

Accreditation of Engineering Education for the Master's Degree Programs in Taiwan

Mandy Liu¹, Pei-Fen Chang², Yeong-Bin Yang³, Suh-Yin Lee⁴

Abstract - Institute of Engineering Education Taiwan (IEET) has launched accreditation of engineering education for the Bachelor's degree level since 2004, and beginning in 2007, it will introduce accreditation for the Master's degree level. This paper is to discuss the following three areas: (1) international trend on accreditation of engineering education at the Master's degree level, (2) rationale for accreditation at the Master's degree in Taiwan, and (3) accreditation criteria for accrediting Master's degree of education. Accreditation of engineering education worldwide is mostly focused on the Bachelor's degree level, but in recent years, many countries have ignited effort to conduct accreditation at the Master's degree. Among the signatories of the Washington Accord, JABEE (Japan), ASIIN (Germany), and Engineers Ireland (Ireland) are the pioneers. In the USA, the National Academy of Engineering (NAE) has called ABET, Inc. to look into this new area. There is an urgency for accreditation of engineering education at the Master's degree level in Taiwan. One of the reasons is that a high proportion of college graduates enroll at the Master's degree level of education which naturally causes the need to have a mechanism to assure high quality of education for the benefit of the public. In the meantime, the focal point of accrediting Master's degree level of education is the program's motivation to integrate continuous improvement mechanism for both the undergraduate and graduate levels of education. In order to implement accreditation for the Master's degree level, IEET has published *Accreditation Criteria 2004⁺* (AC2004⁺), which is an expansion of the previous set of criteria for accrediting Bachelor's degree level, AC2004. AC2004⁺ is based on the notion that Master's degree education is built on the Bachelor's degree, but with more specialized training and in-depth knowledge. Through AC2004⁺, IEET is to help programs validating their own objectives.

Index Terms - Accreditation, Master's Degree, Taiwan

Accreditation of engineering education in Taiwan serves as a quality assurance system in Taiwan. It is a system to review program outcomes by paying attention to the quality of teaching and student outcomes. Despite the fact that the Ministry of Education (MOE) has conducted a program evaluation system to review all higher education programs in Taiwan over the past thirty years, the evaluation system has limited effects on improving the educational programs in

terms of student outcomes and program improvement. However, it continues to serve as a reference agent for the distribution of government resources to higher education programs. Meanwhile, the system is expected to provide ranking information among the education programs, but the ranking information never seems to be satisfactory to all. The top programs will always remain on the top, and at the most, in different order. Those programs that ranked less fair will eventually lose confidence and resources.

Accreditation for engineering programs in Taiwan offers a different mechanism of reviewing educational programs. It adopts an "outcomes-based" approach to emphasize teaching and student outcomes. Educational programs are required to identify their objectives and the process of accreditation is to review the extent to which a program fulfills its own objectives. In the meantime, programs are required to continue to improve itself as a way to assure their quality and to be accountable to their own constituents.

Institute of Engineering Education Taiwan (IEET) was established in 2003 to develop and administer accreditation of engineering programs in Taiwan. IEET launched accreditation for Bachelor's degree programs in 2004 and over the past three years, IEET has accredited about 2/5 of the total programs in Taiwan. Coupled with the number of programs under review in 2007-2008, the proportion of engineering programs participated in IEET accreditation will reach above 40%. This is a significant statistics, because it shows that engineering programs in Taiwan have gradually recognized and accepted the values of accreditation.

Accreditation for engineering education among the Washington Accord signatories has been focused on the Bachelor's degree level, because the Bachelor's degree level is seen as the first entry level to professional practice of engineering. However, accreditation at the Master's degree level has emerged out of different reasons among the signatories, namely Engineers Ireland and JABEE. ASIIN, a provisional signatory of the Washington Accord, has also launched accreditation for the Master's degree level.

IEET will launch accreditation for the Master's degree program beginning in 2007. This new development was ignited by the demand to assure Master's degree programs in Taiwan in light of a high proportion of students entering post-graduate level of education and the mushrooming of Master's degree programs in Taiwan.

The guiding question of this paper is: How does IEET go about conducting accreditation of engineering education at the Master's degree level? This paper is to focus on the following three elements: (1) international trend on

¹ Mandy Liu, Institute of Engineering Education Taiwan, mandyliu@ieet.org.tw

² Pei-Fen Chang, National Central University, pfchang@ncu.edu.tw

³ Yeong-Bin Yang, National Taiwan University, ybyang@ntu.edu.tw

⁴ Suh-Yin Lee, National Chiao Tung University, sylee@nctu.edu.tw

accreditation of engineering education at the Master's degree of education, (2) rationale for accreditation at the Master's degree of education in Taiwan, and (3) accreditation criteria for accrediting Master's degree of education.

INTERNATIONAL TREND ON ACCREDITATION OF ENGINEERING EDUCATION AT THE MASTER'S DEGREE OF EDUCATION

Washington Accord is an agreement among signatories for the recognition of equivalency of accredited engineering education programs leading to the engineering degree. As of May 2007, there are 10 signatories and 4 provisional signatories in the Washington Accord:

#	Organization	Represent
1	ABET	USA
2	CEAB/Engineers Canada	Canada
3	Engineering Council South Africa	S. Africa
4	Engineering Council UK	UK
5	Engineers Australia	Australia
6	Engineers Ireland	Ireland
7	Hong Kong Institution of Engineers	Hong Kong
8	Institution of Engineers Singapore	Singapore
9	Engineers New Zealand	New Zealand
10	Japan Accreditation Board for Engineering Education	Japan
11	ASIIN*	Germany
12	EACM*	Malaysia
13	ABEEK*	Korea
14	IEET*	Chinese Taipei

Note: * Provisional Signatories.

TABLE 1
LIST OF FULL AND PROVISIONAL SIGNATORIES IN THE WASHINGTON ACCORD.

Most of the signatories in the Washington Accord recognize accreditation on engineering programs leading to the Bachelor's degree, which is considered as the first degree entering the engineering profession. In recent years, however, several full and provisional signatories are extending accreditation to the Master's degree programs. JABEE, Engineers Ireland, ASIIN, and IEET are examples.

In accordance with the precepts of the Bologna Declaration of 2001, the "New Structure for Engineering Education in Ireland"^[1], proposed by Engineers Ireland in 2003, envisages that educational standards for the title of Chartered Engineer will move from being an accredited honors Bachelor of Engineering degree to an accredited Master degree in engineering by 2013. As to the structure of Master's degree programs, universities have the discrepancies to decide upon their own individual needs. Educational standard required for the title Chartered Engineer stipulated by Engineers Ireland is the following:

- (a) The educational standard required for the title of Chartered Engineer is as exemplified by a degree in engineering approved by the Council of Engineers Ireland.
- (b) Each candidate for election or transfer to the title of Chartered Engineer shall possess one of the following qualifications:

- (i) A degree in engineering approved by the Council of Engineers Ireland as satisfying the educational standard for the title of Chartered Engineer;
- (ii) The Postgraduate Diploma of Engineers Ireland;
- (iii) An engineering qualification which Engineers Ireland, through an international agreement, recognizes as satisfying the educational standard for the title of Chartered Engineer;
- (iv) Other engineering qualifications deemed by the Council of Engineers Ireland to satisfy the educational standard for the title of Chartered Engineer.

The Accreditation Agency for Degree Programs in Engineering, Informatics, the Natural Sciences and Mathematics (ASIIN) is an independent accreditation agency in Germany. The goal of ASIIN's accreditation activities is to ensure high standards of teaching and study and the equivalency of education^[2]. ASIIN's procedures thus also consider whether the competencies imparted by the degree programs meet the requirements of the European qualification framework. The subjects of accreditation of ASIIN include consecutive degree programs that lead to a Bachelor's followed by a Master's degree, individual Bachelor's and non-consecutive Master's degree programs, and Master's degree programs providing further education.

Specific requirements for the Master's degree programs include (1) deepened specialist and interdisciplinary knowledge and/or broadened this knowledge through further methodological and analytical approaches, (2) ability to formulate solutions to complex problems and tasks, (3) skills of recognizing future problems, technologies and scientific developments, (4) ability to work independently and scientifically, and to organize, carry out and lead more complex projects, and (5) ability to assume leadership responsibilities.

JABEE is perhaps one of the first in Asia to contemplate accreditation of Master's degree program in engineering education. For the time being, JABEE is piloting its criteria, which will not be released until later. Since Japan and Taiwan are in many ways similar when it comes to culture and educational systems, we suspect that the reasons for both to extend accreditation to the Master's degree programs are somewhat similar.

In addition to Ireland, Germany, and Japan, the National Academy of Engineering (NAE) in the USA has made the following recommendations relating to accreditation of engineering programs in *Educating the Engineer of 2020*^[3]:

- (a) The B.S. degree should be considered as "pre-engineering" or "engineer in training" degree.
- (b) Engineering programs should be accredited at both the B.S. and M.S. levels, so that the M.S. degree can be recognized as the engineering "professional" degree.

The above two points indicate clearly that having a Master's degree will become quite important if one is to enter the engineering profession in the next few years.

From the experiences stated above from Ireland, Germany, Japan, and the USA, we can see that accreditation

of the Master's degree programs will be the next level of development in accreditation of engineering education worldwide.

RATIONALE FOR ACCREDITATION AT THE MASTER'S DEGREE OF EDUCATION IN TAIWAN

IEET has been administering accreditation of four-year college degree programs since 2004. By 2007, 230 programs, or approximately 46% of all programs, in Taiwan have participated in IEET accreditation. As mentioned above, this is a significant statistics because it indicates not only a rapid growth in the interest and confidence in accreditation in Taiwan, but also the high demand for accreditation.

Starting from academic year 2007, IEET will launch accreditation for the Master's degree for three primary purposes. First of all, there is a high percentage of college graduates continue education for a Master's degree, and quality assurance of these programs become an issue. Second, Bachelor's and Master's degree programs must be integrated together under accreditation so the continuous improvement system can be operated seamlessly. Third, the government has granted IEET accredited programs waivers to implement program evaluation. As a result, if one program requests accreditation for both levels, it does not need to be reviewed again by the Ministry of Education.

With the expansion of colleges and universities, college student population has gone up several times. This dramatic increase is also reflected in the engineering field, which will affect the supply and demand of the engineering labor force. Over the past decade, the numbers of Bachelor's degree enrollment and graduates in engineering programs have increased nearly fourfold. Similar levels of growth also occurred at the Master's and doctoral degree levels. Figure 1 shows a significant increase from 39,014 in 1990 to 193,752 in 2005 in the enrollment of Bachelor's degree engineering programs in universities. Surpassing this level of growth, the number of Master's degree level students has gone up from 5,618 to 35,544 during the same period.

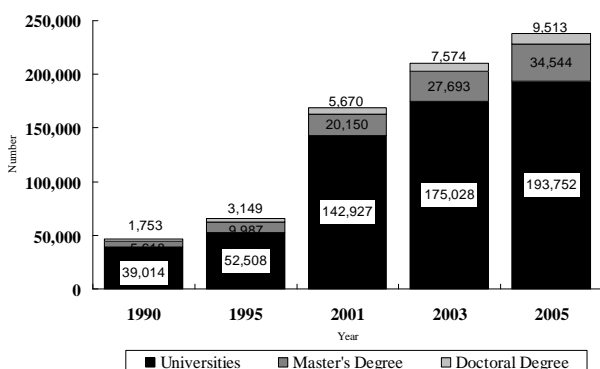


FIGURE 1
STUDENT ENROLLMENT IN ENGINEERING PROGRAMS BY DEGREE, 1990-2005.

Engineering program is among the highest growth of all professionals. Government researchers predicted that supply of labor force in the science and technology sector will exceed demand by more than 15,000 in the next few years. The growth rate in the supply of engineers is among the

highest of all sectors of professionals. In particular, the growth rate in bio-science engineering will be the most extraordinary. This growth reflects in the business sector, as well as in the supply of instructional staff in higher education institutions. Civil engineering is likely to have a surplus of labor force, whereas the supply of workforce in information engineering, engineering design, industrial engineering, materials engineering will fall short.

Along with the expansion of student enrollment in engineering programs in higher education, the number of graduates has undergone tremendous growth accordingly. Figure 2 shows the number of graduates in engineering programs in the university level has gone up from 8,474 in 1990 to 46,852, and the Master's level of graduates from 2,382 to 11,610 from 1990 to 2005.

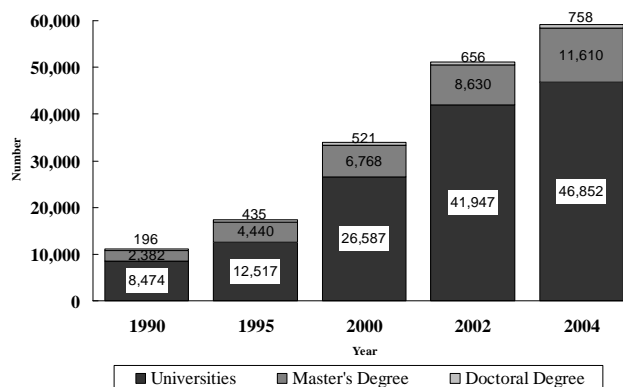


FIGURE 4
NUMBER OF GRADUATES IN ENGINEERING PROGRAMS BY DEGREE, 1990-2004.

The reasons for high proportion of college graduates attending Master's degree programs are two-fold, one is a more cultural and social factor, and the other is naturally economical. Desire for learning and higher degree of education is an inherited quality within the Chinese culture. Coupled with the current economy in Taiwan, as many other economies in the world, which is moving toward knowledge-based economy, and as a result, its demand for workforce with advanced degree is strong. The salary difference between a Bachelor's degree holder and a Master's degree holder is also another reason for college graduates to pursue an advanced degree.

In light of the high percentage of college graduates entering Master's degree programs and the growing number of Master's degree programs, accreditation is gaining importance because it is a system to ensure quality of the educational programs. Many people worry that quality of the advanced degree program will eventually suffer due to the quality of entering students. In order to ensure that Master's degree programs in Taiwan continue to produce competent graduates who will qualify for the professional engineering positions, accreditation must be extended to the Master's degree level.

From the IEET's standpoint, we strongly encourage engineering programs requesting accreditation for both the Bachelor's and Master's degree levels. As presented at the outset, the accreditation for engineering programs in Taiwan serves primarily as a quality assurance system. One of the most important elements in such a quality assurance system

is continuous improvement. Therefore, IEET hopes that an individual engineering program institutionalizes the continuous improvement system throughout its entire program. By doing this, the engineering program is to show that it is determined to provide a quality education and to be accountable to its constituents.

The Ministry of Education has issued a policy to grant IEET accredited programs waivers to participate in the government-initiated program evaluation. Should a program be accredited by IEET at both the Bachelor's and Master's degree levels, it does not need to be reviewed by the government again. It is quite satisfactory to learn that growing number of programs have chosen IEET over the government agencies for a quality control mechanism.

ACCREDITATION CRITERIA FOR ACCREDITING MASTER'S DEGREE OF EDUCATION

In order to launch accreditation for the Master's degree, usually two-year programs, IEET released *Accreditation Criteria 2004⁺ (AC2004⁺)*^[4] in January 2007. AC2004⁺ has nine criteria, the first eight are for accreditation for the Bachelor's degree programs, and the ninth is for that of the Master's degree programs.

The primary purpose of accreditation of Master's degree programs remains to be on program outcomes, especially in the area of teaching. Despite the fact that research is a major activity in post-graduate level, accreditation of Master's degree programs is to ensure not only that these programs place education in a high priority, but also that their graduates possess a certain level of competencies. As a result, the ninth criterion of AC2004⁺ is still predominantly focused on education aspects. Given that, it also requires the programs under review to provide an environment conducive to research activities. Interaction between Master's degree students and faculty advisors is also an important indicator.

Master's degree education is considered as an extension of the Bachelor's degree and with a more focused specialization and depth of knowledge. Therefore, Master's degree programs are required to meet the criteria for Bachelor's degree; in addition, the advanced degree programs must:

- Have appropriate admission policies.
- Emphasis the interactions between faculty advisors and graduate students.
- Graduates of these programs must possess the following:
 - Knowledge in specialized field.
 - Ability to organize and conduct research on a special topic.
 - Ability to write journal papers.
 - Ability to do innovative thinking and independent problem solving.
 - Ability to work in an interdisciplinary setting.
 - An international worldview.
 - Ability in leadership, management, and organization.
 - Ability for life-long learning.

- Must organize appropriate curriculum to meet the students' needs to development in specialized field.
- Faculty members must be engaged in basic or applied research, publications and conference activities.
- Space and facilities must have the capacity to meet the research needs.

As presented above, IEET's AC2004⁺ has clear expectations on the Master's degree programs, and IEET will require programs under review to provide appropriate data to demonstrate that they fulfill these requirements. usua

CONCLUSION

The purpose of this paper is to discuss accreditation of Master's degree programs in education in Taiwan. It briefly presented development in this area in Ireland, Germany, Japan, and the USA. In the meantime, it shows the rationale of accreditation of Master's degree programs in Taiwan. Finally, this paper discussed the ninth criterion of IEET's AC2004⁺, which was developed to review Master's degree programs.

Accreditation of Master's degree programs is still in early stage of development in Taiwan. There are many challenges ahead; some people, for example, who view Master's degree education as heavily involved in research, hence have reservations on the standpoint of accreditation, which places attention on the teaching aspects of education. However, the worldwide trend seems to indicate that accreditation for the Master's degree program is a must in light of the future development of the engineering profession. As a result, IEET continues to work with programs to reinforce the values and purpose of accreditation and to share its experiences with its counterparts in other parts of the world.

REFERENCES

- [1] Accreditation Criteria for Master Degree Programmes in Engineering. <http://www.engineersireland.ie/Home/docs/MastersAccred.pdf>
- [2] Requirements and Procedural Principles for the Accreditation of Bachelor's and Master's Degree Programmes in Engineering, Architecture, Informatics, the Natural Sciences and Mathematics. http://www.asiin.de/english/download/ASIIN_Requirements_2006-12-08.pdf
- [3] National Academy of Engineering, Educating the Engineer of 2020: Adapting Engineering Education to the New Century. p.2.
- [4] Institute of Engineering Education Taiwan. Accreditation Criteria 2004+. <http://www.ieet.org.tw/english/acccri/acccri2004.htm>