

Global Education: Development of Dual Undergraduate Engineering Programs between U.S. and Chinese Universities

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Introduction:

Engineering is becoming an increasingly global enterprise. It is common for companies to have design, development and manufacturing facilities and suppliers spread though out the entire world. In order to help engineers thrive in this environment, it is important that universities provide the opportunity for students to participate in as many culturally diverse educational experiences as possible. Many different approaches have been used by universities, including Oakland University (OU), to provide their students with opportunities to study and interact with students with different cultural backgrounds, including study abroad programs, short term exchange programs ^[1-3], international research experience programs ^[4], as well as joint degree programs or articulation agreements with international partner universities ^[5-7]. One of the advantages of the latter approach is that it provides increased opportunities for the student body at the U.S. institution to work with students from a different culture, which will be extremely valuable in their future careers as engineers.

One particularly important country is China which not only has become the world's second largest economy and a global center of manufacturing, but which also each year graduates about three times as many engineers as the United States ^[8]. Not only is China experiencing tremendous growth in the numbers of college graduates, but the number of Chinese students at U.S. colleges and universities has been growing rapidly in the past few years, increasing by more than 20% between 2011 and 2012 ^[9]. To this end, the School of Engineering and Computer Science (SECS) at Oakland University has recently developed two-plus-two (2+2) undergraduate programs and one-plus-one (1+1) graduate programs with three universities in China: Changchun University of Technology (CCUT), Beijing Information Science and Technology University (BISTU) and Beijing Jiaotong University (BJTU). In the two-plus-two programs students study for their first two years in China and then transfer to the School of Engineering

and Computer Science at OU where they finish the remaining two years of their undergraduate engineering studies. In the one-plus-one programs, students study for one year in China and then transfer to OU to finish their M.S. degrees. This is attractive to many Chinese students since Chinese universities have traditionally been strong in theory based courses, but students are then eager to study some of the more applied courses in engineering using a Western teaching style and laboratories. In this paper we report on the process that was followed to develop these joint programs and present further details about the agreement with one of the partner institutions, CCUT. We also address issues such as logistics, course mapping, cultural issues, successes and challenges. We believe that this type of information would be useful to faculty and institutions wishing to set up similar programs.

Developing Agreements:

The process of selecting partner universities for a two-plus-two or other dual degree program is a courtship requiring relationships based on trust and mutual understanding. It certainly helps if the universities are similar in size and missions. However, the most important factor is that both universities have a strong desire to provide global opportunities for their students. This has certainly been the case with Oakland University and its Chinese partner universities, CCUT, BISTU and BJTU. Prior to constructing the agreements OU has generally had some prior cooperation with the partner university such as hosting visiting scholars, joint research projects and prior teaching of courses by OU faculty at the partner university.

When developing the agreements, two different types of models were followed: The first involves students taking courses following the partner university's standard Chinese undergraduate or graduate engineering curriculum for a given discipline, transferring a portion of those courses over to OU and completing their degree at OU; this was the approach used when developing the agreements with BISTU and BJTU. The second approach involves students following a special curriculum at the partner university, heavily modeled on OU's engineering curriculum and involving more English language courses, and then transferring a portion of those courses over to OU and completing their degree at OU; this latter approach was used when developing the agreement with CCUT.

Since regardless of the model followed, the foreign students must transfer their courses to the U.S. partner university, the most important element of an undergraduate two-plus-two agreement is developing a course map for the first two years of study at the foreign partner university. This was carried out by having course descriptions sent to OU for evaluation. These descriptions are sent to the appropriate department at OU for evaluation of equivalencies. If the course is evaluated as equivalent to an OU course, it will be entered on the course map and Chinese students will be able to automatically transfer this course to OU. By comparing courses taken to those on the course map, the student will have a good idea about how many courses they will have to take at OU. If students have taken other courses outside the course map which they feel have the potential be transferred to OU, these are considered on a course by course basis. Items

contained within the one-plus-one agreements are listing of minimum number of credits to be taken at OU and a section encouraging students to perform M.S. thesis work under the supervision of both a Chinese partner faculty member and an OU faculty member.

Other items listed in both one-plus-one and two-plus-two agreements include: requirements for acceptance, description of English proficiency policy, OUs commitment to help students obtain housing and a requirement that representatives from OU and the partner university meet at least once per year to review curriculum and student progress in the programs. Given, as indicated earlier, that the partner universities were selected based on a history of prior research or teaching collaborations with OU faculty, the agreements with OU's three Chinese partner universities were generally first initiated by two of the co-authors of this paper (Professors Yang and Barber from OU), but eventually involved every level of administration of both OU and the partner universities, including the dean of SECS. The involvement of and buy-in by upper level administration at both institutions is critical to the success and approval of such programs ^[5, 10]. On average, the entire process for negotiation and signing of an agreement takes approximately six months.

Case Study – Changchun University of Technology:

OU and CCUT were seen as being ideal partners for the development of a two-plus-two program in mechanical engineering since OU lies in the Detroit Metropolitan area which is the home of the Big Three (Chrysler, Ford and General Motors) automotive research, design and development centers and CCUT is located in Changchun which is an important center of the Chinese automobile industry. Both Departments of Mechanical Engineering cooperate closely with the local automobile industries and many of the graduates go to work for automotive companies or their suppliers. The first task in the development of the two-plus-two program was the development of course mapping between CCUT and OU. Since CCUT desired that even in the first two years of study, students be exposed to Western style teaching methods, including instruction in English with texts written in English, it was decided that, to the extent possible, OU's engineering curriculum would be duplicated for the first two years of instruction at CCUT. One of the key features of the OU engineering curriculum is a lab-intensive, core engineering program that all OU engineering students take in the first two years of their studies. Chinese students enrolled in the two-plus-two program would hence take different sets of courses than students enrolled in the usual mechanical engineering program at CCUT to be more in line with the curriculum at OU and ease the course transfer procedure. To initiate this process, course outlines for OU courses taught in the first two years at OU were sent to CCUT and CCUT has modified their current courses and in some cases added new courses such as Introduction to Thermal Engineering (Thermodynamics and Heat Transfer) which match OU courses. However, as has been reported in other studies ^[11], undergraduate engineering programs in China require more course credits for graduation than U.S. engineering programs (on the order of 190 credits instead of 128-130), so CCUT students enrolled in our two-plus-two program take additional

courses every semester (including several English language courses) to satisfy the Chinese university degree requirements should they end up not transferring to OU or another U.S. university after two years.

To maximize the use of Western teaching methods in its classrooms, CCUT has sent several instructors to OU to observe teaching methods and learn additional details (such as course organization, testing, and lab assignments) about the courses they will be teaching at CCUT. In Winter 2013, three instructors (co-authors on this paper) came to OU to observe OU's Physics courses, English as a Second Language Courses and the EGR 250: Introduction to Thermal Engineering course. In summer 2013, CCUT sent additional instructors to OU to observe math courses and CAD courses (EGR 120 and ME 308). Currently, in the winter 2014 semester, several instructors are observing the EGR 240: Introduction to Electrical and Computer Engineering course and the EGR 280: Design and Analysis of Electromechanical Systems courses. A second goal of instructor visits is to enhance the English skills of the instructors so that upon return to CCUT, they can provide instruction in English. During their stay at OU, the instructors receive formalized training in English from an OU ESL instructor and informal training by introducing them to English Conversation partners. Beginning in the Winter 2014 semester, the instructors were introduced to conversation partners who are themselves studying Chinese at OU. Thus, the instructors are able to help the OU students with their study of Chinese and the OU students help the instructors with their English.

The formal two-plus-two agreement between OU and CCUT specifies that OU must teach a portion of the instruction to Chinese students at CCUT. This will generally be done during the OU summer break, after the end of the Winter semester. Fortunately, the CCUT spring semester begins about two months after the OU winter semester and hence extends into June/July, so there is no interference in the OU teaching schedule. The first OU faculty participant was Professor Laila Guessous (one of the co-authors) who taught the Introduction to Thermal Engineering course at CCUT for seven weeks during the spring/summer of 2013. Logistically this was accomplished as follows: Professor Yuan Sun visited OU from January to March 2013, to observe Professor Guessous' teaching methods and obtain information about laboratory development for the course. When Professor Sun returned to CCUT, she taught the first seven weeks of the course during April and the first part of May. Then Professor Guessous traveled to CCUT and taught the remaining seven weeks of the course. In order to assist with any potential language barriers, Professor Sun attended all of Professor Guessous' lectures at CCUT and assisted with translation of specific technical terms (such as compressor, turbine, etc.) when needed, which was particularly helpful. Professor Guessous also assisted with the development of the thermodynamics laboratories. CCUT has invested considerable resources in the development of laboratory facilities for the two-plus-two courses in an effort to mirror the hands-on lab experience that students obtain through the core curriculum course.

Every year at the beginning of the fall semester Professors Yang and Barber along with Dean Chamra have been and will continue to visit CCUT to meet the new cohort of students and their

parents and answer any questions that they may have. This is particularly important to both the students and the parents as it shows a strong commitment on the part of OU and immediately helps make them feel part of the OU community. The first cohort of CCUT students in the two-plus-two program entered CCUT in the Fall of 2012. A total of 135 students entered the program at that time and they will have the opportunity to enter OU in the fall of 2014. At this time 29 students have begun their application process and are expected to arrive at OU in the Fall 2014 semester. The remaining students will most likely stay at CCUT to finish their degree and will obtain their BSME degree from CCUT. OU will continue to support their study at CCUT in their third and fourth years of study by providing course materials and instructors who will teach at CCUT during the summers. The second cohort of 153 CCUT students entered CCUT in the Fall of 2013. The students who wish to transfer to OU will enter OU in the Fall of 2015. It is expected that a greater percentage of students from cohort 2 will transfer to OU as compared to cohort 1 since CCUT raised the English proficiency requirements for admission of students into cohort 2.

The minimum qualification of a two-plus-two CCUT student for acceptance to OU is an average grade of 70% in the first two years of study at CCUT. This qualification is stated in the formal agreement and makes it very clear to the students whether or not they will be accepted at OU. Students must also take the TOEFL exam and submit their score as part of their application materials. Students who do not meet the minimum TOEFL score of 79 for regular admission, but still have the required 70% course average, have the opportunity to come to OU as English as a Second Language(ESL) students. After the students pass their required ESL courses they are then automatically accepted into the BSME program at OU.

Successes and Challenges:

There are currently 36 students who have already transferred to OU through the various two-plus-two programs with BJTU, BISTU and CCUT and 9 students who have joined OU through the one-plus-one programs. In the summer of 2013 the first four two-plus-two students graduated and all four are currently pursuing their M.S. degrees in the USA. Overall, OU's experience with these Chinese transfer students has been very positive: they have done well in their classes, seem to have adjusted to life in the U.S. and have been able to integrate and adapt to their lab and project teams in courses that involve teamwork.

One of the challenges encountered has to do with TOEFL exam scheduling. When Chinese students are considering applying for OU, they typically want to wait as long as possible to take the TOEFL exam to maximize their score. They will often wait to see their scores before applying to OU; as a result, their applications come late in OU's application cycle, and hence put a strain on the admission process and the assignment of student housing. To help alleviate this situation, during visits to Chinese partner universities, the early submission of application materials is always emphasized.

As is the case with most U.S. universities, OU requires students to complete several General Education courses outside of their discipline. On the whole, Chinese General Education courses do not map well with the OU General Education curriculum and don't end up being transferred. This results in the students' last two years of study containing a high percentage of General Education courses, many of which are writing intensive. Discussions are ongoing with the Chinese partner schools to see if their general education courses can be modified in such a way so that at least a few of them can be transferred to OU.

Another difference between the two educational systems has to do with the weekly workload expectations in U.S. courses. In China, while students take a very heavy course load during the semester, the bulk of their final grades is determined by their final exam scores. On the other hand, at OU the students take a lighter course load with more outside time allowed and expected for homework, projects and lab reports. The Chinese students at OU have enjoyed the OU system and have generally performed very well in the classroom.

Conclusions:

The two-plus-two and one-plus-one programs between OU and its Chinese partner universities have been beneficial to all institutions involved and have provided a cross-cultural experience for students in both countries. With the increasing interest by Chinese students of pursuing undergraduate and graduate studies in the U.S., these types of programs provide them with such opportunities in a cost-effective way. The OU faculty who have participated and assisted with these programs have all come back with a greater appreciation of China, its culture and more importantly, its people, and have developed strong bonds with the faculty and administrators that they have collaborated with.

Bibliography:

1. Ronald Sterkenburg, David L. Stanley, and James E. Lampe, "The Continuing Globalization Efforts of the Purdue Aviation Technology Department, The China Experience," Proceedings of the 2003 ASEE Annual Conference and Exposition, 2003.
2. Wang, X., Barber, G., Guessous, L., Yang, L.X., Qu, G.Z., and Sethi, I., "International Learning Experience in China for Engineering Students at Oakland University," Paper # AC 2009-1282, Proceedings of the 2009 American Society for Engineering Education Annual Conference and Expo, Austin, TX, June 2009.
3. Said Abubakr and Dewei Qi, "Development of global engineering education in China for Western Michigan university engineering students," Paper # AC 2007-169, Proceedings of the 2007 ASEE Annual Conference and Exposition, 2007.
4. X. Wang, Q. Zou, L. Guessous, G.C. Barber, and M.A. Latcha, "Engaging US Engineering Students in Fuel Cell Research at a Foreign Site," Paper # AC 2013-7524, 2013 ASEE Annual Conference and Exposition, Atlanta, GA, June 2013.
5. Howell, Steven K. "A new Joint Engineering Program between Shanghai University of Engineering Science and Lawrence Technological University," Proceedings of the 2005 ASEE Annual Conference and Exposition, 2005.
6. Scott Segalewitz, "Implementing A 3 + 1 Articulation Agreement in Engineering Technology Between Universities in China and the United States," Paper # AC 2007-2559, Proceedings of the 2007 ASEE Annual Conference and Exposition, 2007.

7. Esteban Rodriguez-Marek, Min-Sung Koh, Michael Brzoska, and Claudio Talarico, "A Multinational 1+2+1 Electrical Engineering Program," Paper # AC 2010-2104, Proceedings of the 2010 ASEE Annual Conference and Exposition, 2010.
8. Council on Competitiveness, *Competitiveness Index: Where America Stands* (February 2007); accessed on February 27, 2014 at <http://www.compete.org/publications/detail/357/competitiveness-index-where-america-stands>.
9. Institute of International Education, *Open Doors@2013Report on International Educational Exchange*, Accessed on February 27, 2014 at <http://www.iie.org/~media/Files/Corporate/Open-Doors/Open-Doors-Briefing-November-2013.ashx>
10. Scott I. Segalewitz, "Seven Years of Success in Implementation of a 3 + 1 Transfer Program in Engineering Technology Between Universities in China and the United States," Proceedings of the 2013 ASEE Annual Conference and Exposition, 2013.
11. Bowman, Jerry, "A Comparison of Engineering Education in the Peoples Republic of China with Engineering Education in the United States of America," Proceedings of the 2008 ASEE Annual Conference and Exposition, 2008.

Biographical Information:

GARY BARBER: Gary Barber, Ph.D. is a professor in the department of mechanical engineering at Oakland University and is the director of the federally funded Automotive Tribology Center. He has been greatly involved with initiating and managing the 2+2 and 1+1 agreements with the partner Chinese universities.

LAILA GUESSOUS: Laila Guessous, Ph.D. is an associate professor in the department of mechanical engineering at Oakland University. Her research and teaching interests lie in the areas of fluid mechanics and heat transfer. She was the first OU faculty member to teach a course at CCUT as part of the 2+2 agreement.

LIANXIANG YANG: Lianxiang Yang, Ph.D. is a professor in the department of mechanical engineering at Oakland University and is a Fellow of SPIE. He is a world renowned expert in the areas of modern optical measuring techniques and their applications and is the recipient of several patents. He has been greatly involved with initiating and managing the 2+2 and 1+1 agreements with the partner Chinese universities.

LOUAY CHAMRA: Louay Chamra, Ph.D. is the dean of the School of Engineering and Computer Science at Oakland University and is the former director of the Micro-CHP and Bio-Fuel Center at Mississippi State University. He has been a strong advocate for the establishment of 2+2 and 1+1 agreements with partner universities in China and other countries.

YUAN SUN: Yuan Sun, Ph.D. is an instructor at Changchun University of Technology. She was among the first three CCUT faculty to visit OU and co-taught the Introduction to Thermal Engineering course to the two-plus-two students at CCUT.

LI SUN: Li Sun is an instructor at Changchun University of Technology. She was among the first three CCUT faculty to visit OU and teaches English language courses to the two-plus-two students at CCUT.

LIJING SUN: Lijing Sun is an instructor at Changchun University of Technology. She was among the first three CCUT faculty to visit OU and teaches Physics courses to the two-plus-two students at CCUT.

HUIQING LAN: Huiqing Lan, Ph.D. is an associate professor in the department of mechanical engineering at Beijing Jiaotong University. Her research area is molecular dynamics and she has taught courses in the international program at BJTU.