ISSN: 2354-5917

PROCEEDINGS

OF

INTERNATIONAL SEMINAR ON CHEMICAL ENGINEERING

in conjunction with

Seminar Teknik Kimia Soehadi Reksowardojo (STKSR) 2016

27-28 October 2016
Institut Teknologi Bandung, Indonesia

Organized by:

Supported by:

Sponsored by:

Department of Chemical Engineering
Faculty of Industrial Technology
Institut Teknologi Bandung

PROCEEDING

International Seminar on Chemical Engineering
in conjunction with
Seminar Teknik Kimia Soehadi Reksowardojo (STKSR)
2016

"Sustainable Food, Energy, and Water"

ISSN: 2353-5917

27-28 October 2016
West and East Hall
Institut Teknologi Bandung
Jl. Ganesha 10 Bandung INDONESIA

Editors:

Ardiyan Harimawan, Ph.D
M.T.A.P. Kresnowati, Ph.D.
Devina Regina
Catharine Bella

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Department of Chemical Engineering
Faculty of Industrial Technology
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MESSAGE

First of all, deep gratitude is dedicated to Allah the Almighty which gives His blessing to the Chemical Engineering Institut Teknologi Bandung which this year evenly becomes 75 years old. The journey of 75 years for Chemical Engineering ITB as the oldest Chemical Engineering program in Indonesia and one of the oldest program in ITB is a long journey with all the hurdles which creates the Chemical Engineering ITB becomes a reputable program.

We gladly overcome the presence of "75 Tahun Teknik Kimia untuk Indonesia" book, as a track record of the contributions of Chemical Engineering ITB and its alumni in advancing Indonesian society. The family of Chemical Engineering ITB and its alumni have been proven to be able to build a strong connectivity among the higher education, Science and technology development, and industrial escalation especially in chemical industry. Therefore, the contribution of Chemical Engineering ITB is unquestionably substantial in showing the objective of Indonesian society to achieve food independency and energy sovereignty. It is highly expected that this book can pass those ideas to the society, especially the young generation which will advance the development of Chemical industry in Indonesia.

We would like to congratulate anew this 75th year Commemoration of Chemical Engineering Higher Education in Indonesia. We hope that the family of Chemical Engineering ITB can be continuously actively contribute in generating intellectual works which are affluent in advantages, as a contribution to the Indonesian society. Especially for the alumni of Chemical Engineering ITB, we hope that can keep the good relation with the alma mater, also to keep working, accomplishing, and being the "energy" for ITB to keep carrying on the credence of the higher education.

Bandung, October 2016

Prof.Dr.Ir. Kadarsah Suryadi, DEA.

Rector of Institut Teknologi Bandung (ITB)

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MESSAGE

Assalamu'alaikum Warahmatullahi Wabarakatuh

Warm Greetings for us all

Ladies and Gentlemen,

Chemical Engineering program in ITB cooperates with Chemical Engineering ITB alumni foundation and the alumni themselves are conducting series of events which consist of the Education Seminar about Chemical Engineering dedicated to High School teachers and students, especially for Science program, on October 26th 2016 and the International Seminar on Chemical Engineering in Conjunction with Seminar Teknik Kimia Soehadi Reksowardojo 2016 on 27-28 October 2016.

The seminar this year is focusing on the topic of Energy, Food and Water. Those three topics were chosen in relation to the scarcity of these three aspects which are starting to give impacts and need a special attention. The chemical engineering bachelors can be involved much in those three sectors, and so the academia, practitioneers and the government in order to harness this moment to share knowledge for the sake of advancement of Republik Indonesia.

For the participants who are actively involved and the invited speakers, the sponsors and Institut Teknologi Bandung who already gave us permission to utilize the facilities, we express our deep gratitude.

Hopefully this seminar can give benefits for us all.

Wassalam

Dr.Ir. Irwan Noezar, MS

Chairman of 75th year Commemoration of Chemical Engineering

Higher Education in Indonesia

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MESSAGE

Dear Colleagues,

On behalf of the Organizing Committee of the International Seminar on Chemical Engineering, I am honorable to welcome you all to Institut Teknologi Bandung, Bandung, Indonesia. This year, Department of Chemical Engineering – Institut Teknologi Bandung is celebrating the 75th year of Chemical Engineering Education in Indonesia. One of the main events is holding this Seminar in conjunction with Seminar Teknik Kimia - Soehadi Reksowardojo (STKSR) 2016 with the topic of 'Sustainable Energy, Food and Water'. Globally and at national level as well, we are aware of the challenges to meet the needs of energy, food and water for all in sustainable ways.

Those topics will be addressed by leading engineers/scientists from 9 countries, either in plenary lectures or parallel sessions. In each session, an invited speaker will address a certain topic with a depth insight and ample of time to discuss the issue with the participants, hopefully they will learn more from an expert in the field.

We have also prepared several social functions, so that delegates may meet one another and experience the Indonesian culture with Bandung pleasant weather and warm hospitality. Finally, the committee is most grateful to all sponsors and ChemEng-ITB Alumni for providing funds. I also thank all International/Technical Committee members, all the plenary and invited speakers and all oral/poster presenters for their kind efforts and contributions in making this conference a success.

Thank you

Prof. Tjandra Setiadi, Ph.D.

Chairman of STKSR 2016

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CHEMICAL ENGINEERING ITB FOR ABET REACCREDITATION: TOWARDS CONTINUOUS QUALITY IMPROVEMENT AND INNOVATION IN EDUCATION

Winny Wulandari*, Johnner Sitompul, and IDG Arsa Putrawan[1]

Department of Chemical Engineering
Faculty of Industrial Technology
Institute of Technology Bandung, Bandung, 40132, Indonesia

* E-mails: winny@che.itb.ac.id & sitompul@che.itb.ac.id

Abstract

Chemical Engineering Program ITB has been accredited by ABET in 2012. A number of program improvements have been carried out since then to maintain the quality of chemical engineering education program in striving for excellence in education. The continuous improvement in education is focused on conducting both course level assessment and program level assessment as a tool to evaluate teaching and learning in chemical engineering education. The reaccreditation process is now being underway in 2016, with ranges of timeline activities, including submission of Self Study Report on July 1st, Program Evaluator site visit to ITB on November 6-7th, Draft Statement report on January 2017, and finally the issue of Final Statement for reaccreditation award on July 2017. This paper concerns on a series of activities to prepare and devise Self Study Report for the reaccreditation process complying with ABET Standard. The preparation has been carried out since April 2015 by forming an ad-hoc team to assist and support Chemical Engineering Program Chair. The team also manages administrative tasks for course and program assessment, as well as provides recommendation for improvement of chemical engineering program and conduct cycle assessment on Program Educational Objectives and Student Outcomes. Further, upgrading and improving safety and facilities is very crucial to ABET Standard. A number of faculty workshops were also conducted to discuss both course level assessment and program assessment, as well as to discuss the learning outcomes of students that have been attained both in sophomore, junior, and senior year. The impact of these various programs conducted will be discussed. While the primary goal of this task is to prepare for a successful ABET reaccreditation, many positive impacts has been recognized by the faculty, students, and Program in general. The paper shows knowledge sharing, some good practices, and innovation in chemical engineering education valuable for other Program to prepare for cycle assessment especially in ABET accreditation or reaccreditation.

Keywords: ABET, Continuous Improvement, engineering education, cycle assessment

1. Introduction

The Higher education institutions (HEI) have a responsibility to increase awareness, knowledge, skills, and value needed to create a just and sustainable future[1]. The challenges of chemical engineering education in the 21th century includes equipping graduates with the essential attributes for the professional chemical engineer as well as challenging the intellectual of students, that includes problem-solving, communication, teamwork, self-assessment, change management and lifelong skills[2,3].

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Chemical Engineering Program Institute of Technology Bandung, hereafter called CEP ITB, has been by accredited by Accreditation Board for Engineering and Technology (ABET) since July 2012 and now due for reaccreditation cycle of 2016-2017. ABET, a non-profit organization, accredit college and university programs in the US and around the world in the disciplines of applied science, computing, engineering, and engineering technology at associate, bachelor, and master degree levels. ABET mission and culture is to promote quality and innovation in education[4]. With ABET accreditation, students, employers, and the society we serve can be confident that a program meets the quality standards that produce graduates prepared to enter a global workforce. The purpose of ABET reaccreditation is to equip students with the skills specified in those Student Outcomes (Outcomes a – k). The guidance for ABET reaccreditation has been defined elsewhere[5]. The reaccreditation process for CEP ITB is now being underway in 2016 while preparation has been conducted since 2014.

This paper concerns on a series of activities to prepare and devise Self Study Report for the reaccreditation process complying with ABET Standard. This paper also shows knowledge sharing, some good practices, and innovation in chemical engineering education valuable for other Program to prepare for cycle assessment in ABET accreditation/re-accreditation.

2. Program History

Initially, Undergraduate Chemical Engineering Program in Indonesia was established in 1940 by the Dutch East Indies Government and officially established in 1941 known as *Chemische Technologie Afdeling* in Technische Hogeschool Bandung by the Dutch East Indies government. During Japanese occupation, circa 1943 to 1944, the chemical engineering program was renamed to Kagaku Kougaku. Up to 1980, the program was mainly focused on undergraduate level study. However, a dissertation on Batch Distillation from Department of Chemical Engineering ITB was recorded in the late 1950's in Perry's Chemical Engineering Handbook, 3rd Edition. Currently, there are two Sub-Programs in Chemical Engineering Program at ITB, which are to be assessed: Chemical Technology and Bioprocess Technology. Hence, the reaccreditation cycle is focused in those two options. Note that throughout all levels, students are also trained to develop and strengthen their soft skills such as wisdom, team-working, life-long learning attitude as shown in the fishbone diagram below. Due to page limitation, only fishbone diagram for chemical engineering program with option Chemical Technology shown here (Figure 1).

Both Chemical Technology and Bioprocess Technology Sub-Programs share the same core curriculum. The difference of the overall curricula of the Sub-Programs lies in more applicative and specialized classroom and laboratory courses, and in courses that are aimed at strengthening the specialized subjects of each Sub-Program through the process of plant design and chemical engineering research.

Curriculum review is conducted regularly every five years. The last curriculum review was in 2013 and it will be conducted again in 2018. The Chemical Engineering Program at ITB was awarded an A (highest rank) by a national accreditation board for higher

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institution, known as BAN PT, which was conducted by the National Accreditation Agency for Higher Education in July 2015.

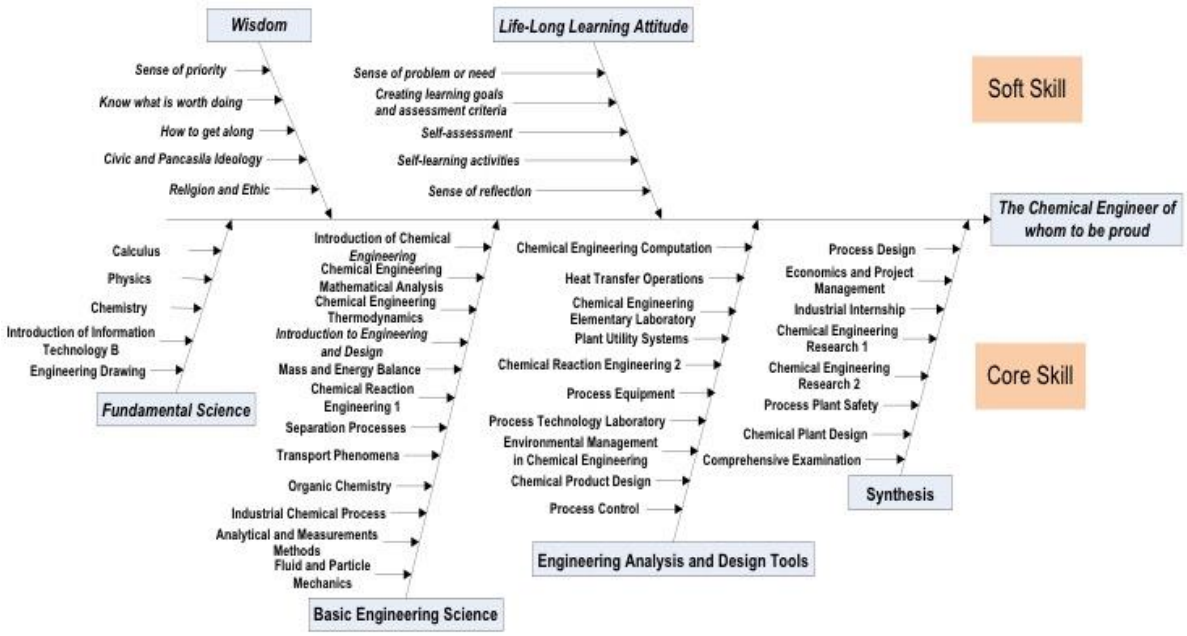

Fig. 1. Fishbone Diagram for Chemical Engineering Program with Option Chemical Technology

All of HEI in Indonesia follows credit system[2]. The minimum credit hours needed for bachelor, so called *sarjana* in Indonesia language, is 144, and the maximum is 160 credit hours. Generally, for courses, one credit cover 1 hour in classroom session, 1 hour for tutorial, 1 hour for independent study by student. It means the contact hour is 2 hours per credit. In case of laboratory, one credit means higher hours for contact/ interview hours. It is equal to 1 hour for interview, 2 hours for laboratory activity, and 2 hours for independent study

The 144 credit hours distributed into 8 semesters. Generally, the curriculum is designed to develop soft skills and core skills of students in CEP. The first three years of the curriculum are primarily devoted to invest the students with fundamental knowledge and skills for limited cases. In the senior level, to develop synthesis design through curriculum containing a concentration of engineering design and research courses to prepare the students for professional practices. Our curriculum is systematically developed to strengthen the fundamental sciences, namely physics, chemistry, and mathematics. The chemical engineering curriculum provides sufficient fundamental science, basic and general engineering topics, engineering analysis and design tools and synthesis topics to thoroughly prepare students for engineering practice.

In July 2011, the Chemical Engineering Program at ITB obtained ABET accreditation and became the third program at ITB with ABET accreditation. Within 5 years, the program has been conducting a number of improvements regarding the last review. They include improvement on the program's Procedures and Policies, and the following

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criterion assessed by ABET: Program Educational Objectives, Continuous Improvement, Facilities, and Institutional Support.

Generally, Chemical Engineering Program at ITB is favored by high school graduates (SMU) across the country. As a result, the incoming students rank top 10% of the national student intake. The graduates from the Chemical Engineering ITB have less difficulty in obtaining their job from industries (waiting time for finding the first job is less than two months on average base on exit survey) and have proven track record for their professional contribution. This has indicated the Chemical Engineering Program strength in the relevancy of educational output as well as the need of the Indonesian society.

3. ABET Reaccreditation Timelines

In July 2011, the Chemical Engineering Program at ITB obtained ABET accreditation and became the third program at ITB with ABET accreditation. Within 5 years, the program has been conducting a number of improvements regarding the last review. They include improvement on the program's Procedures and Policies, and the following criterion assessed by ABET: Program Educational Objectives, Continuous Improvement, Facilities, and Institutional Support. Figure 2 shows the timeline for Chemical Engineering ITB ABET reaccreditation for 2016-2017 cycles. The formal agenda includes Request of Accreditation by Quality of Assurance Unit ITB on January 2016, then submission of Self Study Report on July 1st, and Program Evaluator site visit to ITB on November 6-7th 2016. The formal Draft Statement report is issued on January 2017, and the issue of Final Statement for reaccreditation award will be on July 2017.

Fig.2. ABET Re-Accreditation Timeline for 2016-2017 Cycle

4. Ad-Hoc Team Task Forces

With regards to ABET reaccreditation cycle, an Ad-Hoc team was set up in April 2015 by CEP. This team was also conducted for other program that will be accredited/re-accredited in the same cycle. ABET Reaccreditation preparation Ad-Hoc Team helps Chemical Engineering Program Chair and Quality Management Team to fulfill these huge tasks for the success of reaccreditation. The Ad-Hoc team comprises of the Head of Task force, secretary, a number of lecturers and academic assistant, as well as 3 administrative assistants. The administrative assistants are bachelor or master graduates with full time contract. The roles of Ad-Hoc team is to conduct administrative takes regarding documents and evidences for course and program assessment, organize faculty workshop, prepare Self Study Report and the visitation. Safety officers also embedded to the team to ensure that improvement of safety and facilities have been conducted.

A number of monthly workshops had been conducted by CEP together with Quality Assurance Unit ITB in order to prepare the Self Study Report and site visit evaluation[6].

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The contents of workshop includes training to conduct Student Outcome Analysis, sharing between program to share the progress as well as learning the best ideas conducted in other program.

A detail of timeline for reaccreditation by ChE ITB ABET Ad-Hoc team is shown in Table 1.

Table 1. ChE ITB ABET Reaccreditation Preparation

Timeline	Description of Tasks
April 2015	Ad-Hoc task force was formed
July 2015	Workshop with Quality Assurance Unit for Student Outcome Attainment Team gathering portfolios and course evidences for preceded semesters and years
September 2015	Team gathering evidences and interpret course datas
October 2015	First Faculty Workshop for ABET Preparation: writing Course Plan
September 2015– January 2016	Team preparing a draft of Self Study Report
December 2015	Faculty Workshop: Course Assessment for 2013-2014 for Continuous Improvement
January – April 2016	Team gathering evidences and interpret course datas
March 2016	Faculty Workshop: Course Assessment Semester I 2015-2016
April-June 2016	Team finalizes Self Study Report
August – October 2016	Team preparing evidences and documents for Site Visit Safety facilities are maintained and upgraded.
November 2016	Rehearsal for Site Visit

5. Continuous Improvement Process

Continuous improvement is the core to deliver quality learning and teaching based on ABET compliance. Figure 3 shows the relation of Self Study Report to the continuous improvement process conducted by Chemical Engineering ITB. The SSR as required by ABET comprises of Background Info, Criterion 1 Students, Criterion 2 Program Educational Objectives, Criterion 3 Student Outcomes, Criterion 4 Continuous Improvements, Criterion 5 Curriculum, Criterion 6 Faculty, Criterion 7 Facilities, Criterion 8 Institutional Supports, Appendix A – E.

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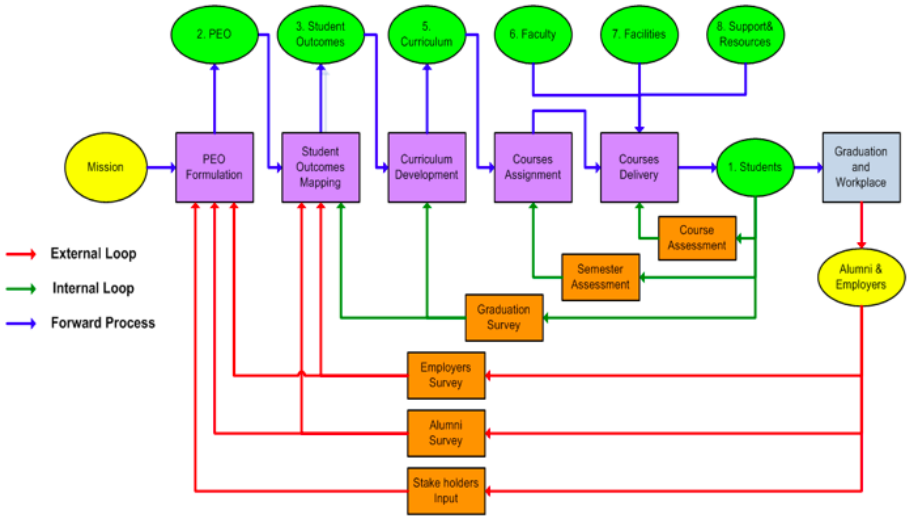

Fig.3. Continuous Improvement Process in Relation to Self-Study Report

The assessment level conducted within Chemical Engineering Program ITB comprises as follow:

a. Course level assessment is carried out by faculty member, whereas Student Outcome attainment is assessed and evaluated every semester using various assessment instrument, including list of mark attained by students, evaluation from student feedback survey, in correlated to the Student Outcome expected in each course. This assessment is documented as Course Portfolio, with the attachment includes examples of student's exam work for highest, lowest, and average scores, list of scores, and the minutes of lecture. The feedback and assessment results are used as an input for continuous improvement in course level.
b. Chemical Engineering Program carries out program level assessment with Chemical Engineering Assessment Team lead by Program Chairman, to assess and evaluate the attainment of Program Educational Objective and Student Outcome in Program Level. The assessment instruments include Course Portfolio, Student Questionnaire, Senior Exit Survey, and Exit test. The assessment results are consulted with various Program Constituents, including Program Chair & Faculty Members to formulate action plan for the following education process.

5. Good Practices and Innovation in Education

A number of various activities conducted in Chemical Engineering as well as a number of description of some good practices and innovation in education at CEP ITB are presented here.

5.1 Program Educational Objectives (PEO) Review

The education in the Chemical Engineering Program prepares our graduates to be significant contributors to their chosen career field. Therefore, it is our aim that our

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graduates will be able to achieve the following objectives within 5 years upon completing their study:

1. Progress in their professions by practicing chemical engineering principles & methods in technical, managerial or other career tracks.
2. Be effective team members in their organization by applying & developing their communications, leadership, and team work skills.

Having completed or pursuing advanced degrees in engineering, science, business or other relevant areas of study, professional certifications, or are actively engaged in professional development activities in his/her employment.

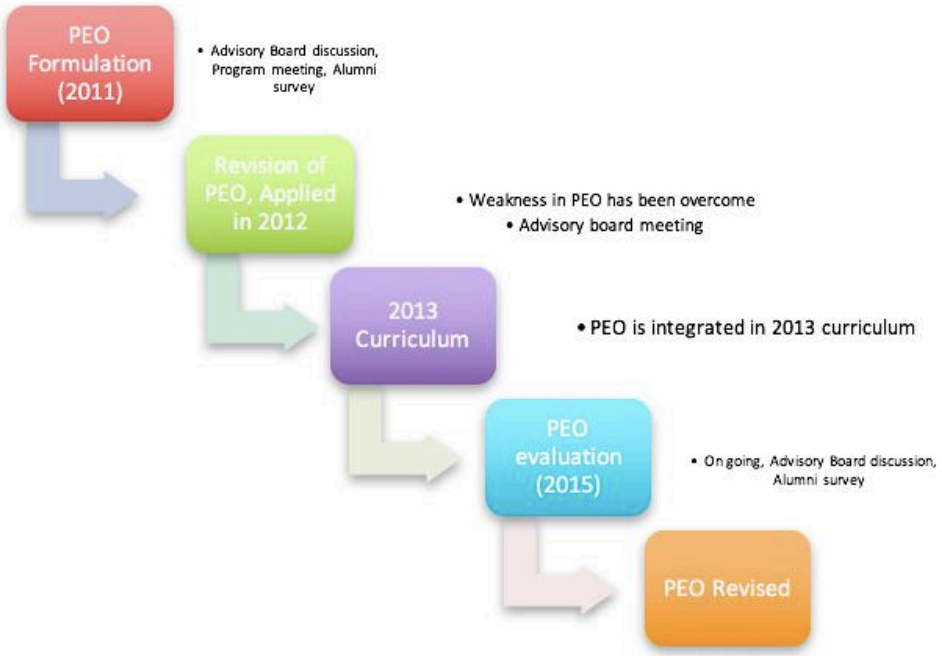

Fig.4. Timeline of PEO Formulation of 2011 – 2015

ABET requires systematically and well documented process to formulate PEO of the program. Figure 4 shows timeline of PEO formulation of Chemical Engineering Program ITB. In 2011, PEO of the program was formulated based on Advisory Boards discussions, Faculty meetings, senior exit survey 2011, alumni and user survey 2011. In 2012, ABET has stated our Program Educational Objectives as one area of weakness of the Program. Based on that statement above, the corrective action was carried out for PEOs, which was detailed in the Due Response Report 2012. Based on feedback from our Program constituencies and from the ABET Draft Statement, we have revised our Program Educational Objectives. The PEO was then incorporated into 2013 Curriculum. The evaluation in Exit Survey, Alumni Survey and Employer Survey of 2015 suggest a number of changes. The evaluation is ongoing based on discussions with Advisory Boards, feedback from our graduates at the Exit Survey, as well as young alumni.

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5.2 Student Outcome Attainments for Course and Program Assessment

Table 2 shows the Student Outcomes, a set of skills that graduate should fulfill by the end of study. There are eleven Student Outcome, as required by ABET.

An example of Student Outcome attainment of Student Outcome (c), an ability to design a system, component, or process to meet desired needs with realistic constraints, is shown in Figure 5. The level of attainments is defined as % of students to have score higher than 3 (scale of 4); or higher than 75%. This result was taken from group assignments on designing distillation and absorption column in TK3101 Separation, in the purpose to measure the following performance indicators: analyze and synthesize chemical engineering unit operations. The students applied some engineering standards for designing the column specifications. The recommendation from this program level assessment is to maintain this type of assignment, as well as to assess SO (c) from exam.

Table 2. Chemical Engineering Program ITB Student Outcomes

Point	Student Outcomes
(a)	an ability to apply knowledge of mathematics, science, and engineering
(b)	an ability to design and conduct experiments, as well as to analyze and interpret data
(c)	an ability to design a system, component, or process to meet desired needs with realistic constraints
(d)	an ability to function on multi-disciplinary teams
(e)	an ability to identify, formulate, and solve engineering problems
(f)	an understanding of professional and ethical responsibility
(g)	an ability to communicate effectively
(h)	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i)	a recognition of the need for and an ability to engage in life-long learning
(j)	a knowledge of contemporary issues
(k)	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

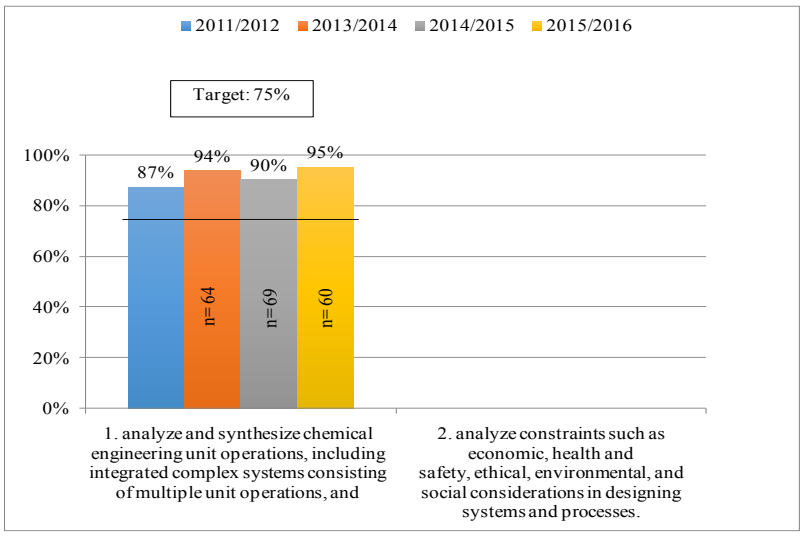

Fig.5. Typical Example of Student Outcome Attainment (Student Outcome, c)

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5.3 Faculty Workshops

A number of faculty workshops have been conducted in recent years, as it found that it makes easier to conduct course and program level assessment. Figure 6 shows photograph of typical course portfolios that contain lecturer's self-evaluation course including student's work, evaluation and course assessment.

Fig.6. Typical example of Course Portfolios.

The faculty workshops comprised the following themes:

- Course Plan Workshop, conducted in the beginning of semester, to review syllabus and course plan, including the assessment plan
- Course Assessment Workshop, to assess the course, and formulate action plan for next year/next semester
- Capstone Design / Plant Design Workshop, discuss the Chemical/Bioprocess Plant Design

In order to reduce administrative loads of the faculty, team administrative assistant conducted analysis of the course data from all of portfolios with the guide of the respective faculty for all course assessment[7]. Faculty workshops allow the faculty to discuss the interrelation of student outcome in different courses, including the mapping of Student Outcome from year 2 (sophomore) to year 4 (senior). Some good practices of faculty in the class are also being shared with other faculty, thus junior faculty member can learn and implement the good practice to their class in the future appointment of course.

5.4 Multidisciplinary Course

The interdisciplinary course taken by the Chemical Engineering students is *TK4091 Interdisciplinary Project for Chemical Engineering* in the 7th semester (4th year). The course was managed by a team of lecturers from different programs at the Faculty of Industrial Technology. It was initially a pilot project, as the first attempt to accommodate the need of an interdisciplinary course and as a respond to the evaluator from ABET committee. It was started as an elective course and has been c for three semesters, from the 2nd semester of 2011/2012 academic year to the 2nd semester of 2012/2013 academic year.

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Since the establishment of new curriculum in 2013, it became a mandatory course of the Faculty of Industrial Technology for 7th semester students. The course focuses on Problem Solving (SO (e) ; Multi-disciplinary Team Work (SO d); and Communication (SO (g). The students are from Chemical Engineering Program, Engineering Physics Program, Industrial Engineering Program, and Engineering Management Program. The themes for the projects are as follows:

- 2x Pilot project (electives, 20 students),
- 2013: Biomass Gasification Project at ITB Jatinangor,
- 2014: Pertamina Projects,
- 2015: Toyota Astra Motor Project,
- 2016: Garuda Foods.

With regards to university student level, the current course is considered sufficient, as it provides the students an entry level of experience of working in a multidisciplinary team.

5.5 Facilities and Lab Modernization and Implementation of Safety Culture

ABET Accreditation Policy and Procedure Manual No. I..E.5.b[8] states that regarding Facilities, is to assure the instructional and learning environments are adequate and are safe for the intended purposes.

To ensure good learning experiences on instructional laboratory, there have been a number of facilities upgrading since 2009 to 2015, for example new addition of drying process module, new addition of agitated thank and refrigeration module. In 2014, some addition of modules includes process control module, tubular furnace, anaerobic chambers, and CCTV. All is from UPP Chevron. Some of additions based on public funds are the addition of biofuel properties module and bio-based extraction.

Chemical Engineering Program also maintain safety culture in daily activities at CEP building with a number of programs, including:

- Safety induction.

Safety induction activities are conducted at the beginning of each semester in purpose to increase the understanding about the importance of safety in chemical engineering builing environment, to explain the contents of safety guidebooks, WI, JSA, HAZOP, MSDS, and explain countermeasure accidents.

- Safety test and safety card

Prior to conduct activities in the building, every person is required to conduct online safety test individually and must pass minimum score of 95 out of 100. After passing the test, the person is then given a safety card.

- Safety documents on laboratory equipments
- Every students in CEP are required to attach experimental module with safety documents that consist of MSDS (Material Safety Data Sheet), JSA (Job Safety

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Analysis), and WI (Working Instruction). These documents also required to be attached to the final report of the research.

- Safety drill program

Purpose of safety drill at CEP are to raise safety awareness to people working in the buillding of CEP, and to train students and academic staff to understand the mitigation system in case of emergency.

- Safety inspection

Safety inspection is an activity to check the safety instruments in any laboratory in chemical engineering building. This activity is conducted by a safety team of chemical engineering department at regular intervals of academic activities.

6. Conclusions

This paper has described some good practices and innovations that has been attained in Chemical Engineering Program ITB with regards to the continuous quality improvement. Regarding the reaccreditation cycle, Chemical Engineering Program ITB has given positive results, such as implementation of Continuous Improvement (cycle need to be improved), promotion of ChE ITB becomes much easier. Furthermore, High Standard of Safety, Health and Environment has been improved and benchmarked by other Programs at ITB level as well as HEI in Indonesia, and open-minded towards criticism within the faculty member. Moreover, Chemical Engineering ITB is committed to deliver quality in education to the students. These knowledge sharing, good practices, and innovation in chemical engineering education are expected to be valuable for other Program to prepare for cycle assessment especially for ABET accreditation or reaccreditation.

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ISSN: 2353-5917