THE INTERNATIONAL COOPERATION OF ENGINEERING EDUCATION IN TAIWAN

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Abstract

The objective of the present article is to give a brief overview on the international cooperation of engineering education in Taiwan. The scope and different types of existing international cooperation programs are outlined from various perspectives. The role of government funding agency – National Science Council (NSC), as well as its supporting mechanism to enhance international cooperation is described. Readers who are interested in future collaboration with NSC may get more comprehensive information from the official website of NSC (http://www.nsc.gov.tw) and its science liaison officers. Despite the fact that the first author served as the director general for the International Cooperation Department of NSC between 03/1999 to 02/2001, and some of the comments and recommendations are made based on his administrative experience, the opinions and suggestions appearing in this paper are the authors’ own, and should not to be considered as representing those of NSC.

Introduction

Due to the global competition and the subsequent industry restructuring, engineering practice today has changed dramatically. The rapid changes of technology due to the advancement of internet applications can be daunting to engineering educators. Unable to predict so volatile a future, we nonetheless have to decide about what to teach engineers and how to prepare them for an increasingly international workplace without compromising the hard-won quality of education programs.

The main purpose of engineering education is to provide engineering graduates with knowledge, skills and attitudes, which will enable them to practice their profession with competence and confidence. There are various reports and survey concerning the generic attributes of an engineering graduates\textsuperscript{1, 2} in the new millennium. Although the research methodologies and conducting agencies are different, the major attributes found are more or less the
same as ABET EC2000. These attributes include:

- Ability to practice engineering
- Apply knowledge (math, science and engineering)
- Design and conduct experiments
- Design systems, components, or processes
- Function in multidisciplinary teams
- Identify, formulate, and solve problems
- Understand professional and ethical responsibilities
- Communicate effectively
- Understand global impact and societal context
- Ready for long-life learning
- Knowledge of contemporary issues

In order to foster these characteristics in engineering programs, the reform of engineering education in Taiwan has been extensive in the last ten years. Major efforts include the restructuring of pedagogy and of curriculum, as well as the creation of a student population with more diverse cultural backgrounds. Among these reform strategies, international cooperation has been a major one. The academia and the government have recognized the importance and the emergence of international cooperation and believe that such cooperation can not only enhance the advancement of science, but also provide the students with a multicultural learning environment and multinational vision. In the 6th scientific and technological development meeting of Taiwan, a series of recommendations emerged to require the government to adopt several strategies to develop science and technology for the next 10 years. A strong consensus was reached during that meeting to promote international cooperation. The objective of this article, accordingly, is to provide an overview on the current status of international cooperation in engineering education in Taiwan, which may be beneficial to those who are willing to broaden their connections in this field across the nation border.

**Background**

One of the key factors that enable Taiwan to evolve from a developing country into a developed country is the success of the education system. Chang gave a general introduction to the education system in Taiwan and many programs in education reform have been conducted recently. Among these reforms, the international cooperation has received extensive attention from the academia and the government. There are many ways to conduct international cooperation such as personnel exchanges, participating in conferences, holding seminars and working on joint research projects. The people involved in these activities could range from undergraduate students, graduate students to faculty members. Among all these activities, personnel exchange is probably the easiest and most popular program to implement. For most universities in Taiwan, establishing the so-called “sister university” around the
world is a way to promote international cooperation. The alliance will result in, mostly, student exchanges and advantages such as:

1. The development of those not necessarily learned in traditional education-like initiative, responsibility and a developed sense of inquisitiveness.
2. A command of a host country’s language.
3. Knowledge of the studying and teaching techniques used in other countries.
4. Access to a greater amount of resources.
5. Obtaining another academic qualification or a certificate of attendance, which will improve his/her resume.

Although the number of faculty members participating in these exchanges is not as significant as that for the students, the purpose of faculty exchanges is mainly to share their expertise with students who have different cultural backgrounds and it will conversely stimulate their teaching techniques, which coincides with the proverb “Learning while Teaching”. Establishing a long-term international partnership is a time consuming process that requires extensive contacts between scholars, therefore personnel exchanges are a common channel with which to build up the initial connection. Most of these visits are short-term and aimed to explore the possibility for further cooperation.

Holding seminars and participating in international conference are other channels for researchers to exchange their views and share respective experiences. According to the statistics of NSC shown in Figure 1, the number of participants at international conference sponsored by NSC is increasing every year and the demand is about twice as much as NSC can offer.

![Figure 1. The number of participant to international conferences sponsored by NSC](image)

Another statistic shown in Figure 2 is the international conferences held in Taiwan in recent years. Figure 3 shows the classification of the conferences held in Year 2004 according to academic discipline.
Although there are more conferences in the area of humanities and social sciences than those on other disciplines according to the statistics, the conferences in the area of engineering, natural science and life science have more participants and more papers are presented. To initiate a major conference in a specific area such as engineering education is also quite common in promoting international cooperation. In order to help advance engineering education and research around the world through international linkages and cooperative partnerships, the International Conference on Engineering Education (ICEE) was organized as an information dissemination and exchange forum for engineering instructor and was first held in Taipei in 1994 and then in 1995. Following the outcome of these two conferences, the ICEE of 1997 was held in Chicago and expanded into a two part format: a traditional 2-3 day conference followed by a 1-2 day international workshop to discuss future cross-regional collaboration efforts in education and research. The participants of the workshop in 1997 included educators from Brazil, Taiwan and the United States. As a result a resolution passed at the February 2, 2000 meeting of the
International Steering Committee of the ICEE, and the International Network for Engineering Education and Research (iNEER) was formed. The goal of iNEER is to enhance the value and concept of ICEE, by enabling and promoting further progress in education and research through international partnership and information exchanges. With the help of an international network of experts from industry, academia and governments, the iNEER initiated a long-term interaction (including personnel exchange) and broadly defined cooperative agreements such as the four agreements signed at ICEE-2000. Academic institutions from Taiwan, U.S.A. and the Czech Republic were the first groups to engage in these agreements.

The same trend observed in these statistics is that the need for international cooperation is increasing and the support from the funding agency is critical to ensure future development. On the other hand, disseminating the outcomes of these cooperative activities more efficiently is another challenge for those collaborators. Developing joint research projects is not the ultimate goal of international cooperation, however, it is definitely an effective way to enhance academic performance from the research point of view. They involve long-term and in-depth discussions between researchers and provide different training experiences that supplement the class education for participating students. The difficulty in implementing international research projects, nevertheless, is also far greater than for the other activities. Among the over ten thousand research projects supported by NSC annually, international research projects account for less than one percent. The statistic shown in Figure 4 is the international research projects supported by NSC in recent years.

![Figure 4. The number of international research projects in in recent years](image_url)

The number of the research projects in the area of engineering education in recent years is shown in Figure 5. In comparison with the overall sponsored projects, it seems that engineering education has lots of space to grow both
locally and internationally. One of the factors that limit the growth in the number of research projects in engineering education is probably the research funding policy of NSC. Since NSC encourages the researchers to focus on a single project with sufficient resources instead of engaging in a number of projects with diversified topics, the researchers tend to prioritize their interests in research that puts engineering education in a weak position.

The Ministry of Education (MOE) also supports several projects concerning education reform and the improvement of engineering curriculum. The focus of these projects is mainly education-oriented and projects in key areas such as precision machinery, air-space technology, material science, communication technology, VLSI, disaster mitigation and mechatronics are all in progress currently. Holding contests is another way to encourage students to participate in engineering related activities. These contests not only can foster their professional techniques but also stimulate creativity and the ability to work together. Therefore both MOE and NSC have held many contests in certain fields to promote engineering education in recent years that receive great response from the students as well as the faculty members.

**Bilateral programs of the government**

The role of the government is to establish solid infrastructure and to provide efficient resources for the development of science and technology. Both ministries, MOE and NSC, share responsibility in the reform of engineering education. As mentioned earlier, MOE is mainly focused on the improvement of existing educational programs. On the other hand, the programs supported by NSC are research oriented and the goal of these programs is mainly to enhance academic excellence that is supplemental to the programs supported by MOE. In order to coordinate these programs and dispense the resources more efficiently, both ministries hold meetings constantly to

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*Figure 5. The number of research projects in the area of engineering education in recent years.*

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integrate the related programs and to cooperate with each other.

Full recognition of the importance of international affairs has also been given by both ministries. Each ministry establishes its own division in charge of international cooperation and provides certain common programs to promote activities as mentioned earlier such as attending international conferences, holding international conferences in Taiwan and providing long-term or short-term visits for foreign scholars. In Year 2000’s overall international mobility expenditure (excluding the research project funding) in NSC, 60% of the expenditure is devoted to these programs. The rest of the expenditure is focused on bilateral cooperation and mission oriented programs.

Establishing the relationship between NSC and other similar foreign agencies (based on a memorandum of understanding (MOU)) is a very effective way to implement international cooperation. There are over 50 MOU, which have been signed in the last 20 years. These partners of the NSC range from funding agencies such as the NSF of U.S.A., the NRC of Canada, the DAAD and the DFG of Germany to government ministries like the Ministry of Education of Latvia and of Lithuania. Besides some specific features for different partners, most of the MOU illustrates the common interests of promoting bilateral cooperation between the two sides and require both sides to initiate certain programs to enhance bilateral mobility. These programs can also be classified into three categories such as engaging bilateral personnel exchanges, holding bilateral seminars and conducting joint bilateral research projects.

Since the bilateral relationship is basically reciprocal and leads to mutual benefits, the personnel exchange programs under this channel are more specific and mission oriented compared with the three application type programs. One of the examples is the project based personnel exchange programs (PPP) between NSC and DAAD. Both agencies jointly support approximately 20 research groups, which include researchers and graduate students to conduct research projects in Taiwan and Germany alternatively for a period of two years. The prerequisite for this program is for the research groups to accommodate the researchers from both countries and be reviewed jointly. The summer institute in Taiwan was originally a bilateral program between NSF and NSC in which it sponsored 10 to 15 graduate students from the USA to work in the laboratories in Taiwan during the summer time. Since it received overwhelming responses from the students, this programs will be expanded to become a multinational program so that more foreign graduate students can start to build up his/her research experience in Taiwan and this experience will definitely play an important role in future international cooperation.

Bilateral seminars are an efficient means to initiate international cooperation especially for a group of researchers who are not known to each other. They can use this activity to share their research results and experiences and, hopefully, evolve into further cooperation in a different format. Figure 6 shows the number of bilateral seminars held in recent years. There were 60 bilateral seminars held in Year 2004 and the distribution of
these seminars according to the academic classification is shown in Figure 7. The participants in each bilateral seminar are approximately 10 researchers from each side and the organizers as well as the theme of the seminars identified jointly by NSC and its partners based on the MOU in most of these cases. However, there are some bilateral seminars which require an application instead of the top down approach.

![Figure 6. The number of bilateral seminars in recent years.](image)

![Figure 7. The distribution of bilateral seminars in Year 2004 according to academic discipline](image)

Among the 128 international research projects in 2004 mentioned above, 83 projects are jointly approved and funded by NSC and its partners. Most of these bilateral research projects are multi-year and involve a close link between the research teams. Although the process of cultivating bilateral research projects is not very easy, the outcome is most fruitful and rewarding in comparison with other activities. In order to maintain the existing bilateral relationships and to explore the new opportunities of cooperation, the NSC set up 14 science liaison offices around the world and the MOE also establish more than 20 cultural divisions to provide global services for students as well as scholars. These overseas offices are invaluable resources in the necessary assistance to those who would like to
Future collaborative models

Although the importance of international cooperation is well recognized, most of the activities are conducted privately and do not completely reflect the statistics provided by the government. One of the reasons is the progression of the Internet, which enables cooperation across the border more easily. Consequently, the need to seek support from funding agencies is diminishing. Another reason might be the inflexibility of the mechanism, which limits the suitability for those who apply for it. Nevertheless, the role of government should always be to try to allocate suitable resources and provide various programs to facilitate international cooperation. On the other hand, the scholars as well as researchers should utilize those programs effectively to bring these advantages into our society through cooperation.

As mentioned earlier, the activities of international cooperation can be classified into three categories: personal exchanges, holding seminars/participating conferences, and conducting research projects. Although these activities don’t necessarily act in any sequence, coordinating these activities closely improves the dissemination of the results of international cooperation. Building up individual connection through personnel exchange and then progressing into cooperation of researchers to reach consensus for further collaboration is the most common collaborative model for most researchers. However, for an integrated proposal in which more researchers like to participate, a seminar which aims to consolidate research ideas collectively instead of present research results is probably a better starting point for collaboration. This can be seen, especially, in many advantageous and popular topics such as bio-technology, communication technology and nano-material.

Some of the research projects require the establishment of large research facilities such as synchrotron radiation accelerator or particle collider. Since this kind of facility involves the investment of large amount of costs and numerous researchers, international cooperation becomes the best resolution consequently. The CERN in Switzerland is a typical example of this kind cooperation. The participation of such research project can generate the mobility program of researchers as well as graduate students and the objective of a subsequent seminar is then mainly exchanging research experiences and discussing the scientific findings.

Conclusions

Internationalizing engineering education has been discussed intensively in recent years. The global economic market allows products, services, and work forces to cross the border between nations with minimum hindrance. A brief overview on the current situation of international cooperation in Taiwan is described and the statistics provided by government show the trend of enhancing international cooperation is fully realized and therefore, an increase in
international academic activities was recently observed. The governmental support is critical in developing international cooperation and hence, several major subsidiary programs as well as bilateral cooperation based on MOU were also outlined. Although engineering education has received attention from both scholars and government in recent years, most activity concentrated on local research projects, while international cooperation was still limited in the formality of sharing experiences and presenting research results. The possible collaboration model for future cooperation was briefly discussed and hopefully, the information can be useful for those researchers who might engage in international cooperation with Taiwan’s colleagues. By expanding the spectrum and variety of our cooperation, we can not only improve the quality and relevance of engineering education, but also increasingly assist engineering education programs in other countries who strive for goals similar to our own.

References


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