were made year by year for the purpose of program quality improvement and sustainability.

Compared to traditional academic exchange programs where overseas students apply, are admitted and enroll in courses, research exchanges are much more human resource intensive since students, faculty, specialization and research interests must be aligned case-by-case to coordinate student project-faculty match-making. In this case, the inbound student proposed their own research project and three faculty member labs where they wished to work. To the extent possible, the students’ proposed research project and faculty nominations were taken into consideration in lab placements. Although a number of US research universities i.e. MIT, Stanford, and Caltech have established summer research internship programs for their students in Japan, TiROP to our knowledge is unique in that it is an institute-wide summer science and engineering inbound research exchange program for undergraduate and graduate students. Table 1 summarizes the summer program main elements when it started in 2012 and year-by-year program and administrative innovations (underlined) that have been implemented to enhance the program (Fig. 1).

### 2. Exchange Program Overview and Innovations

Table 1. Summary of summer TiROP activities and administrative/marketing innovations from 2012 to 2015

2012 (original)	2013 (New)	2014 (New)	2015 (New)
<ul style="list-style-type: none"> <li>◆ Paper based Application</li> <li>◆ Survival Japanese Course</li> <li>◆ Lab Research Project Plan &amp; Report</li> <li>◆ Homepage/Facebook pages</li> <li>◆ e-mail based management</li> <li>◆ Cultural activities</li> <li>◆ Partner Contact Network</li> <li>◆ Agreements (MOU, LOI)</li> </ul>	<ul style="list-style-type: none"> <li>● <u>Online Application</u></li> <li>● High Tech Japan Course</li> <li>● Special Lecture</li> <li>● Student study-abroad short trip*</li> <li>● Intern. Symposium</li> <li>● Corp. Internship</li> <li>● <u>Planning meeting</u></li> </ul>	<ul style="list-style-type: none"> <li>☑ <u>New Member (CMU)</u></li> <li>☑ Bi-weekly Reports</li> <li>☑ Safety training</li> <li>☑ T-Shirts</li> <li>☑ <u>Student Video Production</u></li> <li>☑ Tea Ceremony</li> </ul>	<ul style="list-style-type: none"> <li>◆ <u>Learning Management System Implemented</u></li> <li>◆ Gender Related Lecture</li> <li>◆ Student-Tutor joint activity</li> <li>◆ Progress reports</li> <li>◆ Call for applications revised</li> </ul>

Notes: Tokyo Tech also hosted activities for students coordinated by its CAMPUS Asia Program. \* study abroad short-term trip began in Feb. 2013. \*\* for a list of the partner universities, see TiROP website [2]



Fig 1. Inbound TiROP summer participants at closing ceremony in 2012, 2013 and 2014 taken at Tokyo Tech.

For the 2012 summer program, many things had to be done quickly relating to creating the program, administration, marketing, application procedures admission etc. due the limited time between funding notification (Nov. 2011) and summer program application deadline (Feb. 2012). Overall, the summer program went smoothly but numerous areas were identified that could be improved.

Based upon student feedback from the 2012 program, the 2013 program was slightly revised based upon holding staff and faculty working group planning meetings and review of the students' program questionnaire responses. An online application system was created which cut down time on the application submission time/overseas mailing time compared to the paper-based application. In addition, an advanced technology factory tour course was organized by the School of Engineering Faculty which consisted of visiting four factories in the Tokyo metropolitan area [4]. Furthermore, at the end of the summer research project, a corporate internship opportunity was established and offered to students.

It was observed that the number of Japanese students applying for the outbound program was less than that of the inbound student numbers. To promote internationalization of Japanese Students and create future demand for the longer term outbound research-aboard program, a short 10 day trip was organized for undergraduate students to visit partner Univ. e.g. Univ. of Washington and MIT in Feb./March 2013. This gave Japanese undergraduate students an opportunity to experience study abroad with Faculty and Staff accompaniment as well as an opportunity to meet the TiROP inbound students from the 2012 program at their home universities. This type of short-term was repeated in 2013, 2014 (Fig. 2) and 2015 for undergraduate students.



Fig. 2 Outbound Tokyo Tech students talking with MIT and Georgia Tech students at Tokyo Tech (left), preparatory meeting and discussions with Tokyo Tech/Georgia Tech faculty (middle), and visiting MIT Japanese language lunch table during a 11 day trip (right).

In 2014, in addition to making slight revisions to the program, students from Carnegie Mellon Univ. participated in TiROP for the first time. To track the student's research program progress and overall wellness, the students were requested to submit bi-weekly reports. Furthermore, to promote the program on campus, T-shirts were printed and distributed to TiROP students which they wore to TiROP events. In addition, videos were recorded of the inbound students while at Tokyo Tech talking about their thoughts on the programs which lead to greater insight into the student's own personal development. From the beginning, international students wanted to learn about Japanese culture in addition to doing research. As a result, a Tea Ceremony was organized on campus to allow the students to learn about Japanese culture.

In 2015, to reduce the e-mail correspondence frequency between the inbound students and TiROP office staff, a learning management system was introduced which served as the program internal website file depository for program information for participants (see below). Furthermore, approximately half of the inbound students were female which lead to discussion on gender differences and a special activity is planned for female students in July 2015. To encourage greater interactions with the Tokyo Tech host tutors (buddy) many of whom are Japanese, a joint activity is also planned for exchange students and their tutor hosts to promote communication.

### 3. Program e-mail management challenges

When the summer program began, communications with overseas partners and students was primarily done by e-mail and periodic visit which allowed for direct discussions. Due to the time difference between Japan and North America and Europe, telephone conversations were limited. Several short-comings of e-mail based communications were realized, that is, once the students graduate from their home university, e-mail communications via their university e-mail account are terminated. Secondly, the volume of e-mail correspondence involving student mobility related to the research exchange program exceeded 2,300 messages/year in 2014 and was proportional to the number of participants, which made management and future scale-up a challenge. To reduce the e-mail messages between inbound students and the TiROP office staff relating to administration and program issues, a Learning Management System (LMS) was introduced from April 2015. The LMS provided the TiROP office a depository for program materials which the students could access at their convenience and also an online site to submit their various forms such as research plan, forms, and reports. Although the LMS has been utilized for only one month (at the time of writing in May 2015), it has led to net reduction in e-mail messages between the TiROP office staff and the students by approximately 50%. It should also be noted that using the LMS allows for monitoring of student logins. (Although Tokyo Tech has a learning management system called open courseware (OCW), it does not allow for file uploads by non-registered exchange students.) As Tokyo Tech begins implementing its new Top Global University program which involves university-wide activity and internationalization, it has become a priority to consider exchange program sustainability and efficiency.

### 4. Program overall mobility

Overall, the number of inbound student participants is almost double the number of outbound students. Inbound students feel that Japan is an interesting place to experience because of its history, society, high technology and traditional/pop culture. The summer program provided them a vehicle to visit Japan as well as develop both personally and professionally. The reason why fewer Japanese students applied to do research abroad is due in part to limited financial support provided, possible interference with job-hunting activity, potential delay in graduation by research abroad, and lack of post-graduation incentive [5].

As noted in the Table 2, TiROP not only supported student mobility but also made efforts to disperse information on the program. For example, it held an international symposium in January 2013 [6], that allowed for direct information exchanges with the partner university leadership. In 2014, assistant professors who assisted the inbound exchange student research projects were encouraged to apply for and travel overseas to visit TiROP partner university faculty in order to strengthen the faculty-faculty research related network.

Table 2. Summary of student, staff and faculty that have participated in TiROP related activities.

<b>Program/Activity</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
Inbound summer TiROP students	14	19	24	19
Tokyo Tech outbound (2+ month stay) students	11	12	6	8
Faculty Mobility Inbound/Outbound	7/14	4/12	3/22	TBD
Overseas Univ. Student Short-visit Program	8	10	8	TBD

TBD – to be determined

The 2015 program has yet to begun which is why some activities are listed as TBD in Table 2, but overall activity is expected to be similar to previous years.

### 5. Inbound Student Program Feedback

The inbound research exchange program has provided the students not only with an opportunity to learn about Japanese culture which is novel to about 3/4 of them, but a research-derived cross-cultural leadership opportunity both for personal development and professional development. (This type of student development has also been observed in another research university based Japan summer research program for undergraduate students funded by the US National Science Foundation [7].)

To date, six students have published journal papers based upon their summer research results, four of which were undergraduates. Many of the students have found the knowledge they gain during the research phase to be particularly enlightening and they are able to take this knowledge and experiences with them and utilize it in their academic program or in their careers after they graduate. A number of students after spending the summer at Tokyo Tech have decided to attend graduate school and one is an entrepreneur. Although some students' research experience was less than they expected based upon their questionnaire responses, highlights of inbound student comments on the summer research program are below. The comments were received between one and three years after they participated in TiROP.

- *My time at Tokyo Tech via the TiROP program is the highlight of my educational history.*
- *Although I didn't get a research paper out of the summer (summer research project), I did end up with a fantastic experience, both research-wise and culture-wise! Even now, I use some skills I learned from my*

*summer at Tokyo Tech in my current research, and my travels through Japan will often come up in conversation. The elucidating experience gave me a real view of what electrical engineering research looks like, as opposed to the glamorized ideas students generally have. Luckily for me, the experience solidified my drive for research and convinced me to pursue a PhD.*

- *The experiences from TiROP would never leave my memory, not just because of a wonderful campus in a wonderful country, but it was also because of the great learning experience in my project and various classes in TiROP programs. The program helped me push my limits further both in life and in education. And I am more than happy to use some of those skills I learned from Japan for my current work which is actually at a Japan based company (in the USA).*
- *Having an experience abroad with study and research in Japan was one of the things that set me apart as a job candidate and ultimately what enabled me to get my current job. I am actively pursuing international opportunities within my company and hope to do a 1-2 year term abroad as part of my career advancement. Studying at Tokyo Tech really helped me with this journey, and I'm thankful everyday that I was able to do the program.*
- *My company works very extensively with Japanese companies, and I've had the opportunity to interact with representatives from them. Needless to say, I've benefited from having firsthand experience with Japanese culture. More generally, I feel that it was very helpful to have been in an environment in which I had to adapt to a different culture and language; it seems to me that it is a very similar experience to starting a career and being new to working at a company. Furthermore, my company is sufficiently large that different groups within the company tend to have very different practices and perspectives from each other. Especially for my role, which involves mediation between different groups, it is important to be sensitive to the differences between them, much like when I interacted with people from many different countries and cultural backgrounds during TiROP. For these reasons, I think that everyone would benefit from a program such as TiROP, and should absolutely pursue the opportunity to participate in one. I, for one, am grateful beyond words that I was offered such an opportunity.*

In conversations with overseas faculty in the US and UK, the summer research program has been compared to a cross-cultural research based training and student leadership development program because of what the students say they have learned during the summer. It appears that the program that began as a research program has matured in something more and has allowed the participants to achieve their individual goals. A small number of the summer students have returned to Tokyo Tech on different programs and several of them are employed in Japan. Furthermore, we found that it was beneficial to have the inbound students interact with the outbound students while at Tokyo Tech then meet the overseas students again after they returned to their home campuses.

## **6. Conclusions**

The 17 university inbound summer TiROP was successful in part because it attracted very motivated and talented students from around the world and Tokyo Tech faculty provided research opportunities for them. It should also be noted that teamwork between staff and faculty are important when operating the program and carrying out innovations. Participating students were not only able to interact with Japanese and international students at Tokyo Tech but also peers from the world's top research universities. Multilateral and repetitive interactions between overseas faculty, staff and students with their Tokyo Tech counter-parts were an important program aspect. Information technology was implemented to carryout the program and innovations adopted during the program such as using a learning management system reduced e-mail usage.

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### **Biography**

#### **Prof. Jeffrey S. Cross**

Jeffrey received a Ph.D. in chemical engineering from Iowa State University of Science and Technology in 1992. He came to Japan in 1993 as a US National Science Foundation Post-doctoral fellow to do research at NIRIM (currently NIMS) in Tsukuba, Japan. He has subsequently worked at Fujitsu Laboratory Ltd. for 14 years and at Tokyo Tech since 2008, where he serves on numerous international program committees involving student research exchanges and chairs the steering committee of the Asia Oceania Top University League on Engineering (AOTULE). He holds the chair in the Dept. of Engineering Fundamentals and Strategic Planning and is an adjunct Prof. in 3 different engineering depts. In addition, he teaches technical communications for graduate students, researches biomass liquification and biosensors. In 2013, Jeffrey received two Tokyo Tech teaching awards. He manages the Tokyo Tech Online Education Development Office that develops TokyoTechx MOOCs in collaboration with edX.

#### **Prof. Kikuo Kishimoto**

Dr. Kikuo Kishimoto is currently a Professor of the Department of Mechanical Sciences and Engineering and Dean of School of Engineering, Tokyo Institute of Technology. He received his B.S. degree in 1975, M.S. degree in 1977, and Doctor of Engineering degree in 1982 from Tokyo Institute of Technology. He worked as a Research Associate and Associate Professor at Tokyo Institute of Technology from 1977 to 1995 and was a Visiting Scholar at Cambridge University from 1987 to 1988. He has published over 250 journal papers in the areas of applied mechanics, fracture mechanics, reliability of microelectronic devices, and others. He is a fellow of Japan Society of Mechanical Engineers, a fellow of American Society of Mechanical Engineers and a member of Science Council of Japan. He has served and chaired various scientific and technological committees promoting research and education. He is a vice-president of Japan Accreditation Board for Engineering Education and is currently the principal investigator for the TiROP grant.

#### **Prof. Sachio Hirose**

Dr. Hirose Sachio is currently working as a specially appointed Professor at Tokyo Institute of Technology in the TiROP Team which is part of the International Office. He previously served as the Chairman of the Japan Association of International Student Education. Prior to joining Tokyo Tech in 1999, he was a visiting researcher at Rutgers University in 1980 to 1982, an Executive Director at Yuka Medias Co., Ltd. Tokyo, Japan, and Director of the Research Center of Diagnostics at Mitsubishi Chemical Corporation, Tokyo, Japan.

#### **Prof. Hidetoshi Sekiguchi**

Prof. Sekiguchi currently serves as the Vice-President for International Affairs at Tokyo Tech and manages the Top Global University Program. He was an academic advisor at Thammasat University in Thailand in 1996-1997 and also a visiting researcher at McGill University in 2000-2001. In addition to his international program administration duties, his research laboratory aims to develop innovative chemical processes utilizing plasma, ultrasound, supercritical fluids for environmental protection and material synthesis.