"Like Going to Mars", a Summer Research Exchange Experience at Tokyo Institute of Technology

Cross, J.S. [1]
Professor, Graduate School of Engineering
Tokyo Institute of Technology
Ookayama, Meguro-ku, Tokyo, Japan

Kishimoto, K.
Engineering Dean and Professor
Tokyo Institute of Technology
Ookayama, Meguro-ku, Tokyo, Japan

Sekiguchi, H.
Assistant to Vice-President and Professor
Tokyo Institute of Technology
Ookayama, Meguro-ku, Tokyo, Japan

Susa, M.
Associate Engineering Dean and Professor
Director International Student Center
Tokyo Institute of Technology
Ookayama, Meguro-ku, Tokyo, Japan

Conference Topic: Global Engineer

INTRODUCTION

In an age where globalization and international student mobility has become the norm, on the contrary, the number of Japanese university students studying abroad worldwide has been declining for years e.g. from 2008 it dropped by 20% or 25,000 students compared to 2004 [1]. This trend has caught the attention of the Japanese prime minister and the ministry of education which have pledged financial resources to Japanese institutions to create/promote study abroad programs to reverse this trend [2]. This topic is also of interest to Japanese corporations that are looking for greater business opportunities in Asia and a more diverse engineering work force to pursue their business objectives [3][4]. Hence it is of great importance to internationalize Japanese engineering students by creating real world work-like experiences in the academic laboratory by utilizing overseas research exchanges (internships) to develop cross-cultural competency in graduates desired by multinational corporations.

While the above tread was taking place, Tokyo Institute of Technology's (Tokyo Tech) Graduate School of Engineering established bilateral summer student research exchange programs with overseas engineering universities to promote student global engineering competencies based upon 3 month academic laboratory research experiences. School/College/Faculty level agreements were established to allow for bilateral student exchanges resulting in the establishment of research exchange programs: Summer Exchange Research Program (SERP) with European and American universities in 2005 and then the Asia Oceania Top University League on Engineering (AOTULE) was created to promote research and study-abroad mobilities within Asia and Oceania universities in 2007[5]. Fortuitously, these programs were both topical and well positioned to form the backbone for a new university-wide research exchange program called Tokyo Institute of Technology International Research Opportunities Program (TiROP) that began in 2011, with many of the same partner universities. TiROP was funded by a 4.5 year grant in the Re-inventing Japan Project [6] with financial

---

[1] Corresponding Author: Cross, J.S.

support from the Japan Society for the Promotion of Science (JSPS). A summary of the partner universities involved in research exchanges with Tokyo Tech and programs under which they participate is shown in Table 1. At some universities, the level of participation maybe limited to a particular program, department, college or school whereas at over universities the participation maybe university-wide. In this paper, the research exchange programs' attributes will be reviewed and what the students learn by participating in these research exchange programs at Tokyo Tech will be discussed.

Table 1 Tokyo Tech Summer Research Exchange Programs and Participating Institutions

	AOTULE	TiROP	SERP
Imperial College London (UK)		☑	☑
University of Cambridge (UK)			☑
University of Oxford (UK)			☑
University of Southampton (UK)			☑
Ecole Polytechnique (France)			☑
University of Minnesota (USA)		☑	☑
University of Wisconsin-Madison (USA)		☑	☑
University Polytechnic Madrid (Spain)			☑
Univ. of California – Santa Barbara (USA)			☑
RWTH Aachen (Germany)		☑	☑
University of Warwick (UK)			☑
The University of Melbourne (Australia)	☑		
Tsinghua University (China)	☑		
The Hong Kong Univ. of Science & Technology (China)	☑	☑	
KAIST (Korea)	☑		
University of Malaya (Malaysia)	☑		
The University of Auckland (New Zealand)	☑		
Nanyang Technological University (Singapore)	☑	☑	
National Taiwan University (Taiwan)	☑		
Chulalongkorn University (Thailand)	☑		
Brown University (USA)		☑	
California Institute of Technology (USA)		☑	
Carnegie Mellon University (USA)		☑	
Georgia Institute of Technology (USA)		☑	
Massachusetts Institute of Technology(USA)		☑	
Stanford University (USA)		☑	
University of California- Berkeley (USA)		☑	
University of Washington-Seattle (USA)		☑	
ETH Zurich (Switzerland)		☑	
Parish Tech (France)		☑	
Delft University of Technology (Holland)		☑	

Mobility Summary: in the AOTULE program 13 Tokyo Tech students have been dispatched and 88 have been received since 2008. In the SERP program, 70 Tokyo Tech students have been dispatched and 35 received since 2006. In the TiROP program approximately, 24 students have been dispatched and 58 received since 2012.

1 TOKYO INSTITUTE OF TECHNOLOGY

1.1 Overview, Student Body and Calendar

Before reviewing the exchange programs mentioned above, a brief overview of Tokyo Tech follows. Tokyo Tech has approximately 10,000 students enrolled, evenly divided between graduate and undergraduate students, 1,100 faculty (96% Japanese) and 600 staff. Approximately 4% of the undergraduates are international students, whereas as at the graduate level over 20% are international students. 90% of its international students are from Asia whereas Occidental (North America and EU) students comprise 1% of the student body.

The institute's mission is to educate engineering and scientists primarily for Japanese industry, where approximately 90% of its graduates seek employment. 90% of the undergraduate students in engineering proceed to a two years MS program after completing a 4 year undergraduate program. The last year of the undergraduate program and at least one year or more of the MS program is devoted to laboratory research and so students have several years of experience upon graduation.

The undergraduate curriculum is taught in Japanese, whereas the graduate program courses are taught in English and Japanese. Its graduates are highly evaluated by industry for their employability as noted by Times Higher Education surveys ranking either first in 2012, or second among Japanese universities in 2013, respectively [7].

At Tokyo Tech, the academic year follows the Japan fiscal year which starts in April and ends in March. The academic calendar consists of two 15-week semesters starting in April ending in Aug. and then from October to February. This unique calendar makes it difficult to exchange students for semesters since it does not match most overseas academic institutions' calendar. However, since the Tokyo Tech Spring semester overlaps with most overseas university summer breaks, this period allows for inbound overseas summer exchange students to interact with the Tokyo Tech students.

1.2 Summer Research Programs in Japan

Tokyo Tech is not only university in Tokyo providing summer research experiences for inbound students, for example the University of Tokyo School of Science offers a research based 6 week summer program called UTRIP, that accepts approximately 30 undergraduates in two co-horts [8], where students are expected to learn 1) how to define a research question, 2) undertake research to answer the research question and 3) analysis and present their research results.

In addition, a summer research program for graduate students in Japan is supported by JSPS with participation of academic institutions in the USA, UK, France, Germany, Canada, and Sweden. The summer students can be placed in Tokyo or at other institutions throughout Japan.

Other universities such as Waseda, Meiji, Sophia, Keio, Tokyo Medical and Dental University etc. in Tokyo also offer summer programs focusing on courses and lectures for visiting summer students.

2 SUMMER RESEARCH EXCHANGES

2.1 Model

Summer exchange programs at Tokyo Tech were developed to circumvent the problems related with an asynchronous academic semesters, however, in addition to have the study abroad experience, the objective of a research exchange is to gain an overseas' research (work-related) experience and in depth knowledge on the research topic. As a result, an exchange model of dispatching graduate students and receiving undergraduate or graduate students was conceived to accommodate partner universities [9]. Supporting a 3-month summer exchange student costs approximately US $10,000, so a business model is important especially to make the programs sustainable.
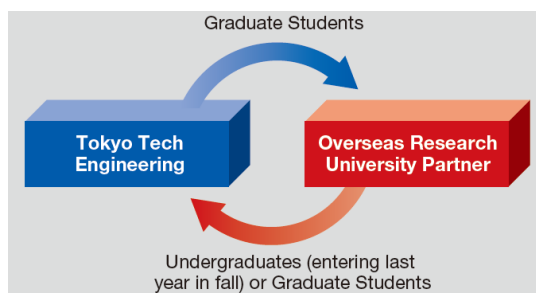

Fig. 1 Tokyo Tech Engineering Summer Exchange Research Model [9].

2.2 Laboratory, Research and Cross-Cultural Experience

To begin the process, inbound summer research exchange students outline their summer research topic in their Tokyo Tech application admission form and prior to arrival propose a research plan in consultation with the host Prof. (TiROP). Selection of the host varies with the program in some cases the host is nominated by the applicant, whereas in other cases the program coordinator matches the student with a host Prof. As noted above, Tokyo Tech faculty members are already supervising both 4th year undergraduate students and graduate students in their labs since a research projects are part of the education curriculum. Exchange students are given a desk in the lab and assigned a student tutor to help them with getting around on campus, administrative procedures, and in the laboratory since the institution language of operation is in Japanese.

The host Professor's laboratory often acts a surrogate family for the research exchange student and operates in a spirit of harmony (Wa in Japanese), where the harmony of the group takes precedent over individual needs. Each lab is headed by a Prof. or an associate Prof. Some labs may also have Asst. Prof., who help students with laboratory research and an administrative assistant (secretary) that handles administration paperwork. The student numbers in a Professor's lab vary, but from 5 to 15 students are common. The lab students often form a social group that supports research activity as well as socialize off-campus together. Each laboratory has a compulsory weekly seminar for 90 -120 min in Japanese or English, where students make periodic research progress reports to their Prof, who provides advice. Many of the students are working on independent but inter-related research topics so exchange students can often turn to lab peers who have more experience in the lab to answer basic research questions. Exchange students that speak Japanese often find they can gather more information and integrate more quickly into the laboratory than those that only speak English. However, some labs are more international than others based upon the nationality of the students within it, and English conversation maybe more common than Japanese conversation.

2.3 Research Exchange Program

Of the three summer programs that the school of engineering or engineering faculty are involved with, each have some differences as noted below (Table 2). Items marked with asterisk were specifically arranged for summer research exchange students and to ensure learning outcomes.

Table 2 Summary of 2014 Tokyo Tech Summer Exchange Program Attributes

	TiROP	SERP	AOTULE
Period	June-Aug.	June-Aug.	June-Aug.
Inbound students	24	10	12
Financial support for participants*	Yes	No	Yes
Administrated by*	International Office	Engineering International Cooperation Office	Engineering International Cooperation Office
Student Nominations*	Coordinators at each partner Univ.	Coordinators at each partner Univ.	Deans office at each partner institution
Placement of exchange student in the host lab*	applicant nominates potential host but coordinator makes placement	Faculty & Program coordinator at Tokyo Tech	Faculty & Program coordinator at Tokyo Tech
Aug. student Workshop Participation (MISW)	optional	required	required
Certificate of Completion*	awarded upon submission of research report	awarded upon submission of research report	awarded upon submission of research report
Closing Ceremony with student oral presentation*	Yes	No	No

Summer courses for exchange students with credit*	Survival Japanese, Japan High Technology	Survival Japanese, Japan High Technology	Survival Japanese, Japan High Technology
Housing*	Apartments (shared common space)	Dormitory style accommodation	Dormitory style accommodation

A large number of corporate manufacturing facilities are located within greater Tokyo, which allows for easy access and scheduling of factory visits. Two courses were established to allow for summer students to learn basic Japanese language in case they had not studied it previously and to visit corporations as part of the summer program (High Tech Japan Course).

Since there are 29 different universities in the exchange programs as shown in Table 1, this gives the inbound exchange students, Tokyo Tech students and labs that are hosting an exchange student an opportunity to interact with peers from around the world, which is an attractive attribute for students that are interested in developing a global network of peers. On-campus housing is not available to the summer exchange students but housing is arranged for students either as single bed apartments or shared dormitory rooms (Table 2). Students in TiROP report that the shared housing provided, where kitchen, dining and living spaces are shared, provides an excellent opportunity to meet working adults and exchange information with individuals outside of academia.

3   FEEDBACK ON PROGRAMS

3.1 Student Feedback and Lessons Learned

Feedback from participating students was collected in post-exchange questionnaire, on-campus interviews, and after exchange program completion over a number of years. Despite differences in the programs noted in Table 1, the overall student comments were extremely positive for a variety of reasons because the research experience allowed them to 1) complete a self-directed research project overseas, 2) challenge themselves to adapt to cross-cultural work related experience in which English is not spoken as the native language, 3) participate in off-campus activities such as sight-seeing in Tokyo or climbing Mt. Fuji, 4) exposure to Japanese pop and traditional culture, 5) enjoy Japanese food and drink, 6) experience a harmonious research laboratory camaraderie, and 7) formation of an international network of peers (Japanese and non-Japanese). Photographs of the students at Tokyo Tech in the summer program and Tokyo Tech students during a visit to Brown Univ. are shown in Fig 2.

Returning to the second point above and the main point in the title (going to Mars) of this article, what a number of students have noted about their research and living experience is that they are intertwined into Japanese culture, which is unlike any culture they have experienced and beyond their expectation or out of this world. One student noted that although it is helpful to study the Japanese language and culture in advance of arrival, nothing can prepare one in advance for actually being embedded in a Japanese culture centric research based environment, where one is given an opportunity to undertake laboratory research, receive individual guidance from a faculty member, and expected to produce a tangible outcome at the end of the summer.

When students are asked what they have learned from their Tokyo Tech research experience the following generalized observations were reported.

1) Personal development – gains in maturity/self-confidence, time management skills, navigating and research in a non-English speaking environment

2) Professional development - research project planning, management and knowledge gained in the field of research undertaken to address an open-ended problem

3) Industrial experience – working in collaboration or on internships with industry (lab/topic dependent)

4) Knowledge about Japanese working environment, food, people, human relationships and culture

5) Undertaking research related to Japanese advanced technology/engineering (topic dependent)

6) Oral presentation skills development

7) Japanese language ability improvement (student dependent)

Fig. 1 a)2013 TiROP summer students, b)visit to a Shrine in Asakusa, Tokyo, c)lab tour at Riken, d)AOTULE 2013 summer students, e) discussions at international communication space, f)workshop poster session g) participation certificate conferment h)Tokyo Tech students visit Brown Univ. in March 2014 and meet 2013 TiROP summer participants (far right), i) TiROP closing ceremony luncheon.

Although service learning or volunteering is not part of the research exchange program, a number of exchange students travel to the Tohoku region to volunteer in the 2011 Tsunami damaged area and note this is a positive personal experience for them to see the damage and contribute to the clean-up.

So far we have yet to systemically evaluate what happens to the students after their exchange program participation but some have reportedly made use of the experience in seeking employment, scholarships and on their graduate school applications. We have also noted that some of the undergraduate students from the US universities that participate in TiROP often end up going to another TiROP partner university to graduate school (e.g. Brown to MIT, MIT to Berkeley, Minnesota to Stanford). Since many of these students stay in touch via e-mail or Facebook, they have formed or widened their global network by spending a summer at Tokyo Tech. Furthermore, to encourage Tokyo Tech undergraduate students to study abroad in the future, 10 day overseas study trips are organized to TiROP partner universities (Brown Univ., MIT, Univ. Washington-Seattle, Stanford Univ., Nanyang Tech. Univ., Univ. Melbourne and Georgia Tech) and summer exchange students are visited at their home universities that allows the Tokyo Tech students an opportunity to exchange information.

One of the most effective ways to advertise the program is for students to have a positive summer research experience and these students then return to their home university and inform their peers, who then apply for the program the following year. In this regards, it is important that the exchange student returns to an academic institution in the fall. In some cases, Tokyo Tech students network with the exchange students during the summer and then apply to be dispatched overseas to the same or to a different exchange program partner institution.

3.2 Faculty

Overall, Tokyo Tech faculty have made very favourable reports on the exchange students they supervise during the summer exchange projects (including the authors of this paper). Furthermore, the exchange students presence in some cases have been reported to change the atmosphere of the lab since the weekly seminar is switched partially or completely to holding oral presentations in English. It should be noted that hosting and advising the research exchange students is somewhat of a burden for the host faculty member particularly when hosting an undergraduate student who require greater supervision. In the case of TiROP, faculty that host students do not receive direct financial support of the exchange students' laboratory project and may feel they are "volunteering". In the case of AOTULE and SERP, faculty members receive a small allocation to cover research expenditures for the exchange student.

It has been observed that to make these exchange programs effective and also to make the partner universities staff and faculty aware of their existence, frequent overseas travel to make briefings, recruit, and negotiate/renew agreements are needed. Furthermore, supporting inbound faculty visits for stays of one month or longer also provides for greater exchange of information, cultivation of research collaborations and provides a greater depth of exchange program feedback.

3.3 Administration Staff

The above programs are basically coordinated/administered by administrative staff with faculty supervision. Close communication with overseas faculty and staff member (point of contact) is essential in order to ensure students are aware of the programs and submit their application to meet the program deadline. The primary mode of communications with the participants and overseas coordinators is by e-mail which allows personalized attention but also is time consuming.

3.4 Reflections

Hansei, is a Japanese word and cultural concept that means self-reflection and is often undertaken when things did not proceed as expected. In the TiROP summer program at the closing ceremony, we ask the students to reflect upon their summer research, what they learned and what they could have done better to make their research experience more meaningful. This also provides the program organizers an opportunity for *Hansei* as well. For example, although the research exchanges are

greatly appreciate by the participating students, the number of faculty and students at the overseas universities that are aware that the research exchange programs exist is limited. To make these programs more visible in order to attract talented students, greater effort on marketing the programs online is something to consider.

4   SUMMARY

Overall operating bilateral research exchange programs has allowed several hundreds of students' opportunities to experience undertaking research projects at Tokyo Tech or at its partner universities overseas. The true beneficiary of these programs is the student participants and they greatly appreciate the opportunity to learn by utilizing the research abroad experience as well as living abroad experience. Considering the high costs to operate research exchanges, it remains to be seen to what degree these programs can be scaled up or should lower cost alternatives be considered such as shorter programs to meet the need to dispatch and receive growing numbers of students. Based upon the knowledge and feedback gained by operating these programs, it is concluded that overseas research exchanges are an excellent vehicle to train engineering students for the global work force that they will soon enter.

5   ACKNOWLEDGMENTS

REFERENCES

[1] Tanikawa, M., "Fewer Japanese Students Studying Abroad", New York Times, Feb. 20, 2011.
http://www.nytimes.com/2011/02/21/world/asia/21iht-educLede21.html?pagewanted=all&_r=0

[2]Kakuchi, S., Boosting Foreign student numbers to 300,000, Jan 31 2014, University World News, http://www.universityworldnews.com/article.php?story=20140129160918747

[3] Tokyo Tech School of Engineering Internal Report based upon interviews with Japanese Corporations Human Resource Mangers, Feb. 2014.

[4] Nagata, K. "Firms hiring more foreign students", The Japan Times, Oct. 8, 2013, http://www.japantimes.co.jp/news/2013/10/08/national/firms-hiring-more-foreign-students/#.U3AE8igzfAk

[5] Asia Ocean Top University League on Engineering (AOTULE) website, http://www.aotule.eng.titech.ac.jp/ and AOTULE brochure, http://www.aotule.eng.titech.ac.jp/Library/AOTULE-5thAnv-brochure.pdf

[6] Cross, J.S., Kishimoto, K., Mihara, H., Hara M., (2013) Overview on the "Tokyo Institute of Technology International Research Opportunities Program (TiROP)" - Season One: 2012, Proceedings of 120th ASEE Annual Conference and Exhibition, June 23-26, 2013, Atlanta, GA, USA, Paper ID # 5856, 10 pp.

[7] John Elmes, Global Employability University Ranking 2013 puts Oxford top of the world, Oct. 13, 2013, http://www.timeshighereducation.co.uk/news/global-employability-university-ranking-2013/2008497.article

[8]The University of Tokyo Research Internship Program (UTRIP),

https://www.s.u-tokyo.ac.jp/en/utrip/archive/2013/overview/

[9] Tokyo Tech Graduate School of Engineering Research Exchanges Vol. 1, 2012 and Vol 2, 2014.