Development and Management of Burapha University's Industrial Engineering Undergraduate Program to Meet International Requirements
การพัฒนาและการจัดการการผลิตบัณฑิตวิศวกรรมอุตสาหการ มหาวิทยาลัยบูรพาสู่ระดับนานาชาติ

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ABSTRACT

This research aims to study the desirable features of international engineers, and use them as a guide in developing an industrial engineering undergraduate program, Burapha University, to meet international requirements. From the questionnaires, the major desirable features were found to be as follows. Knowledge: Engineering subjects and English. Skills: Team working and creative thinking. Characteristics: On time and continuous improvement of working potential. Teaching and learning's opinions of Industrial engineering students were also surveyed. The information showed that the practical sectors and discussions of learning subject are important to stimulate students' interests and more understanding than listen to lecture. The skillful teachers are important too. In developing industrial engineering undergraduate program, so that the graduates meet international requirement, it is essential to develop the teaching and learning techniques, as well as activities inside and outside the classroom that encourage students.

บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาคุณลักษณะพึงประสงค์ของวิศวกรระดับนานาชาติ เพื่อนำมาเป็นแนวทางพัฒนาในการผลิตบัณฑิตวิศวกรรมอุตสาหการปริญญาตรีมหาวิทยาลัยบูรพาสู่ระดับนานาชาติ โดยใช้แบบสอบถาม พบว่าคุณลักษณะพึงประสงค์สำคัญที่ต้องการ ด้านความรู้ ได้แก่ วิศวกรรมเฉพาะทาง ภาษาอังกฤษ ด้านทักษะได้แก่ การทำงานเป็นทีม ความคิดสร้างสรรค์ ด้านประพฤติได้แก่ การตรงต่อเวลา การพัฒนาศักยภาพการทำงานของตนเองอย่างต่อเนื่อง สอบถามความคิดเห็นของนิสิตต่อการเรียนการสอน พบว่าการเรียนภาคปฏิบัติและการอภิปรายเรื่องที่เรียนมีความสำคัญมากในการกระตุ้นความสนใจและได้รับความเข้าใจมากกว่าการฟังการ

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บรรยาย ความชำนาญในการสอนของครูก็มีความสำคัญ ดังนั้นการพัฒนาการผลิตบัณฑิตวิศวกรรมอุตสาหการให้มีคุณลักษณะสู่ระดับนานาชาติได้ จำเป็นต้องมีการพัฒนาเทคนิคการเรียนการสอน รวมถึงกิจกรรมทั้งในและนอกห้องเรียนที่สามารถกระตุ้นความสนใจเรียนของผู้เรียน

Key Words: Development, Industrial Engineering, International requirements
คำสำคัญ: การพัฒนา วิศวกรรมอุตสาหการ ระดับนานาชาติ

Introduction

The framework of economic cooperation in human resource development of countries in the APEC area (Asia Pacific Economic Corporation, 21 countries) has the primary purpose to create equality comparable in the practice of multinational independent. In the first phase, it will focus on the engineering profession in the form of APEC Engineer and had member countries signed an APEC Engineer's agreement at the meeting in Sydney, Australia, November 2000. APEC has a memorandum of cooperation to improve the quality and standards of engineering education, called the Washington Accord, which are evaluated based on achievement of the principles of the ABET (Accreditation Broad for Engineering and Technology). [1]

ASEAN (Association of South East Asian Nations, 10 countries) have agreed to establish the AFTA (ASEAN Free Trade Area) in 1992. ASEAN Summit in Bali, 2003, which approved the proposal of cooperation in trade and services, and agrees together on the Mutual Recognition Arrangements (MRA). The major professionals, including engineering, architecture, nursing and accountancy, completed by the year 2008, to facilitate movement of professionals, skilled workers and specific ability persons. ASEAN have signed an agreement to share of engineering services in the 11st ASEAN Summit on December 12-14, 2005. So the engineering profession has taken the first agreements in the MRA, named ASEAN Chartered Professional Engineer. [2]

General criteria for Industrial Engineering program must demonstrate that graduates have the ability to design, develop, implement, and improve integrated systems that include people, materials, information, equipment and energy. The program must include in-depth instruction to accomplish the integration of systems using appropriate analytical, computational, and experimental practices. [3] In industry sector, the critical humanity and social characteristics of Industrial Engineer needed are as follows: responsibility, discipline, diligence integrity and punctuality. The second rank is good personality, ability to communicate with others. The third rank is the ability to use computer programs including Microsoft Office programs, ability to use English to communicate and work. [4] Also the newly graduates that private enterprises are expected to have professional knowledge,

including foreign language and IT. [5] However, for engineers to work in APEC and ASEAN, the knowledge in Engineering and Science subjects has relatively well. Engineering practical skills should improve. English skills have to seriously improve. Humanity and Social; discipline, respect to rules / regulation, ethics and punctuality are specially improved. [6]

Thailand which signed both agreements in the APEC and ASEAN need to follow the agreement. Therefore, it is required to prepare the institutions that produce engineers to have the potential to produce engineers which are up to international standard.

This is why the research has aimed to study the desirable features of international engineers that can be used as a guide in the development of industrial engineering undergraduate educational program, Burapha University, that meet international requirement, a first step towards international competition, and to a sustainable development.

Methodology

Questionnaires were used to survey the desirable features of international engineers from the three purposive sample groups covering the engineering professors, research engineers and plant executives who are the graduate student's user. Opinions of Industrial Engineering Burapha University students studying 4 different engineering subjects and 1 created activity were also surveyed. Steps of research methodology were as follows:

1. Sample groups

Poll of the desirable features of international engineers using questionnaires distributed to three purposive groups which are:

(1) Group of engineering professors who are institutional administrators or those who teach in engineering's institution which are members of the Council of Engineering Deans of Thailand in 2008. For 35 institutions, 10 issues per institution were sent. The number of responded questionnaire was 111 issues that equal 31.71 %.

(2) Group of executives and engineers who work in factories in Eastern Thailand employing foreign engineers. These factories also offered job training facilities for Burapha University's engineering students in 2008. For 57 factories, 2 issues per factory were sent. The number of responded questionnaire was 74 issues that equal 64.91 %.

(3) Group of foreign academicians and researchers who participated at Materials and Manufacturing academic seminars organized by AUN / SEED-Net at Malaysia and Laos in 2008, total about 70 persons. The number of responded questionnaire was 32 issues that equal 45.71 %.

Opinions of every student who attended 4 engineering subjects offered by faculty of Engineering, Burapha University in the 2009 academic year: Engineering Materials represents the 1st year subject.

Advanced Engineering Materials represents the 2nd year subject. Internship (On the job training) represents the 3rd year subject. Seminar represents the 4th year subject. Supplementary learning English TOEIC (Test of English for International Communication) for the 4th year students was also obtained.

2. The questionnaire

Questionnaire of the desirable features of international engineers, 5 level rating scales, is divided into three areas: 1. Knowledge. 2. Skill. 3. Humanity and social characteristic. Level of importance: 1 = least importance. 2 = fair. 3 = satisfactory. 4 = good. 5 = most importance. See table 1, 2 and 3 for more details on topics asked.

3. Data collection

The questionnaires are mailed or delivered personally to respondents'. Collected response questionnaires were analyzed.

4. Data analysis

The data were analyzed, using SPSS program for windows, arithmetic mean and standard deviation and sort priorities.

5. Conclusion and recommendations

Analyzed data are discussed and conclusions are also given.

Results

1. Desirable features of international engineer.

Analyzed questionnaire data from three respondent groups, engineering professors, executives and engineers, foreign academicians and researchers, totaling 217 issues in three areas are as shown in Table 1, Table 2 and Table 3. The data were analyzed, using SPSS program for windows, arithmetic mean and standard deviation.

First area: Knowledge.

Desirable knowledge was sorted and ranked based on an average (Mean), full scale is 5, and standard deviation (SD). The results were as in Table 1.

The top 5 requirements of knowledge are:

1) Specific engineering knowledge. 2) English. 3) Basic engineering subject. 4) Advanced technologies and 5) Computer aided design.

Second area: Skill

Desirable skills were sorted and ranked based on an average (Mean), full scale is 5, and standard deviation (SD). The results were as in table 2.

The top 5 requirements of skills are:

1) Team work. 2) Creative thinking. 3) English speaking. 4) English reading and equal 5) are skill in research and development, Communication and Co-operation.

Third area: Humanity and Social Characteristic.

Table 1 Sorted and ranked desirable knowledge.

Order	A qualified international Engineer's requirements : knowledge	N = 217	
		Mean	S.D.
1	Specific engineering	4.55	0.637
2	English language	4.50	0.708
3	Basic engineering	4.39	0.686
4	Advanced technologies	4.28	0.712
5	Computer aided design	4.05	0.768
6	Personal management	3.98	0.805
7	Information and Communication Technologies (ICT)	3.94	0.797
8	Basic Statistics	3.93	0.871
9	Basic Physics	3.88	0.884
10	Calculus	3.83	0.940
11	Factory management	3.80	0.785
12	General sciences	3.74	0.832
13	Basic Chemistry	3.39	0.906

Desirable characteristics were sorted and ranked based on an average (Mean), full scale is 5, and standard deviation (SD). The results were as in Table 3.

The top 5 requirements of characteristics are as follows: 1) On time (Punctuality). 2) Continuous improvement of working potential. 3) Self learning. 4) Actively working and 5) Respect to rules / regulation. Engineering Ethics came very close to the fifth rank respect to rule and regulation and should not lightly disregard.

Table 2 Sorted and ranked desirable skills

Order	A qualified international Engineer's requirements: Skill	N = 217	
		Mean	S.D.
1	Team working	4.52	0.617
2	Creative thinking	4.37	0.633
3	Speaking skill in English	4.36	0.752
4	Reading skill in English	4.35	0.755
5	Research and development	4.30	0.474
6	Communication	4.30	0.700
7	Co-operation	4.30	0.700
8	Planning	4.29	0.654
9	Writing skill in English	4.26	0.774
10	Problem solving relative to set task	4.24	0.667
11	Technical skill	4.24	0.706
12	Computer application	4.13	0.767
13	Task presentation	4.11	0.722
14	Task follow up	4.09	0.727
15	Problem solving relative to human relation	4.00	0.785

2. Student's opinions on the method of teaching and learning.

Responded questionnaire from 4 courses and 1 special activity were from:

1) Engineering Materials course (60 issues).

2) Advanced Engineering Materials course (39 issues).

3) Seminar course (76 issues).

4) On the job training course (77 issues).

Table3 Sorted and ranked desirable humanity and social characteristics.

Order	A qualified international Engineer's requirements: Characteristics	N = 217	
		Mean	S.D.
1	On time (Punctuality)	4.55	0.623
2	Continuous improvement of working potential	4.48	0.602
3	Self learning	4.44	0.622
4	Actively working (Dedicate, hard working)	4.43	0.650
5	Respect to rules / regulation	4.43	0.678
6	Engineering Ethics	4.42	0.735
7	Open mindedness (listen to people)	4.39	0.644
8	Positive thinking towards organization	4.31	0.676
9	Respectful	4.30	0.713
10	Friendliness	4.26	0.719
11	Creative actions	4.22	0.665
12	Belief in religion	3.07	1.051

5) Special activity, supplementary English (TOEIC, 31 issues).

Analyzed data from 4 courses and 1 special activity are as follows:

1) Engineering Materials course.

The course is a 3 credit hours lecture (14 weeks semester) with the aid of PowerPoint and some VDO. Homework was also assigned and scores kept.

The students' expressed satisfaction as follow: (1) Interested in VDOs (4:40). (2) The knowledge gained from the homework (4.08). (3) Interested in PowerPoint (3.87). (4) Interested to do homework (3.85) and (5) Interested in lecture (3.80).

It can be clearly seen that the learning media and homework formed important parts of the learning process more than lecture.

2) Advanced Engineering Materials course.

The course is 3 credit hours with 2 lecture hours and 3 practice hours per week.

The lecture section was divided into two sub-sections. The main class was lectured by teacher followed by a presentation by a working group of students who were assigned to report on selected topics.

The practice section did practical experiments enforced with discussion for more understanding.

The students' expressed satisfaction as follow: (1) the literature review which were reported in front of class (3.82). (2) Practices and discussions (3.79). (3) Practice without discussion (3.77). (4) Listening to teacher's lecture (3.49). And (5) Listening to students' report (3.28).

It can be seen quite clearly that the practices with discussions were more interesting than lecture alone. The teacher's lectures were more interesting than students' reports in front of the class.

The class also reported that skills obtained in attending the course were: (1) Presentation (3.87). (2) Problem solving (3.77). (3) Team working (3.77). (4) Planning (3.77) and (5) Computer application (3.77). They also reported that the receiving characteristics were: (1) Respect to rules/

regulation (4.28). (2) Respectfulness (4:26). (3) Friendliness (4:23). (4) Open mindedness (4:10) and (5) On time (punctuality) (4:03).

3) Seminar course.

The course is a 1 credit hour course to prepare students' ability to conduct independent study.

They searched for new knowledge, innovation and related researches for senior project from various sources such as research reports, papers published in journals etc. They prepared reports and present their reports in front of the class.

The receiving skills reported were: (1) Computer application (4.28). (2) Team working (4.08). (3) Presentation (4:01). (4) Planning (3.82) and (5) Continuous improvement of working potential (3.75).

The receiving characteristics were reported to be: (1) Friendliness (4:16). (2) Respectfulness (4:09). (3) Open mindedness (4:08). (4) Respect to rules /regulation (4:04) and (5) Ethics (i.e. not to copy work) (4:01).

4) On the job training course.

This course is a 2 credits hour course to prepare students' internship in the industry for 2 months to gain working experiences.

The essential knowledge's needs for internship were as follows: (1) Computer Aided Design (4:30). (2) Computer communications (4:19). (3) Specific engineering knowledge (4.19). (4) Basic engineering subjects (4.14) and (5) Modern technologies (4.13).

The receiving skills were: (1) Computer application (4:36). (2) Coordination (4.14). (3) Team working (4.13). (4) Planning (4.01) and (5) Communications (3.99).

The receiving characteristics were: (1) Respectfulness (4:53). (2) Respect to rules/regulation (4:52). (3) On time (Punctuality) (4:48). (4) Friendliness (4.48) and (5) Open mindedness (4.29).

5) Special activity (supplementary English, TOEIC)

The special activity was a supplementary program in English (TOEIC). During term recess, 31 students of 4th year volunteered to attend the special course to prepare for entry into working life.

The minimum, maximum and average score of pre-test and post-test by the instructors who taught TOEIC, were shown in table 4.

Table 4 The minimum, maximum and average scores of pre-test and post-test by the instructors who teach TOEIC.

Score	minimum	maximum	average
pre-test	31.00 %	65.00 %	44.94 %
post–test	36.00 %	58.00 %	46.42 %

The maximum of the pre-test score was more than the post-test score.

The minimum of the pre-test score was less than the post-test score.

Some more details were as follow:

8 persons showed the pre-test score to be more than the post-test score.

2 persons showed the pre-test score equal to the post-test score.

21 persons showed the pre-test score to be less than the post-test score.

30 persons' under-took TOEIC test scores from Institute TOEIC Services Thailand. The minimum score was 215, maximum score was 645 and average score was 331. Then scores were divided into 50 scores interval as shown in table 5. The most scores were in the range of 251 to 350 (21 persons) and only one person got over 500 scores.

Table 5 TOEIC test scores, 50 scores interval, from Institute TOEIC Services

Score interval	Person amount
0-250	1
251-300	10
301-350	11
351-400	5
401-450	1
451-500	1
501-550	0
551-600	0
601-650	1
Minimum score = 215 Maximum score = 645 Average score = 331	

In general, if TOEIC score is to be used to apply for job, it should be more than 550 test scores.

TOEIC scores showed that the students were very weak in English. Moreover, the average score of pre-test and at post-test were different by only 1.48 %. It showed that student did not do well to develop English for future use.

In case a larger difference between pre-test and pose-test mark is required the modified Deming Cycle, PDCA, chart as shown in figure 1 should be followed to manage the course.

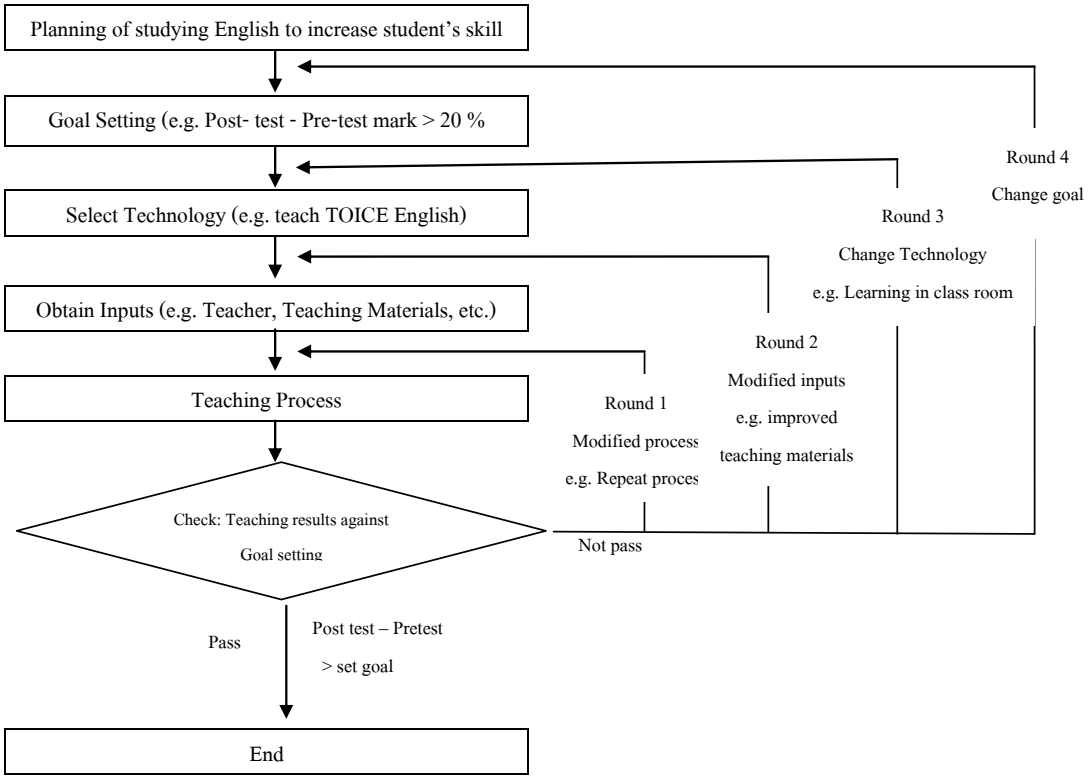

Figure 1 Modified Deming Cycle, PDCA for teaching TOEIC English adapted from Deming PDCA Cycle. (Adapted from Boonphak [7])

Discussion

Survey of desirable characteristics of an international engineer composes of knowledge, skills, and characters. The researches' conclusions are as follows.

Knowledge, the top 5 requirements of knowledge is found to be as follows: 1. Specific engineering knowledge. 2. English. 3. Basic engineering subject. 4. Advanced technologies and 5. Computer aided design.

Skill, the top 5 requirements of the desirable skills is found to be as follows 1. Team working. 2. Creative thinking. 3. Speaking English. 4. English reading and 5. Skill to carry out research and development, communication and in co-operating.

Characteristic, the top 5 requirements of characteristics are found to be as follows: 1. on time (Punctuality). 2. Continuous improvement of working potential. 3. Self learning. 4. Actively working and 5. Respect to rules / regulation.

These desirable characteristics of an international engineer correspond with the properties of Industrial Engineer at the industries and private sectors need that Paitoon Poolsukkho and Sakda Wankaew found..

This research information showed that Industrial Engineering students of

Burapha University expressed satisfaction to the learning media, homework, practices and discussions. These are important to stimulate students' interests and more understanding than listen to lecture only. The skillful teachers are important too. So students should be allowed the opportunity to practice and discuss the results of the studies. The teachers should develop interesting teaching techniques for interested students. The teachers should also carefully prepare homework and took information from homework to obtain the understanding of the students. Then, take the information back to improve teaching techniques according to PDCA process of Deming Cycle. These will ensure that students really learn their lessons.

TOEIC scores showed quite clear that Industrial Engineering students of Burapha University, were very weak in English. Moreover, the average score of pre-test and at post-test were different by only 1.48 %. It showed that students did not do well to develop English or they did not pay their full attention to the teaching of English. Addition activities should be added into in class and off class activities e.g. English movies or songs that have some explanations, talking with English spoken foreigners' activities, to increase the knowledge and skill in English.

In addition, teaching and learning in the bigger classrooms will face with more problems because there are more students in class. This made the class less interesting. e-Learning system should be taken to form part of teaching process to help the students who have inferior learning ability or are not ready to learn. These learning processes enable students to repeat lessons several times so that they can gain more understanding. [8]

Conclusion

By building up more desirable knowledge, skills and humanity and social characteristics in students, industrial engineering Burapha University graduates could be able to work in Thailand as well as in APEC and ASEAN countries.

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