ABET
Self-Study Report

for the

Industrial Engineering Program

at

Escuela Superior Politécnica del Litoral (ESPOL)

Guayaquil, Ecuador

June 2016

CONFIDENTIAL

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Program Self-Study Report
for
EAC of ABET
Accreditation or Reaccreditation

BACKGROUND INFORMATION

A. Contact Information

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B. Program History

In April 11, 1995, the Industrial Engineering (IE) program was established at ESPOL; after an analysis of the needs of the Ecuadorian manufacturing sector. The IE program provides students with a broad scientific and engineering base. The program contains a sequence of courses in mathematics, physics, chemistry, statistics and the engineering sciences, as well as classes in: manufacturing systems control, operations research, quality, logistics, finance, safety and human resources.

The first students transferred from existing engineering programs at the university. However, in 1996 IE received students fulfilling the admission criteria of ESPOL. Year after year, admissions increased and reached an average of 45 new students per semester.

At the beginning, IE faculty included instructors from the Mechanical Engineering Program and others from the local industry. At present, the program faculty comprises former students with master's and doctoral degrees in Industrial Engineering related areas and high experienced instructors.

In 2005, a major review of the curriculum was made, based on the needs of the local industry, alumni and faculty. Courses in the areas of: operations research, quality, manufacturing systems control, safety and human resources management were strengthened.

Currently, there are 425 full-time students and 16 faculty members to cover professional curriculum areas. In 2015, the IE program enhanced its curriculum considering input from the advisory board, graduates, local and national agencies, and research reports from leading experts in the field.

This is the first time the Industrial Engineering program of ESPOL applies for ABET accreditation.

C. Options

The IE program does not offer any standardized tracks or concentrations.

D. Program Delivery Modes

The program is exclusively delivered on campus on a traditional lecture/laboratory format. The Mechanical and Production Sciences Engineering College offers IE undergraduate courses mainly during weekdays (M-F) between 07:30am and 08:30pm. All courses are provided with a learning management platform, called SIDWeb.

E. Program Locations

The program is offered only at ESPOL main campus in Guayaquil, Ecuador.

F. Public Disclosure

The program educational objectives (PEOs) were developed with the participation of representatives of all the constituents. They can be found on the FIMCP website: http://www.fimcp.espol.edu.ec/en/departments/Industrial-and-Systems-Engineering/undergraduateprogram/missionandobjectives.html

G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

This is an initial accreditation for the program.

GENERAL CRITERIA

CRITERION 1. STUDENTS

For the sections below, attach any written policies that apply.

A. Student Admissions

ESPOL as a public-funded university follows the admission process established by the National Board for Leveling and Admissions (SSNNA Acronyms in Spanish). Additionally, the process is managed centrally by ESPOL's Admissions office. This process consists of the four stages described in Figure 1-1:

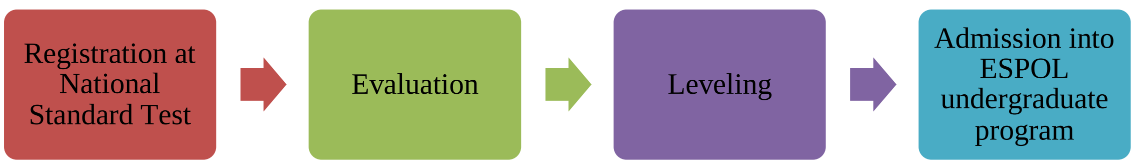

Figure 1-1: SSNNA admissions process

Prospective students that finished high school register at the SSNNA web site to take the National Standard Test. The test evaluates: critical reading, mathematics and abstract reasoning. If the applicant scores above 750 points out of 1,000 is eligible to enroll for ESPOL leveling process.

The leveling process at ESPOL comprises the following courses: Communication and Thinking skills development as well as Mathematics, Physics and Chemistry for the engineering path. The regular leveling process takes 6 months; however applicants can apply to an intensive 3 months course work. The minimum grade to pass any of the leveling processes is 8 points out of 10. Summarize the requirements and process for accepting new students into the program.

Every year, each program at ESPOL recommends a quota for admitted students. Applicants in the leveling courses are not IE students; they do not represent resource usage for the program. With the minimum grade and proper documentation applicants are admitted into the Industrial Engineering Program.

Table 1-1 shows the history of Student admissions to the IE program for the past five years.

Table 1-1. Admitted students to the IE Program

Year	Semester	Admitted Students
2012	1	29
2012	2	39
2013	1	51
2013	2	35
2014	1	62
2014	2	40
2015	1	38
2015	2	69
2016	1	42

B. Evaluating Student Performance

Progress in the IE curriculum is established through prerequisites included in the program description. Within a course, the instructor monitors class performance. If students are having difficulties during a class, they are encouraged to discuss academic concerns with their instructor or academic advisor. Also, faculty can commend students to ESPOL Counseling Services. There, a staff of professionals is able to assist students.

The evaluation of student performance at ESPOL considers:

a. The fulfillment of objectives of each course and the achievement of the general objectives of the undergraduate program.
b. The evaluation is a component of the teaching-learning process, so it is done throughout the course. This includes evaluations such as: homework, quizzes, group projects and exams. Evaluations are taken according to the Regulations for Undergraduate Evaluation and Grading.

At ESPOL, courses are classified as theoretical or practical. Theoretical courses have three evaluations, known as First, Second and Third evaluation.

For the first two evaluations, the grade is composed by: the exam score (which weights between 50% and 70% of the total score), and the overall score for other assignments such as quizzes, homework, short exams, projects and other activities (which weights between 50% and 30%). Weight percentages for the exam and the other form of evaluations are defined at the syllabus of each course. For the third evaluation, 100% of the grade corresponds to an exam. The evaluation of each exam is on a maximum of 100 points using only integer numbers.

The final grade is the result of averaging the two best grades out of the three evaluations; and dividing it by 10. In this way, the student obtains a final grade on a scale from 0.00 to 10.00.

Practical courses are evaluated with a single grade, reported at the end of the semester. This grade considers homework assignments, quizzes, reports, projects and other activities established by the instructor in the evaluation policy. The policy is handed in to the students during the first week of the semester

In the case, that the course includes one final exam, the exam grade cannot weight more than 20% of the total. The final exam, if it is considered, must be administered during the period allocated for the Third evaluation. The passing grade for both theoretical and practical courses is 6 on a maximum of 10.

IE assigns academic advisors to monitor each student's academic progress. Every semester, all the students are required to meet with their academic advisors before registering for courses. The regulations for academic advising ask students to report to their academic advisors after partial grades are released. (See section on academic advising).

C. Transfer Students and Transfer Courses

Admitted students may transfer credits from other universities through the process of validation of studies. ESPOL policy is to accept credits earned from fully accredited institutions, only if such credits have been earned through university-level courses. This policy applies to credits earned from both Ecuadorian and foreign institutions. Requirements for validation of studies include the submission of certified and legalized documents (in the case of applicants from foreign countries, by the corresponding ministries and consulate offices). Students willing to transfer credits must present their application to the Provost of ESPOL.

Transfer applications are reviewed to determine which applicant's credits apply toward the Bachelor of Sciences in Industrial Engineering degree. The reviewing process requires the analysis of a faculty member and further approval of the program coordinator and the associate dean of academics.

There have been five transfer students during the last five academic years.

Also, according to Regulations for Undergraduate Studies, ESPOL students are able to transfer course credits from one program to another. Regulations state:

- A change in career may be granted twice, according to the admission rules of the new program, and,
- Courses from another ESPOL program could be accredited as free electives for the current curriculum.

D. Advising and Career Guidance

Academic counseling at ESPOL is mandatory since 2013. The goal is to provide students with orientation on issues relating their studies and their future profession, as well as to monitor their progress until they finish the curriculum. In order to support and achieve this goal, ESPOL counts with and information system: Academic Advising System (AAS).

Every student at ESPOL has an advisor. Advisors are faculty members randomly assigned by the AAS. Once assigned, a student's advisor will accompany him or her until graduation, unless the Program Coordinator makes any changes. IE faculty advises approximately 30 students each.

ESPOL determines that advice meetings should occur three times during the academic year: twice before the first examination and once after the third examination. Students schedule meetings with advisors through the AAS.

During the advising meeting, advisors discuss student academic progress, internships -if that is the case-, and personal interests. Besides, advisors assist students with personal issues and career counseling.

In addition to the counseling provided by teachers, ESPOL provides students counseling services that includes an available staff of psychologists and social workers. These services aim to provide students with emotional support and guidance.

ESPOL offers the support of its Career Center: CEPROEM - Acronym in Spanish-. This Center aims to:

- Promote students and graduates in firms/industry from the public and private sectors.
- Support the academic programs in the internship process.
- Sign agreements with industry in order to facilitate internships
- Encourage students to develop their personality and sense of leadership through the issuance of extracurricular workshops and courses on labor-related topics.
- Expand the network of contacts of public and private institutions to provide greater opportunities to our students and graduates
- Organize career fairs to enable our students to have the opportunity to be recruited by firms/industry or carry out their internships
- Organize customized events for recruiting.

E. Work in Lieu of Courses

ESPOL and the program do not award credit for work in lieu of courses. Nonetheless, graduation requirements include 640 internship hours.

F. Graduation Requirements

In order to graduate, IE students must complete all requirements in the curricular plan, including a capstone design course and internship hours. The graduation date corresponds to the day of capstone design project presentation.

For ensuring and documenting that each graduate completes all graduation requirements, Undergraduate Regulations requires students to obtain the Unique Certificate for Graduation, which is provided by the Office of the Registrar once the IE Program Coordinator checked the fulfillment of all the requirements.

The degree that is awarded at the IE Program is: Industrial Engineer, corresponding to the Bachelor of Science level, from the program Industrial Engineering

Transcripts of Recent Graduates

A list of IE students who graduated during 2014-1 and 2014-2 is presented in Table 1-2. It includes the student's registration number and name.

Table 1-2. Recent graduates of the IE Program

Id.	Registration number	Name
1	200818268	ALBAN MALDONADO LUIS EDUARDO
2	200834224	ARTEAGA CUEVA MICHELLE DENISSE
3	200632131	BAGUA FERNANDEZ WILSON XAVIER
4	199819871	BERMEO REYES ROSA VIVIANA
5	200508349	BLACIO MALDONADO LIZBETH GABRIELA
6	201008844	BROWN ESTRADA KARLA ALEJANDRA
7	201129118	CASTELLON CORDOVEZ CARLOS JAVIER
8	200849255	CASTILLO ALVARADO EDUARDO XAVIER
9	201010840	CELI LUPERA NELSON JAVIER
10	200732659	CHALEN JIMENEZ EDUARDO ALEJANDRO
11	200902039	CHIA DE LA FLOR JUAN CARLOS
12	201010097	CHIMARRO TORRES SANTIAGO JAVIER
13	201018561	CORREA TORRES GRACE KATHERINE
14	200902419	ESPINOZA CORDERO ANDREA ISABEL
15	200903748	ESPINOZA MORAN WALTER HONORATO
16	200815314	ESPINOZA ROJAS RUSBELL ALEXANDER
17	200712362	GUERRERO MUÑIZ CARLOS ALEJANDRO
18	201020443	HIDALGO IBARRA JAVIER ANDRES
19	200907582	MEDINA GARATE CARLOS LEONARDO
20	201019890	MOLINA GARCIA BRYAN ANDREE
21	201019684	MOREIRA TOALA JORGE ANDRES
22	201020526	MOROMENACHO SOLIS NADIA STEFANY
23	200730539	MURILLO FLORES LUIS JAVIER
24	200726826	NUÑEZ GONZALEZ LUIS ZENEN
25	201021847	PACHECO PAZMIÑO PRISCILA YOLANDA
26	201144257	RETAMALES GARCIA SOFIA LORETO
27	199900812	RIOFRIO LAZO ROMMELL FABRISIO
28	200720209	RIVERA SOZORANGA LUIS FERNANDO
29	201015161	SALTOS PEÑAFIEL PAOLA ESTEFANIA
30	200407294	SANTAMARIA HEREDIA GARY BRYAN
31	201149731	SEGURA OLAYA MELISA LUCIA
32	200217131	SIERRA MARTINEZ CHARLES DAVID

Id.	Registration number	Name
34	200810695	TOALA QUIMIS BYRON JAVIER
35	201016425	VELEZ COJITAMBO KATTY VIVIANA
36	200835262	VERA MALDONADO EDY MAURICIO
37	200217040	VERA MUÑOZ DELIA DOLORES
38	200008498	VILLAO BORBOR EVELYN NARCISA
39	201016839	VILLAVICENCIO PERERO CRISTHIAN ERNESTO
40	200519569	VILLACIS CHAFLA JOSE DAVID

G. Transcripts of Recent Graduates

The program will provide transcripts from some of the most recent graduates to the visiting team along with any needed explanation of how the transcripts are to be interpreted. **These transcripts will be requested separately by the team chair.** State how the program and any program options are designated on the transcript. (See 2015-2016 APPM, Section II.G.4.a.). Masters degree programs under review must also provide copies of the same students' undergraduate academic transcripts that were used to make an admission decision.

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. *Mission Statement*

The Escuela Superior Politécnica del Litoral, ESPOL, has the following mission:

"To form excellent, socially-responsible professionals, leaders, entrepreneurs, with solid moral and ethical values that contribute to the scientific, technological, social, economic, environmental and political development of the country, and to serve society by carrying out research, innovating, promoting technology transfer and providing high quality services."

The Mission of the College of Mechanical Engineering and Production Sciences (FIMCP, acronym in Spanish) is:

"The College of Mechanical Engineering and Production Sciences in its engineering programs forms professionals of excellence, leaders, and entrepreneurs, with solid moral and ethical values, that will contribute to the development of the country, and empower its social, economic, environmental and political development. The faculty conduct high quality research, technology transfer, and extension to serve society."

The Mission of the Industrial Engineering (IE) Program is:

"To educate industrial engineers of excellence that are socially conscious, leaders and entrepreneurs, with solid moral and ethical values, with knowledge and skills to (1) use human, financial and technical resources efficiently, (2) design, optimize and continuously improve manufacturing and service processes, (3) manage human resources, and, (4) use effective information for decision-making. They are professionals with the necessary competence to carry out research, innovate, and promote technology transfer, to serve society and contribute to the development of the country."

B. *Program Educational Objectives*

IE graduates from ESPOL, after 3 to 5 years of professional practice, will have:

PEO 1. Experienced a successful career by effectively and ethically practicing industrial engineering or applying IE knowledge in related fields.
PEO 2. Attained new knowledge and expertise through professional development opportunities, continuing education or advanced degree programs.
PEO 3. Been involved in entrepreneurial activities and/or assumed management or leadership roles of increasing responsibility and impact during their professional practice.
PEO 4. Contributed to the sustainable development of their communities or society.

C. *Consistency of the Program Educational Objectives with the Mission of the Institution*

The PEOs of the IE program are fully consistent with the program and institution missions. Table 2-1 shows the consistency of the PEOs with the mission of the institution, and the mission of the IE program.

Table 2-1. Consistency of the Program Educational Objectives with the Institutional and Program Missions

Institutional Mission	**Program Mission**	**Program Educational Objectives**
(I) To educate excellent, socially-responsible professionals	To educate industrial engineers of excellence that are socially conscious,	PEO 1. Experienced a successful career by effectively and ethically practicing industrial engineering or applying IE knowledge in related fields.
(II) leaders, entrepreneurs,	leaders and entrepreneurs,	PEO 3. Been involved in entrepreneurial activities and/or assumed management or leadership roles of increasing responsibility and impact during their professional practice.
(III) with solid moral and ethical values	With knowledge and skills to (1) use the human, financial, and technical resources efficiently, (2) design, optimize and continuously improve manufacturing and service processes, (3) manage human resources, (4) use effective information for decision-making.	PEO 1. Experienced a successful career by effectively and ethically practicing industrial engineering or applying IE knowledge in related fields.
(IV) that contribute to the scientific, technological, social, economic, environmental and political development of the country,	**They are professionals with the necessary competence to do research, innovate, promote technology transfer, to serve society and contribute to the development of the country.**	PEO 1. Experienced a successful career by effectively and ethically practicing industrial engineering or applying IE knowledge in related fields. PEO 4. Contributed to the sustainable development of their communities or society.

Institutional Mission	Program Mission	Program Educational Objectives
(V) To serve society by carrying out research, innovating, promoting technology transfer and providing high quality services	**They are professionals with the necessary competence to do research, innovate, promote technology transfer, to serve society and contribute to the development of the country.**	PEO 2. Attained new knowledge and expertise through professional development opportunities, continuing education or advanced degree programs. PEO 4. Contributed to the sustainable development of their communities or society.

D. Program Constituencies

The program has considered the following constituents:

- Alumni: The IE program meets the needs of alumni by preparing them for jobs in industry and/or academia. Yearly, we survey alumni who graduated one, three and five years ago. Survey questions focus on alumni's satisfaction with the IE academic program as a whole, as well as their plans for future education and employment. The information that we get from surveys helps us to track if both educational objectives and student outcomes are being met.

- Employers: Our graduates work in almost all sectors of the industry, including, but not limited to, manufacturing, financial and health services, engineering education, business, consulting, and public policy making. Therefore, we aim to keep the IE program’s curriculum up-to-date with the needs of industry. Our program is aimed at providing our students with the essential knowledge that will allow them to grow intellectually as they work in the industry and provide them with the ability to adapt their problem-solving skills to attain success regardless of the career path they take. By using employer surveys on alumni job performance, the program monitors whether or not employers expectations are being met.

- Faculty: The IE program depends on its faculty. To become a leading IE program in Ecuador would be extremely difficult without the input and enthusiasm of our faculty to adjust and renew the program. The faculty members have been involved in every aspect during the development of our PEOs and student outcomes (SOs). Additionally, they have been responsible for the assessment and evaluation of the SOs for continuous improvement.

E. Process for Review of the Program Educational Objectives

The IE program has an Advisory Board comprising of representatives of the alumni, employers and faculty. This board meets once a year. The last meeting was held in November 2015. The PEOs were established by the board taking into consideration the institutional mission, national and international needs, and the ABET criteria. Alumni surveys were used to ensure this alignment.

The PEOs are reviewed by the Advisory Board every three (3) years. Information from the follow-up surveys, evaluation of student outcomes, and an overview of national needs and international perspectives is discussed.

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

ESPOL's Industrial Engineering (IE) program student outcomes (SOs) are the following. Graduates will have:

- SO_a: An ability to apply knowledge of mathematics, science and industrial engineering.
- SO_b: An ability to design and conduct experiments, as well as to analyze and interpret data in the context of industrial engineering.
- SO_c: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- SO_d: An ability to function on multidisciplinary teams.
- SO_e: An ability to identify, formulate, and solve industrial engineering problems.
- SO_f: An understanding of professional and ethical responsibility.
- SO_g1: An ability to communicate effectively (orally and in writing).
- SO_g2: An ability to communicate in English.
- SO_h: The broad education necessary to understand the impact of industrial engineering solutions in a global, economic, environmental, and societal context.
- SO_i: A recognition of the need for and an ability to engage in life-long learning.
- SO_j: A knowledge of contemporary issues.
- SO_k: An ability to use the techniques, skills, and modern engineering tools necessary for industrial engineering practice.
- SO_l: A recognition of the need for entrepreneurship and the abilities to become an entrepreneur.

A mapping of the IE student outcomes to the ABET a-k and to the ABET IE program criteria is presented in Table 3-1. The table includes the IE program mission along with the ABET criteria.

Table 3-1. Relationships between Program Student Outcomes and Criterion 3 Student Outcomes/Program Criteria

Program Educational Objectives **IE Program Outcome**	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
SO_a: An ability to apply knowledge of mathematics, science and industrial engineering	x										
SO_b: An ability to design and conduct experiments, as well as to analyze and interpret data in the context of industrial engineering		x									

Program Educational Objectives IE Program Outcome	a	b	c	d	e	f	g	h	i	j	k
SO_c: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.			X								
SO_d: An ability to function on multidisciplinary teams				X							
SO_e: An ability to identify, formulate, and solve industrial engineering problems					X						
SO_f: An understanding of professional and ethical responsibility						x					
SO_g1: An ability to communicate effectively (orally and in writing)							x				
SO_g2: An ability to communicate in English							x				
SO_h: The broad education necessary to understand the impact of industrial engineering solutions in a global, economic, environmental, and societal context								x			
SO_i: A recognition of the need for and an ability to engage in life-long learning									x		
SO_k: An ability to use the techniques, skills, and modern engineering tools necessary for industrial engineering practice											
SO_j: A knowledge of contemporary issues										x	
SO_l: A recognition of the need for entrepreneurship and an ability to become an entrepreneur											

B. Relationship of Student Outcomes to Program Educational Objectives

A matrix showing how the IE program student outcomes contribute to the attainment of the IE program educational objectives (PEOs) is presented in Table 3.2

Table 3-2. Relationships between IE Program Student Outcomes and Educational Objectives

ABET Student Outcomes	PEO 1. Experienced a successful career by effectively and ethically practicing industrial engineering or applying IE knowledge in related fields.	PEO 2. Attained new knowledge and expertise through professional development opportunities, continuing education or advanced degree programs.	PEO 3. Been involved in entrepreneurial activities and/ or assumed management or leadership roles of increasing responsibility and impact during their professional practice.	PEO 4. Contributed to the sustainable development of their communities or society.
SO_a: An ability to apply knowledge of mathematics, science and industrial engineering	x			
SO_b: An ability to design and conduct experiments, as well as to analyze and interpret data in the context of industrial engineering	x			
SO_c: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	x			x
SO_d: An ability to function on multidisciplinary teams			X	
SO_e: An ability to identify, formulate, and solve industrial engineering problems	x			

ABET Student Outcomes	**PEO 1. Experienced a successful career by effectively and ethically practicing industrial engineering or applying IE knowledge in related fields.**	**PEO 2. Attained new knowledge and expertise through professional development opportunities, continuing education or advanced degree programs.**	**PEO 3. Been involved in entrepreneurial activities and/ or assumed management or leadership roles of increasing responsibility and impact during their professional practice.**	**PEO 4. Contributed to the sustainable development of their communities or society.**
SO_f: An understanding of professional and ethical responsibility				x
SO_g1: An ability to communicate effectively (orally and in writing)	x			
SO_g2: An ability to communicate in English	x			
SO_h: The broad education necessary to understand the impact of industrial engineering solutions in a global, economic, environmental, and societal context	x		X	x
SO_i: A recognition of the need for, and an ability to engage in life-long learning		x		
SO_j: A knowledge of contemporary issues		x		
SO_k: An ability to use the techniques, skills, and modern engineering tools necessary for industrial engineering practice	x			
SO_l: A recognition of the need for entrepreneurship, and an ability to become an entrepreneur	x		X	x

CRITERION 4. CONTINUOUS IMPROVEMENT

A. *Student Outcomes*

The Industrial Engineering (IE) student outcomes (SOs) are listed in Criterion 3, and the way the curriculum and its associated prerequisite structure support the attainment of the SOs is described in Criterion 5. This section documents how the IE program assesses and evaluates the extent to which the IE SOs are being attained.

(a) Listing and description of the assessment process

The IE program annually assesses and evaluates the attainment of SOs using direct measures in the courses. Also, indirect measures are obtained from evaluations of the IE program internships.

Faculty are responsible for assessing and evaluating one or two specific SOs. The ABET Coordinator is responsible for collecting evidence. Once the results of all the SOs have been processed, meetings are scheduled with faculty to evaluate the results and discuss improvement actions.

The assessment tools to measure the attainment of SOs include course assignments and exams. These comprise of specific exam questions, class discussions, case studies and project reports. The IE program also addresses the attainment of SOs during the annual Industrial Advisory Board meeting.

Faculty Meetings

ABET and IE Coordinators, along with some faculty, discuss the data collection processes, review the rubrics used to measure the SOs, and define the courses in which the SOs are going to be measured. For each SO, two courses are selected for formative assessment and one course for summative assessment (see Table 4.1 Direct Measurement Cycle 2014-2016).

Survey to alumni

IE graduates from 2009, 2011, and 2013 were asked to complete a survey regarding their professional development and evolution. The survey also asked about the university's contribution to developing engineering skills (i.e. the SOs were listed and alumni gave their opinions).

Assessment of student outcomes in specific courses

The IE SOs are directly measured in the courses. The IE program took the initiative to develop the rubrics to assess and evaluate SOs during the first semester of 2014.

Assessment of student outcomes in Internship evaluations.

Internships at the IE program are planned beforehand with industrial partners. Faculty and/or the Program Coordinator establish meetings before the internship begins to schedule activities for each student and develop an action plan. Students have a tutor available to answer questions and evaluate their performance in the company.

(b) Frequency with which these assessment processes are carried out

As mentioned, the IE program annually assesses and evaluates the attainment of SOs in required courses. The Direct Measurement Collection Cycle is presented in Table 4-1

Table 4-1. Direct Measurement Cycle 2014-2016

IE Student Outcome	2014-	2014-	2015-	2015-	2016-	2016-
SO_a: An ability to apply knowledge of mathematics, science, and industrial engineering.		X		X		X
SO_b: An ability to design and conduct experiments, as well as to analyze and interpret data in the context of industrial engineering.	X		X		X	
SO_c: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	X		X		X	
SO_d: An ability to function on multidisciplinary teams.		X		X		X
SO_e: An ability to identify, formulate, and solve industrial engineering problems	X		X		X	
SO_f: An understanding of professional and ethical responsibility.	X		X		X	
SO_g1: An ability to communicate effectively (3g1 orally, 3g2 written).		X		X		X
SO_g2: An ability to communicate in English.		X		X		X
SO_h: The broad education necessary to understand the impact of industrial engineering solutions in a global, economic, environmental, and societal context.	X		X		X	
SO_i: A recognition of the need for, and an ability to engage in life-long learning.		X		X		X

IE Student Outcome	2014-	2014-	2015-	2015-	2016-	2016-
SO_j: A knowledge of contemporary issues.	X		X		X	
SO_k: An ability to use the techniques, skills, and modern engineering tools necessary for industrial engineering practice.		X		X		X
SO_l: A recognition of the need for entrepreneurship and the abilities to become an entrepreneur.		X		X		X

(c) Expected level of attainment for each of the student outcomes

The program has set the expected level of attainment at 80% of students either at the satisfactory or exemplary level (the rubrics used consists of a four-level scale: unsatisfactory, developing, satisfactory, and exemplary).

(d) Summaries of the results of the evaluation process and an analysis

The results and evaluation of the evaluation process in specific courses are presented in this section by outcome.

SO_a: An ability to apply knowledge of mathematics, science and industrial engineering.

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-II	Facility Design/ Project	No. 58%	February/2015	Faculty will require several project progress reports before its final delivery date. The feedback will be stated in writing. Held private sessions with students to review reports.	The rubric was presented at the beginning of the semester. The students presented several progress reports along the semester.
2014-II	Statistical Quality Control. Exam question	Yes.88%	February/2015	Continue monitoring progress	

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2015-II	Statistical Quality Control. Exam questions	No. 77%	May 2016	Increase the use of spreadsheets to process raw data under timing constraints	

Conclusions and evaluation of results of SO_a : The assessments used for outcome (a) included direct methods in two courses: Statistical Quality Control and Facility Design. During 2014-II in the Facility Design class the students were not familiar with the rubric, therefore they did not have a clear idea of the evaluation areas. Also, faculty provided feedback during class and not in private sessions. The latter hindered important questions from the students. During 2015-II in the Statistical Quality Control class the students were required to use software to construct control charts and develop capability analysis from raw data. Also, conclusions and interpretations of the results were required.

SO_b: An ability to design and conduct experiments, as well as to analyze and interpret data in the context of industrial engineering

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-I	Design of Experiments /Final Project	No. 75%	February 2015	Develop several experiments, starting with one factor and finishing with several input variables	Divide the project in stages. Ask for partial reports and give feedback
2015-I	Design of Experiments / Final Project	Yes. 92%	November 2015	Continue to monitor progress	

Conclusion and Evaluation of SO_b: The assessment used for outcome (b) was composed from the final project of the Design of Experiments class. The project comprised the interpretation of customer needs based on variables, model formulation, leading the experiment, the analysis of the results and conclusions. During the first evaluation (2014-I), students had issues applying concepts like sample size and randomization, and analyzing several factors.

SO_c: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Data Performed	**Assessment Method**	**Met Target?**	**Faculty Review/Approval**	**Recommended Action**	**Action Taken if necessary**
2014-I	Facility Design /Project	No. 60%	February 2015	Faculty will require partial project reports before the due date. The suggested corrections and next steps must be included in the following reports. Analysis of constraints must be included.	The rubric was presented at the beginning of the semester. The students presented several progress reports along the semester.
2015-I	Facility Design/ Project	Yes. 88%	November 2015	Continue to monitor progress.	
2015-I	Capstone Course/Final executive Presentation	Yes. 86%	June 2016	Continue to monitor progress.	

Conclusions and evaluation of results of SO_c : In the first measurement cycle 60% of the students in the Facility Design final project reached the satisfactory and exemplary level. In most of the cases, the students presented incomplete constraints definitions. In 2015-I this SO was evaluated at the final executive presentation of the Capstone Design course. During this presentation, the students had to demonstrate the implementation/prototyping of IE related solutions in the company, considering each firm's real constraints. Students were expected to apply their implementations/prototypes around the 14th week.

SO_d: An ability to function on multidisciplinary teams.

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-II	Basic Instrumentation /Peer evaluation	Yes. 100%	February 2015	Use a more discriminatory instrument for assessment.	A better instrument for assessment was used in 2015
2014-II	Market Research/ Exam questions	Yes. 100%	February 2015		
2015-II	Basic Instrumentation /Peer evaluation	Yes. 98%	November 2015	Continue to monitor progress	
2015-II	Market Research/ Exam questions	Yes. 89%	November 2015	Continue to monitor progress	
2015 - II	Capstone Design/Executive presentations	Yes.86%	June 2016	Continue to monitor progress. Next semester each project tutor will assess this outcome.	
2015 I & II	Internships. Sample of Company's evaluations	No.75%	June 2016	Reinforce teamwork concepts through classes. Provide tips for a successful teamwork experience prior internship	

Conclusions: When it comes to evaluating multidisciplinary teams, the IE program faces some difficulties because most of our courses are for IE students only. However, the outcome has been assessed within individual courses, i.e. Basic Instrumentation (IE and ME students), Capstone Design executive presentations, and companies' internship evaluations. At the beginning of the measurement process, faculty did have issues with the discriminatory power of their measuring tool.

Evaluation of results of SO_d: In general, the expected level of attainment for this student outcome is achieved at the course level, including the Capstone Design class. Within the classroom, the support of the tutors during weekly meetings helps students to deal with team working issues. On the other hand, internship company evaluations showed that approximately 43% of the students required supervision to fulfill tasks.

SO_e: An ability to identify, formulate and solve industrial engineering problems

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-I	Stochastic processes and Queuing Theory/ Exam questions	Yes. 85%	February 2015	Continue Monitoring. Include real case scenarios that help students internalize engineering concepts	A discussion on airport queuing performance assessment was included in the lectures.
2014-I	Logistics/Case study	No. 39%	May 2016	Reinforce the proper selection of method and models to solve the problem	When problems were resolved in class, it was reinforced which and why a method/ model from the previous and current courses is the right choice vs. others
2015-I	Stochastic processes and Queuing Theory/ Exam questions	Yes.79%	May 2016	Continue monitoring	
2015-I	Logistics/Case study	Yes.85%	May 2016	Continue monitoring	
2015-I	Capstone Course/Executive Presentations	Yes.83%	June 2016	Continue monitoring	

Conclusions and Evaluation of results of SO_e: In 2014-I the students from the Logistics class had issues describing the problem, identifying relevant data, applying the proper methodology, and proposing solutions. Faculty realized that students were applying formulas without considering the implications of the addressed problems and without analyzing the data.

SO_f: An understanding of professional and ethical responsibility

Data Performed	Assessment Method	Met Target ?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-I	Organizational Behavior/Individual workplace scenarios	No. 37%	February 2015	Expose students to ethical issues in the IE profession	Workplace scenarios were discussed in class in order for students to analyze ethical issues within an organization.
2014-I	Integrated Management Systems/real life situations related to the course	Yes. 100%	February 2015	Use a more individual instrument for assessment.	Real-life ethical settings have been discussed in the classroom, evaluating possible outcomes according to the path of action taken by decision makers.
2015-I	Organizational Behavior/Individual workplace scenarios	No. 50%	March 2016		
2015-I	Integrated Management Systems		By the date of the meeting there was no evidence of the assessment	Assess this SO at the Capstone Design course (2016-I)	
2015 I&II	Internships. Sample of Company's evaluations	Yes. 89%	June 2016	Continue monitoring	Tutor meets with company supervisor and the student separately to discuss a student’s performance in ethics within a professional environment.

Conclusions and Evaluation of results of SO_f: In 2014-I in the Organizational Behavior class, students identified ethical issues in the scenarios that were presented, but they did not analyze the ethical issue in order to present alternatives. For instance, the students lacked arguments to support the solutions to the identified problem. On the other hand, in real-world settings (internships), industry reported that students did understand their role as professionals nor the ethical responsibility associated with professional practices.

SO_g1: An ability to communicate effectively (orally and written).

Oral Skills

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-II	Quality System Management/ Project Oral presentations	Yes. 86%	February 2015	Make presentations on applications of quality methodologies	Oral presentations. Faculty assigned specific topics for each group.
2014-II	Organizational Behaviour /Oral presentation of an academic paper.	Yes.95%	February 2015	Continue monitoring	
2015-II	Quality System Management/ Project Oral presentations	Yes. 98%	May 2016	Continue monitoring	
2015-II	Organizational Behaviour /Oral presentation of an academic paper.	Yes.95%	May 2016	Continue monitoring	
2015 I & II	Internships. Survey of company evaluations	Yes. 92%	June 2016	Modify the rubric to include the evaluation of the arguments.	

Conclusions and Evaluation of results of SO_g1: Students demonstrate the correct structure when they deliver an oral presentation, which includes introduction, body, and conclusion. Additionally, students demonstrate that the intended message reaches the audience. According to the assessment, the target for this outcome was achieved.

Written Skills

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-II	Integrated Management Systems	Yes. 80%	February 2015	Continue monitoring	
2014-II	Business Economics/ Written report of an macroeconomic analysis.	No. 58%	February 2015	Request students to justify their conclusions with the indicators and graphs	Analysis of macroeconomic reports.
2015-I	Capstone Course/ Project Report	No. 77%	November 2015	Create a standardized format report for capstone project	Starting 2015 II capstone course students received a standardized format for their report, and also handouts and a rubric for argumentative writing.
2015-II	Integrated Management Systems	Yes. 90%	March 2016	Continue Monitoring	
2015-II	Business Economics/Written report of an macroeconomic analysis.	No. 62%	March 2016	Request students to justify their conclusions with the indicators and graphs	
2015-II	Human Resources Management/ Project reports	Yes. 89%	June 2016	Incorporate generic format for reports for classroom activities among different courses	

Conclusions and Evaluation of results of SO_g1: At the summative level, the target for this outcome was reached in 2015 II, meaning students were able to deal with text organization, coherence, and spelling. However, students seemed to struggle with complex grammar structure, the quality of the content (argumentation and creativity), and the use of figures, tables, and statistics during compositions.

SO_g2: An ability to communicate effectively in English

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-II	Formulation and Evaluation Of Projects/ Project	Yes. 90%	February 2015	None	None
2014-II	Production Planning/ Homework assignment: Critical Essay	No. 67%	February 2015	Include additional homework assignments that require writing essays in English	Students worked on a critical analysis essay before midterms, as well as, working on an argumentative essay before finals.
2015-I	Capstone Course/ Abstract	No. 75%	June 2016	Incorporate workload activities in English, including readings, composition and oral presentations	Production Planning, Advanced Production Systems, Simulation, and Facility Design have included reading in English. Inferential Statistics and Formulation and Evaluation of Projects have included oral presentations in English.
2015-II	Production Planning/ Essay	No. 65%	May 2016	Continue with essays	
2015-II	Capstone Course/Recorded presentation in English	No. 76%	June 2016	Perform executive presentations in English	

Conclusions and Evaluation of results of SO_g2: For this particular outcome, students did not achieved the expected 80% level of attainment. Faculty members agree that more work needs to be done at the course level, which must include strategies for improving communications skills in English. Faculty have also sensed that cognitive processing is ignored under prevailing views of second language instruction.

SO_h: The broad education necessary to understand the impact of industrial engineering solutions in a global, economic, environmental, and societal context

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-I	Strategic Planning/ Project	No. Classwide average 8%	February 2015	Use a more discriminatory instrument for assessment.	
2014-I	Business Economics/ Economic written report	No. Classwide average is 46%	February 2015	Develop a case study in a small business environment.	Lead students to the analysis of basic economic indicators
2015-I	Strategic Planning/ Project	Yes. 92%	February 2016	Next occasion, measure in the Capstone Design class.	
2015- I	Business Economics/ Economic written report	No. Classwide average is 72%	February 2016	Develop a case study in a small business environment.	Lead students to the analysis of basic economic indicators
2015-I	Capstone Course/Executive Presentations	Yes 92%	June 2016	Continue monitoring	

Conclusions and Evaluation of results of SO_h: During 2014-I the evaluation instrument was not discriminatory at the Strategic Planning class. At the Business Economics class, the students had issues identifying factors that impact society, evaluating critical factors, and selecting alternatives. In the 2015-I, the Strategic Planning faculty did not present measurements. During the same period, students from the Business Economics class improved their performance in the identification of factors that impact society and their evaluation. However, there are opportunities for improvement in selecting the solutions to solve society problems.

SO_i: A recognition of the need for, and an ability to engage in life-long learning.

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-II	Strategic Planning	No. 8%	February 2015	Improve measurement tool.	
2014-II	Advanced Production Systems	No. 34%	February 2015	Implement the use of self-study guides	Several self-study guides were implemented for solving course projects
2015-II	Strategic Planning	No. 8%	June 2016	Measure in Hygiene and Industrial Safety.	
2015-II	Advanced Production Systems	Yes. 84%	June 2016	Continue monitoring. Improve rubric.	Improve self-study guides

Conclusions and Evaluation of results of SO_i: According to experiences in the Advanced Production Systems class, students have major issues when they need to argue or support ideas. In addition, they appear to lack curiosity, initiative, and independence when it comes to exploring topics in depth on their own. Thus, it is necessary to improve abilities related to information processing aimed at analyzing, synthesizing, evaluating, and proposing ideas. In order to evaluate lifelong learning skills in a better way, the rubric for this outcome will be changed while self-study guides will be provided in more courses.

The IE program will change the evaluation from the Strategic Planning class and consider the Hygiene and Industry Safety class instead.

SO_ j: A knowledge of contemporary issues

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-I	Integrated Management Systems/ Project	No. 75 %	February 2015	Faculty must request that students address the current changes in the law related with integrated systems.	Analysis of new regulations on Quality, Safety and Security should be included in the students' reports.
2014-I	Hygiene and Industrial Safety	No. 71%	February 2015		
2014-I	Quality Systems Management/Assignment	No. 79%	February 2015	Faculty suggest incorporating discussion sections about contemporary issues.	The "Relevant News of the week" activity was implemented. Students must bring
2015-I	Integrated Management Systems/Project	Yes. 94%	May 2016	Continue monitoring.	
2015-I	Hygiene and Industrial Safety	No. 60%	May 2016	Faculty recommend that analysis of contemporary issues should be requested in more courses.	
2015-I	Quality Systems Management/Assignment	Yes. 83%	May 2016	Continue monitoring.	

Conclusions and Evaluation of results of SO_j: On average, the target was met. However, faculty agreed the rubric should include new aspects for evaluation, such as analysis, and evaluation.

SO_k: An ability to use the techniques, skills, and modern engineering tools necessary for industrial engineering practice.

Data Performed	**Assessment Method**	**Met Target?**	**Faculty Review/Approval**	**Recommended Action**	**Action Taken if necessary**
2014-II	Simulation/ Final Project: Promodel	No. 71%	February 2015	Faculty develop mini cases in class.	Minicases workshop in classes.
2014-II	Production Planning/ Assignment using Excel Solver	Yes. 83%	February 2015	Continue monitoring	
2015-II	Simulation/Final Project	Yes. 92%	May 2016	Continue monitoring	
2015-II	Production Planning/Project	No. 76%	May 2016		

Conclusions and Evaluation of results of SO_k: Faculty realized that students have difficulties selecting appropriate tools to solve the proposed problems, e.g.. in the Simulation class students are required to use additional Promodel commands to model the case. Some of those commands are not taught in class. Students presented issues identifying the applications of the new commands.

In 2015-II, the Production Planning Project required the use of scheduling techniques to model a job-floor control systems.

SO_l: A recognition of the need for entrepreneurship, and the abilities to become an entrepreneur.

Data Performed	Assessment Method	Met Target?	Faculty Review/Approval	Recommended Action	Action Taken if necessary
2014-II	Formulation and Evaluation of Projects	No. 72%	February 2015		
2015-II	Formulation and Evaluation of Projects	No. 13%	June 2016		

Conclusions and Evaluation of results of SO_l: For this outcome, we have not achieved the target. This results are related to the focus of the courses where the outcome is measured and the rubric is used (Methods Engineering and Formulation and Evaluation of Projects). The rubric of this outcome is mandatory for all ESPOL courses, but the faculty members did not thoroughly analyze the rubric before selecting the measurement instrument. Furthermore, the rubric contains some criteria that faculty feels is not appropriate for some courses. For example, criteria 2 and 4 were difficult to measure during the Methods engineering course

(e) How the results are documented and maintained

The instruments used for the outcomes measurement are kept at the IE Program Coordination Office in the respective SO portfolio. Each portfolio also includes the rubrics for the outcome measured, the results attained, and the measures proposed to improve students' performance.

The reports of the surveys to alumni are kept in the IE Program Coordination Office as well.

B. Continuous Improvement

Faculty, a student representative, and staff were involved in several meetings in order to evaluate the SO results and to propose future improvement actions. These meetings were held in February 2015, November 2015, May 2016 and June 2016.

The first meeting was called the "ABET Kick-off meeting" (see Figure 4-15). ESPOL's chief executive officers, as well as the College Dean, actively participated with their analysis of the causes behind the figures presented in the "Summary of results" section. As a team, we also developed some improvement actions. The overall actions for improvement were:

- Present and explain the rubric during the first class session.
- Post the rubric on the web-based course platform (SIDWeb).
- Focus on the interpretation of indicators and graphs.
- Provide appropriate feedback.
- Gradually increase the level of complexity of assignments.

Figure 4- 15. Kick-off meeting

The following sessions included the reinforcement of the overall Improvement actions. Also, faculty reviewed the results, discussed recommended actions and suggested for improvement faculty working in groups

Improvement actions per outcome.

SO_a: An ability to apply knowledge of mathematics, science, and industrial engineering.

Two assessments led to actions. The Facility Design project requires the application of at least two concentration areas from the program, such as productions planning, operations research (including simulation tools), quality, and human factors. Also, the students had to include real constraints, such as safety, environmental, and financial. Considering the complexity of the project, faculty suggested asking for several partial deliverables on specific dates. With this initiative, students had the opportunity to build their project at each stage until all the constraints were properly covered with the right interpretation of the results with limited time.

In 2015-II, the students in the Facility Design class were familiar with the rubric since the first day of class and were asked to hold private sessions with the instructor to review progress reports. Faculty will continue holding private sessions guiding students to apply methodology considering case constrains. Also, peer evaluations will be established.

The Statistical Quality Control class faculty required the use of Excel to develop control charts and calculate indicators during the final test from raw data. The time students invested in processing the data exceeded the expected time for such an activity. Therefore, the students ended up lacking the time to properly apply the techniques and interpret results. On the other hand, when students received processed data, e.g. process means or standard deviations, they were able to accomplish the task.

Discussions with faculty led to the conclusion that students must reinforce the abilities provided from the Digital Collaboration course (freshman year). The classes, Methods Engineering, Inferential Statistics, Statistical Quality Control, Production Planning, Advanced Production Systems, and Simulation, will require the use of spreadsheets to process data.

SO_b: An ability to design and conduct experiments, as well as to analyze and interpret data in the context of industrial engineering.

Faculty will continue monitoring the Design of Experiments class. In 2016-I, faculty will emphasize the importance of the verification of solutions according to the desired levels of the relevant factors.

SO_c: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

One assessment led to improvement actions. Faculty required students to deliver partial progress reports and they gave feedback on time. Also, open issues were discussed during class and during private sessions before the final project report due date. From the beginning, students were requested to clearly identify constraints and their implications in the design process.

During the Capstone Design course, faculty will continue monitoring the design process weekly and provide feedback to students.

SO_d: An ability to function on multidisciplinary teams.

During the last meeting (June 20, 2016), faculty made the following recommendations for improving teamwork skills within the IE program:

1. Emphasize the importance of teamwork: During class, faculty must address the need of working in teams. Industry demands employees who can work with others they don't know or may not like, who hold different views, and who possess different skills and capabilities. Students need strategies for dealing with members who are not doing their assignments, for constructively resolving disagreements, and for time management. Whether through handouts, online resources, or class discussions, faculty members will address the roles and responsibilities that members have in relation to the group.
2. Use team-building exercises to build cohesive groups: Faculty should incorporate activities such as picking a group name or creating logos for teams in order to build a sense of identity among team members. Furthermore, faculty members should encourage students to know their team members better and discuss the worst and the best experiences during teamwork, making clear that there are some behaviors to avoid providing strategies to address those behaviors successfully.
3. Thoughtfully consider group formation: Faculty should articulate the groups in a way that furthers the learning goals of the group activity, considering that in most professional contexts, people don't get to choose their project partners.
4. Include peer assessment in the evaluation process. Students should be able to assess and evaluate each other, so faculty will provide rubrics and the framework for peer assessment during projects or groups activities.

The previous recommendations will be addressed in a progressive manner by the following courses: Methods Engineering, Inferential Statistics, Statistical Quality Control, Production Planning, Organizational Behavior and Logistics.

SO_e: An ability to identify, formulate, and solve industrial engineering problems Use of the case study method has proven to be an effective tool to help identify, formulate, and solve engineering problems. It is required that the complexity level of the case studies used in classes is gradually increased throughout the student's program.

Students had difficulties linking theoretical concepts and methods/models with practical application to solve problems. Here, faculty will provide feedback on the way students consider constraints and the validation of model assumptions. Experience from faculty is a crucial resource in this exercise.

SO_f: An understanding of professional and ethical responsibility.

Faculty recognize the need to expose students to ethical dilemmas in the professional practices. At the formative level, in Production Planning course, the analysis of ethical dilemmas has been incorporated for each step of the planning process. Students must address argumentation, considering human factors like the employee's well-being, capacity constraints, and capital budgeting. IE faculty members suggest continuing to incorporate real-life situations in which students must identify and debate ethical behaviour within a professional context. Debate must include the use of valid arguments applying concepts that have been learned in the class.

SO_g1: An ability to communicate effectively (orally and in writing).

Faculty continues to encourage students to critically analyze web sources in oral communication, for example TED Talks. Faculty will also focus on the use of graphs, figures, and indicators to get their messages across. Also, faculty will emphasize the practice of argumentation, time management and executive presentations. These improvements will be incorporate in a new rubric for this outcome.

SO_g2: An ability to communicate in English.

The IE program will evaluate this SO in disciplinary classes after the students have finished their English program at the university.

SO_h: The broad education necessary to understand the impact of industrial engineering solutions in a global, economic, environmental, and societal context.

Faculty need to identify the courses where this is introduced, emphasized, and reinforced. Besides evaluating this outcome in economics-related courses, the IE program will consider evaluating it in classes related to the human factors area, too.

SO_i: A recognition of the need for, and an ability to engage in life-long learning.

Simulation, Production Planning, and Advanced Production Systems implemented self-study guides for homework assignments and projects back the first semester of 2016. Self-study guides are intended to build understanding of the topics covered in class. These guides address the use of in-depth texts and additional references that are relevant for the context of the courses to promote initiative and independency. To be a truly useful tool, self-study guides for projects also address applications for solving open-problems so that students engage in lifelong learning by exploring topics and pursuing knowledge independently, yielding awareness and reflection that indicates interest in the subject. During the second semester of 2015, Inferential Statistics and Engineering Methods started including self-study guides for homework assignments and course projects to develop lifelong learning skills. For capturing more realistic lifelong learning skills, a new rubric for this outcome will be developed during 2016 and will be implemented in 2017.

SO_ j: A knowledge of contemporary issues.

In Integrated Management Systems, Hygiene and Industrial Safety, and Quality Systems Management, faculty request students to describe how the current changes in the law impact IE-related areas. At the formative level, in Industrial Processes and Industrial Psychology, faculty must implement the “relevant news of the week” assignment.

SO_k: An ability to use the techniques, skills, and modern engineering tools necessary for industrial engineering practice.

The Simulation faculty decided to develop workshops during his class. Students previously receive mini cases; afterwards, during the class, they are challenged to develop the model using additional commands. This practice provides a complete experience in using modern tools with the coach of the instructor. Additionally, students are required to develop hypotheses, analyze data (using Minitab), and draw conclusions.

SO_l: A recognition of the need for entrepreneurship, and the abilities to become an entrepreneur.

The ESPOL Entrepreneur Center (CEEMP, acronym in Spanish) is currently working on a new syllabus for the Entrepreneurship course. The objective is to provide students with the skills needed to pursue start-up opportunities after graduation. CEEMP is also preparing a training plan for faculty members across the campus regarding new ways to teach entrepreneurship in class.

Consequently, with the actions of CEEMP, faculty members need to be trained in ways to reinforce the entrepreneurship aspects not only in the Entrepreneurship course, but also in professional courses.

Another improvement action is that faculty members will gather together and analyze ways to reinforce the development of entrepreneurial abilities among the students. This is not an easy task due to the diversity of students and the complexity of the tasks involved.

C. Additional Information

Copies of the assessment instruments or materials referenced in 4.A and 4.B will be available for review at the time of the visit, including minutes from meetings where the assessment results were evaluated and recommendations for action that were made.

CRITERION 5. CURRICULUM

A. Program Curriculum

1. Curriculum Plan of Study

ESPOL has a semester system. Two semesters are offered per year, the first starting mid-May and ending mid-September, and the second term starting mid-October and ending in early March. The Industrial Engineering (IE) curriculum is designed to be completed in 10 semesters and has a total of 253 course credit hours. Table 5.1 describes the plan of study for students in the IE program. Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be provided during the campus visit.

Table 5-1. Industrial Engineering Curriculum

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	*Subject Area (Credit Hours)* Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other	Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
ICM01941, Differential Calculus	R	5				2015-2016: Term 1 & 2	51
ICF00687, Physics A	R	6				2015-2016: Term 1 & 2	51
FIEC06460, Digital Collaboration Tools	R			4		2015-2016: Term 1 & 2	40
ICQ00018, General Chemistry I	R	5				2015-2016: Term 1 & 2	52
ICHE00877, Oral and Written Communication and Research Techniques	R			4		2015-2016: Term 1 & 2	37
CELEX00067, Basic English A	R			6		2015-2016: Term 1 & 2	34
ICM00604, Linear Algebra	R	4				2015-2016: Term 1 & 2	55
FMAR04093, Biology	R	3				2015-2016: Term 1 & 2	43
ICM01958, Integral Calculus	R	5				2015-2016: Term 1 & 2	57

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	*Subject Area (Credit Hours)*				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
ICF00695, Physics B	R	6				2015-2016: Term 1 & 2	53
ICM00794, Fundamentals of Computing	R			4		2015-2016: Term 1 & 2	40
CELEX00075, Basic English B	R			6		2015-2016: Term 1 & 2	40
ICM01966, Multivariable Calculus	R	5				2015-2016: Term 1 & 2	53
ICM01974, Differential Equations	R	5				2015-2016: Term 1 & 2	55
ICF00703, Physics C	R	6				2015-2016: Term 1 & 2	53
FIMP05355, Introduction to Industrial Engineering	R		4			2015-2016: Term 1 & 2	39
FIMP05504, Industrial Materials	R	4				2015-2016: Term 1 & 2	36
CELEX00083, Intermediate English A	R			6		2015-2016: Term 1 & 2	40
ICHE00885, Ecology and Environmental Education	R	4				2015-2016: Term 1 & 2	42
FIMP01263, Statics	R	4				2015-2016: Term 1 & 2	39
ICM00786, Technical Drawing	R	5				2015-2016: Term 1 & 2	42

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.1	*Subject Area (Credit Hours)*				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered2
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
FIMP07781, Descriptive Statistics and Probability	R	4				2015-2016: Term 1 & 2	40
FIMP05389, Industrial Processes	R		3			2015-2016: Term 1 & 2	41
CELEX00091, Intermediate English B	R			6		2015-2016: Term 1 & 2	49
FIMP01271, Dynamics	R	4				2015-2016: Term 1 & 2	47
FIMP07815, Business Economics	R				3	2015-2016: Term 1 & 2	30
FIMP04382, Methods Engineering	R		4			2015-2016: Term 1 & 2	20
FIMP05363, Introduction to Optimization	R		4			2015-2016: Term 1 & 2	34
FIMP07765, Inferential Statistics	R		4			2015-2016: Term 1 & 2	35
FIMP04333, Electromechanical Practices	R			*3*		2015-2016: Term 1 & 2	33
CELEX00109, Advanced English A	R			4		2015-2016: Term 1 & 2	41
ICHE01222, Accounting	R				4	2015-2016: Term 1 & 2	46
FIMP07757, Statistical Quality Control	R		4			2015-2016: Term 1 & 2	30
FIMP06775, Computer-aided Design	R		4			2015-2016: Term 1 & 2	31

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.1	*Subject Area (Credit Hours)*				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered2
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
FIMP05371, Stochastic Processes and Queuing Theory	R		3			2015-2016: Term 1 & 2	30
FIMP05447, Industrial Psychology	R				3	2015-2016: Term 1 & 2	30
FIMP04358, Thermofluids	R	4				2015-2016: Term 1 & 2	35
CELEX00117, Advanced English B	R			4		2015-2016: Term 1 & 2	42
FIMP05520, Organizational Behavior	R				4	2015-2016: Term 1 & 2	34
FIMP06502, Design of Experiments	R		3			2015-2016: Term 1 & 2	30
ICHE03541, Entrepreneurship and Technological Innovation	R			4		2015-2016: Term 1 & 2	38
FIMP05421, Production Costs Estimation	R				4	2015-2016: Term 1 & 2	39
Free Elective I	E				3	2015-2016: Term 1 & 2	
FIMP03913, Basic Instrumentation	R		4			2015-2016: Term 1 & 2	43
FIMP04374, Production Planning	R		4			2015-2016: Term 1 & 2	30
FIMP04887, Quality Systems Management	R				3	2015-2016: Term 1 & 2	32
Technical Elective I	E		3			2015-2016: Term 1 & 2	

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.	*Subject Area (Credit Hours)*				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
FIMP07740, Human Resources Management	R				4	2015-2016: Term 1 & 2	18
ICHE00612, Engineering Economics	R		4			2015-2016: Term 1 & 2	47
FIMP05645, Market Research	R		4			2015-2016: Term 1 & 2	23
FIMP04408, Advanced Production Systems	R		4			2015-2016: Term 1 & 2	20
FIMP05470, Simulation	R		4			2015-2016: Term 1 & 2	28
FIMP05462, Strategic Planning	R				3	2015-2016: Term 1 & 2	42
FIMP04416, Corporate Finance	R				4	2015-2016: Term 1 & 2	44
Free Elective II	E				3	2015-2016: Term 1 & 2	
FIMP06783, Hygiene and Industrial Safety	R				4	2015-2016: Term 1 & 2	50
FIMP06445, Logistics	R		4			2015-2016: Term 1 & 2	31
Technical Elective II	E		3			2015-2016: Term 1 & 2	
Technical Elective III	E		3			2015-2016: Term 1 & 2	
FIMP04549, Facility Design	R		4			2015-2016: Term 1 & 2	42

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.1	*Subject Area (Credit Hours)* Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
FIMP06254, Formulation and Evaluation of Projects	R				3	2015-2016: Term 1 & 2	30
FIMP08243, Integrated Management Systems	R				4	2015-2016: Term 1 & 2	31
FIMP08805, Capstone	R	-	-	-	-	2015: Term 1&2	40
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		79	74	51	49		
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM	253						
PERCENT OF TOTAL		31.2 %	29.2%	20.2%	19.4 %		
Minimum Semester Credit Hours		32 Hours	48 Hours				
Minimum Percentage		25%	37.5 %				

2. **Alignment of the curriculum with the program educational objectives**
   Courses in the curriculum are aimed at preparing students to perform at the satisfactory and exemplary level during the assessment of student outcomes (SOs), which in turn give students the knowledge, abilities and skills for them to attain the program educational objectives (PEOs), as shown in the link between IE program SOs and PEOs in the section on Criterion 3.

   The ESPOL IE curriculum provides several opportunities for our students to be exposed to real-life problems in industrial engineering, and acquire the skills to grow into experts in the engineering field. Besides, some IE courses also offer opportunities for teamwork participating in real-life projects. During the first two years students are provided with fundamental math and science skills, while in the last three years, students are provided with more in-depth industrial engineering knowledge and skills. Our capstone course demonstrates the learning in professional settings such as manufacturing companies, logistics companies, health institutions and service firms.

3. **Description of how the curriculum and its associated prerequisite structure support the attainment of the student outcomes.**

   This section uses the information provided in Table 5.1 and Figure 1.

   The curriculum and the prerequisite structure are aimed at ensuring that students' progress without difficulties in their studies. Most of the mathematics and basic science courses are scheduled to be taken during the first four semesters. These classes are offered by the College of Natural Sciences and Mathematics (FCNM, acronym in Spanish). The Biology course is offered by the College of Maritime Engineering, and Biological, Oceanic and Natural Resources Sciences (FIMCBOR, acronym in Spanish). Students also take courses in software programming early in the curriculum as well.

   Relatively early in the program, an Introduction to Industrial Engineering course is offered so that students become familiarized with the industrial engineering profession. In this course, the students have their first encounter with design, ethics, the industry, and the impact of engineering on society and human well-being.

   Students take courses that develop their statistical skills, drawing skills, and fundamentals of manufacturing and operations management. Most of the general courses, including oral and written communication and research techniques courses and most of the English courses are also scheduled during the first two years. An introductory course of Ecology and Environmental Education is scheduled early in the curriculum too.

   Engineering science, design and professionalization courses are offered by the IE program during the following six semesters. In this group, students take Statics, Dynamics, Thermofluids, Production Planning, Introduction to Optimization, Stochastic Processes and Queuing Theory, Corporate Finance, Statistics, and Human Resource Management. IE students must take a minimum of three technical electives and two free electives. The Entrepreneurship course can be taken after students have passed 50% of the curriculum, and the Formulation and Evaluation of Projects course is programmed so that students take it during the last year.

4. **Flowchart that illustrates the prerequisite structure of the program's required courses**.

Figure 5.1 shows a flowchart of the IE program of study, including the prerequisite structure of the courses. The science courses are colored in light blue, the engineering science and professionalization courses are in orange, the humanities courses are in green, the technical electives are in pink, and the free electives in yellow.

The IE curriculum concentrates the following areas: 1) Production Control Systems, 2) Logistics, 3) Operations Research and 4) Quality, Human Resources and Safety Management Systems.

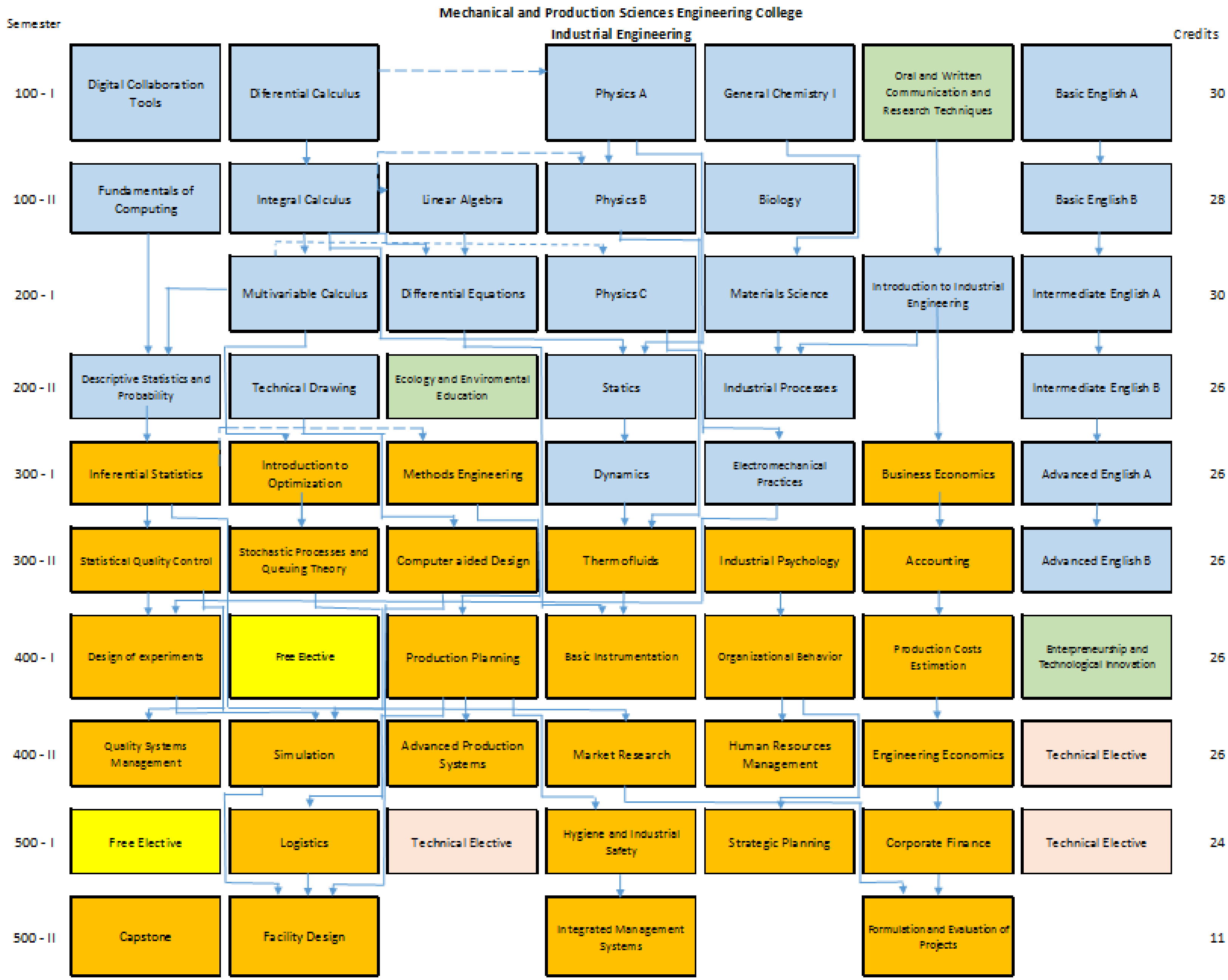

Figure 5-1. IE Flowchart

5. Program Compliance with requirements

From Table 5.1 it can be seen that IE students have to study 79 credit hours of math and basic sciences, 77 credit hours of engineering topics, 48 credit hours of general education and 49 credit hours in other areas (management courses and free electives). The total number of credit hours in the program is 253, out of which 31.2% correspond to math and basic sciences, and 30.4% to engineering topics.

Math and Basic Sciences
IE students take Differential Calculus, Integral Calculus, Linear Algebra, Multivariable Calculus, and Differential Equations. They also need to take 3 calculus-based physics courses, which include laboratory components (Physics A, Physics B and Physics C with their labs). Students also take a General Chemistry course (including laboratory component) and one Biology course. They also have to take Descriptive Statistics and Probability, and Inferential Statistics. All these courses provide the basis and depth called by both the general curricular requirements and the ABET Program Criteria for IE.

Engineering Topics
The bulk of the curriculum addresses engineering topics, including engineering sciences and engineering design. Students take courses in Materials Science, Thermofluids, Industrial Processes, Methods Engineering, Production Planning, Operations Research, Statistical Quality Control, Design of Experiments, Simulation, Basic Instrumentation, Logistics, and Facility Design. Additionally, IE students have to take three technical electives.

General Education
ESPOL requires students to take the Ecology and Environmental Education, Entrepreneurship, and Oral and Written Communication and Research Techniques courses. They also need to take 32 credit hours of English courses and 6 credit hours of free electives.

6. Industrial Engineering program culminating design experience

The IE program has a required capstone course (FIMP08805). During this course, the students apply the skills acquired during the IE program coursework. The students work in teams to:

- Identify the customer needs and requirements.
- Conceptualize the project.
- Gather accurate and reliable data.
- Perform the analysis to identify critical factors.
- Propose solutions consistent with relevant factors.
- Analyze, Evaluate and prioritize alternatives.
- Prototype and/or implement solutions.

The IE program develops capstone projects that solve real-world and open-ended problems from Ecuadorian companies. Faculty reaches the local industry to identify potential projects. The projects are evaluated during a faculty meeting before the semester starts. Afterwards, the students choose the project they will work on.

The IE capstone projects have included companies from: manufacturing, logistics, transportation, retail and healthcare areas. In all the cases, the students must spend at least 8 hours/week in the company site and work with their counterparts from the firm according to the proposed schedule.

Capstone projects have to be completed in 18 weeks. During this time, teams hold weekly meeting with their leading faculty to discuss the methodology and the issues they face. Besides the meetings, the students should attend three faculty talks and prepare five executive presentations during the semester. The output of the capstone work includes a final written report and an oral presentation during a poster session at the end of the course.

7. Cooperative education

The IE program does not use cooperative education to satisfy curricular requirements.

8. Materials that will be available for reviewing during the visit

At the time of the scheduled visit, the following material will be available for the Program Evaluator:

- Course syllabi
- Textbooks
- Course Portfolios with samples of work students for all courses
- Capstone Design Project Reports.

B. Course Syllabi

The syllabus for each course used to satisfy the mathematics, science, and discipline-specific requirements required by Criterion 5 and the IE program criteria are included in Appendix A

CRITERION 6. FACULTY

A. Faculty Qualifications

Considering the size of the program, faculty members cover all areas of industrial engineering in the curriculum. There is an adequate mix of full-time professors, part-time professors and instructors. At the time of writing, the Industrial Engineering (IE) program has a total of 15 faculty members including tenured, tenure-track and non-tenure track (instructors). In the academic year 2014-2015, 94% were full-time professors, and 6% part-time.

Most faculty members hold Master of Science degrees in Industrial Engineering or related engineering fields. There are six faculty members with PhD degrees in Industrial Engineering and Operations Research. Two of our PhD faculty are members of the Institute for Operations Research and Management Sciences (INFORMS), one is member of the American Society of Quality (ASQ), and three of them are members of the Institute of Industrial Engineers (IIE).

Additionally, professional development is an ongoing process in the IE program. Two of our faculty have Six Sigma certifications; one is a certified APICS Supply Chain Professional. ESPOL also motivates faculty to get involved with industry to keep them abreast of current professional practice. All IE faculty members have professional experience outside academia. We strongly believe that professional experiences in real-world settings allow faculty to enrich their classes. Most of the consultancy projects in which faculty have been involved have focused on productivity improvement, safety engineering, and systems design.

In addition to teaching in the undergraduate program, several faculty are committed to being active researchers and lead several key departments of ESPOL, such as the Quality Assurance Office, the Office of the Registrar and the Health and Safety Department.

Table 6-1. Faculty Qualifications

Faculty Name	Highest Degree Earned- Field and Year	Rank[1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[3]	Years of Experience			Professional Registration/ Certification	Level of Activity[4] H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Abad Moran, Jorge	PhD. in Industrial Engineering, 2015		T	FT	15	15	15		L	M	M
Abad Robalino, Andrés Guillermo	PhD. in Industrial Operations Engineering, 2010		TT	FT	5	10	5		H	M	L
Adanaqué Bravo, Ingrid	MEng. in Quality Management, 2008		NTT	FT	8	3	3	BPM, SART, and ISO Auditor	M	M	H
Arias Ulloa, Christian	MEng. in Operations Management, 2010		NTT	FT	13	11	11	BPM, SART, and ISO Auditor	M	H	H
Barcia Villacreces, Kléber	PhD. in Industrial Engineering, 2003		T	FT	12	22	22		L	H	h
Buestán Benavides, Marcos	PhD. in Industrial Engineering and Operations Research,2015		TT	FT	13	10	10	MasterBlack Belt	H	H	H

Faculty Name	Highest Degree Earned- Field and Year	Rank[1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[3]	Years of Experience			Professional Registration/ Certification	Level of Activity[4] H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Calvo Uriguen, Juan	MBA, 2016		NTT	FT	18	14	14		L	M	H
Desintonio León, Edwin Orlando	MSc. Industrial Engineering, 2013		NTT	FT	7	2	2		L	H	M
López Iglesias Sofía Anabel	MSc. Industrial Engineering		NTT	FT	15	15	15		M	M	H
Macias Aguayo Jaime Eduardo	MSc. International Supply Chain Management		NTT	FT	7	0.5	0.5		L	H	M
Márquez Pinoargote, María Claudia	MA Communication, 2004		NTT	FT	2	8	2		L	H	L
Mendoza Vélez, Marcos	M.Eng. Operations and Quality Management, 2007		TT	FT		10	10		L	L	L

Faculty Name	Highest Degree Earned- Field and Year	Rank[1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[3]	Years of Experience			Professional Registration/ Certification	Level of Activity[4] H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Murrieta Oquendo, María Elena	MBA, 1998		TT	FT	8	15	15		L	L	L
Perez Siguenza, Cinthia Cristina	PhD. in Industrial and Systems Engineering, 2014		NTT	FT	5	8	4		H	H	L
Rodríguez Zurita, María Denise	PhD. in Industrial Engineering and Operations Research, 2015		TT	FT	8	10	10		H	H	M
Serrano Segura, Oscar Marcelo	MBA		NTT	PT	17	1	1		H	M	H
Tapia Quincha, Marcos	MSc. in Quality Systems Management		T (Honorary Professor)	FT	30	34	34		H	M	H

B. Faculty Workload

Table 6.2 shows the faculty workload summary for the academic term 2015. The expected teaching workload is from 1 to 3 courses per semester for full-time faculty and two courses per semester for part-time faculty. Hired instructors are normally retained to teach one course per semester in their areas of specialty. Some faculty pursue research opportunities or training in pedagogy, and some will carry out other administrative activities

Table 6-2Faculty Workload Summary

Faculty Member (name)	PT or FT	Classes Taught (Course No. /Credit Hrs.) Term and Year	Program Activity Distribution			% of Time Devoted to the Program
			Teaching	Research or Scholarship	Other	
Abad Moran, Jorge	FT	FIMP06445, Logistics (4 credits) 2016-1 FIMP08805 Capstone 2016-1	20	80		100
Abad Robalino, Andrés Guillermo	FT	FIMP05363, Introduction to Optimization (4) 2015-1&2 FIMP05371, Stochastic Processes and Queuing Theory (3) 2015-1&2 FIMP05843, Multiple-criteria Decision Analysis (3) 2015-1 FIMP08805 Capstone 2015-1	40	50	10	100
Adanaqué Bravo, Ingrid	FT	FIMP07757, Statistical Quality Control (4 credits) 2015-1&2 FIMP04887, Quality Systems Management (3 credits) 2015-1&2 FIMP08805 Capstone 2015-2	40		60	100
Arias Ulloa, Christian	FT	FIMP06783, Hygiene and Industrial Safety (4 credits) 2015-1&2 FIMP05041, Leadership (3 credits) 2015-1 FIMP06494, Total Productive Maintenance (3 credits) 2015-1 FIMP06486, Ergonomics (3 credits) 2015-1&2 FIMP08805 Capstone 2015-1&2	60		40	100
Barcia Villacreces, Kléber	FT	FIMP07138, Lean Manufacturing (3 credits) 2015-1&2 , and 2015-2	100			100
Buestán Benavides, Marcos	FT	FIMP04408, Advanced Production Systems (4 credits) 2015-1&2 FIMP05470, Simulation (4 credits) 2015-1&-2 FIMP08805 Capstone 2015-1&2	50	25	25	100
Calvo Uriguen, Juan	FT	FIMP05355, Introduction to Industrial Engineering (4 credits) 2015-1&2 FIMP05389, Industrial Processes (3 credits) 2015-1&2	70		30	100

Faculty Member (name)	PT or FT	Classes Taught (Course No./Credit Hrs.) Term and Year	Program Activity Distribution			% of Time Devoted to the Program
			Teaching	Research or Scholarship	Other	
Desintonio León, Edwin Orlando	FT	FIMP07765, Inferential Statistics (4 credits) 2015-2, 2015-2 FIMP04374, Production Planning (4 credits) 2015-1&2 FIMP08805 Capstone 2015-2	40	10	50	100
López Iglesias Sofía Anabel	FT	FIMP07757, Statistical Quality Control (4 credits) 2015-1&2 FIMP08805 Capstone 2015-1&2	40		60	100
Macias Aguayo Jaime Eduardo	FT	FIMP04382, Methods Engineering (4 credits) 2015-2 FIMP08805 Capstone 2015-2	75		25	100
Márquez Pinoargote, María Claudia	FT	FIMP05447, Industrial Psychology (3 credits) 2015-1&2 FIMP05520, Organizational Behavior (4 credits) 2015-1&2	70		30	100
Mendoza Vélez, Marcos	FT	FIMP07781, Descriptive Statistics and Probability (4 credits) 2015-1&2	100			100
Murrieta Oquendo, María Elena	FT	FIMP05645, Market Research (4 credits) 2015-1&2	50		50	100
Perez Siguenza, Cinthia Cristina	FT	FIMP04549, Facility Design (4 credits) 2015-1&2	50	50		100
Rodríguez Zurita, María Denise	FT	FIMP04382, Methods Engineering (4 credits) 2015-1&2 FIMP08805 Capstone 2015-1	50	25	25	100
Serrano Segura, Oscar Marcelo	PT	FIMP06445, Logistics (4 credits) 2015-1&2 FIMP07815, Business Economics (3 credits) 2014-2 FIMP06254, Formulation and Evaluation of Projects (3 credits) 2014-2 FIMP08805 Capstone 2015-1&2	75		25	100
Tapia Quincha, Marcos	FT	FIMP06254, Formulation and Evaluation of Projects (3 credits) 2014-2 FIMP01271, Dynamics (4 credits) 2014-1&2 FIMP08805 Capstone 2015-2	50		50	100

C. Faculty Size

Currently, the faculty size seems adequate in terms of coverage of the different courses, and student advising and counseling. Faculty interact with students at a variety of venues both within and outside the classroom. We aim to create a sense of community within the IE program. In class, faculty make an extra effort to get to know their students by name. Faculty also serve as advisors for student chapters. These advisors spend considerable time attending chapter meetings, advising student leaders and traveling with students to regional and national conferences.

Faculty members interact with industrial and professional practitioners in different ways. Some faculty participate in consultancy and sponsored projects within the industry, and some faculty are in charge of monitoring students' performance during internships.

Service is expected from faculty members. Selected faculty members participate in committees of ESPOL. In recent years, IE faculty members have served on the following college committees: Promotion and Tenure, Committee for Quality Assurance, ESPOL Affairs Committee and Engineering Curriculum Committee. It is important to mention that 22% of our faculty members have administrative joint appointments.

D. Professional Development

Faculty members are expected to stay up-to-date with developments in the fields where they are teaching, so they can request funding from ESPOL to cover fees and expenses for courses/seminars (locally or internationally). The approval of such a request is based on the budget available. In particular, new faculty are encouraged to attend courses dedicated to refining teaching skills, funded by ESPOL. One of our faculty members attended a Logistics Distribution System Design course and a Metrics and Measurement course at the University of Texas in Arlington. Last year, seven of our faculty members were sent to workshops and conferences focusing on curriculum design. Besides, one faculty member attended the Master Black Belt course in Arizona State University, another attended the 2015 ABET symposium in Atlanta (GA, USA) and the ABET IDEAL program 2014 in Baltimore (MD, USA), three faculty attended the 2015 Latin American and Caribbean Consortium of Engineering Institutions-LACCEI-Conference. Two faculty member attended an Optimization Program at MIT, and another attended the Lean Healthcare program at the University of Michigan

E. Authority and Responsibility of Faculty

Faculty members can propose any necessary changes to the courses they teach, including changes to content, pre-requisites and assessment and evaluation tools. However, the IE Program Coordinator is responsible for the maintenance and updating of the syllabi, course content, textbook collection and course outcomes. In general, changes go to the area leader who then discusses them with the professors of the area and with the Program Coordinator.

Minor changes are presented to the Dean for review. Changes affecting less than 10% of the curriculum are considered minor. Major curricular reviews can be either an initiative of the faculty or declared a requirement at the institutional level. In either case, faculty is responsible for redesigning the curriculum, including the reviewing of the program educational objectives (PEOs) and student outcomes (SOs).

Faculty are in charge of performing the assessment and evaluation of the attainment of the course outcomes and the assessment of a given SO, as requested by the Program Coordinator. Each faculty member has to prepare a course portfolio for each of the sections that he/she teaches. They are also required to participate in faculty meetings with their area leaders.

Faculty also recommend any improvements that they consider necessary. These improvements go to the IE Quality Assurance Committee. This committee comprises of the leaders of the four areas of industrial engineering, and the Program Coordinator. They are responsible for the evaluation, assessment and continuous improvement of the program based on the attainment of the SOs and/or the alumni and employers survey.

CRITERION 7. FACILITIES[1]

A. Offices, Classrooms and Laboratories

Offices

The Program Coordinator as well as each full-time professor in the Industrial Engineering (IE) program has their own office. Offices are fitted with computer, peripherals and wired or wireless internet access. Most half-time and even some part-time faculty have been assigned shared offices. Lecturers do not have private offices, but there is one large conference room where they can hold meetings with the students during office hours. Offices are located at the main administrative building.

For teaching assistant office hours, classrooms are reserved through the Associate Dean's Office.

Classrooms

There are two classroom buildings with wireless internet access and projectors. All classrooms are air-conditioned to provide an appropriate environment for the students.

Laboratory facilities

The IE program uses the following labs of the Mechanical Engineering program: 1) the Thermal-fluids Lab, used in the courses of Basic Instrumentation and Thermofluids, and 2) the Material Synthesis Laboratory, used in Material Sciences.

Earlier this year, the construction of the Human Factors, Ergonomics and Work Measurement laboratory was approved by ESPOL. This lab will be used to integrate the concepts and the practice of Industrial Hygiene and Labor Ergonomics through the evaluation of physical, chemical and biomechanical risks. At the moment of writing, the ESPOL Acquisition Unit is working on the process for purchasing the equipment and software that will be used, and the Physical Infrastructure and Planning Management department (PIPM) is analyzing where the lab will be located.

B. Computing Resources

There are two computer labs at the College of Mechanical Engineering and Production Sciences (FIMCP, acronym in Spanish) and IE program students have access to them. These laboratories are equipped with 90 Dell computers and a display projector. Software packages installed include general purpose as well as specialized software for supporting IE classes. Students taking the Computer-aid Design and Facility Layout courses use AutoCAD and Solidworks. Besides this, Minitab, R and SPSS are used for Descriptive and Inferential Statistics, Statistical Quality Control, Design of Experiments and Market Research. For probabilistic models and optimization in Operations Research courses, Matlab and GAMS are used. For Production Planning, Logistics and Simulation, students might use Simul8, Promodel, Simulink and Witness.

The Library and Information Center (CIB, acronym in Spanish) also has five computer labs that ESPOL students can use as needed. The labs are open from 8am to 6pm.

The ESPOL arranges the acquisition and maintenance of licenses. There are a number of packages which are licensed to ESPOL, namely: Microsoft Campus Agreement, ESET Smart Security Autodesk, Statistica – Advanced, and Adobe. ESPOL also has a learning management system (LMS) called SIDWeb which is used by faculty to plan classes and activities with their students.

C. Guidance

From the first semester, admitted students receive induction sessions during Welcome Week. Sessions include the presentation of all the regulations regarding the use of computing resources and laboratories at ESPOL as well as all the other services that ESPOL provides.

Furthermore, lab instructors are required to provide appropriate guidance regarding the use of the tools and equipment as well as safety and security. The lab instructor also trains the laboratory teaching assistants in the use of the equipment, and the teaching assistants support students. During training, topics relating to safety and emergency procedures are addressed.

D. Maintenance and Upgrading of Facilities

Labs instructors are responsible for developing plans for maintenance and the upgrading of facilities. Funding for those plans is primarily provided by ESPOL. Plans are annually made, and include a list of equipment and activities that are going to be executed.

E. Library Services

The ESPOL libraries offer a wide range of physical and virtual collections and services to students. Each college has a library, which is run under the supervision of CIB. In addition to physical collections (57,000 books), the libraries subscribe to many electronic resources, including engineering journals, magazines, and newsletters. Full-text databases, such as IEEE, ASME and JSTOR digital libraries are also available. The libraries also provide access to e-book collections from the major science and technology publishers: Springer, EBL and ProQuest. Other services include a newspapers library, and filming and video library.

The libraries are open 57 hours per week during regular classes. During the exam week and the week before, the library is open 70 hours. On average, 2000 students visit the main library. At this library, there are 700 seats for students. Additionally, there are 500 computers in 5 labs. There are 20 conference rooms that range in seating capacity from 6 to 10 students. The FIMCP library provides additional study space, accommodating about 40 students.

The libraries provide assistance to students and any other user through their Information Desk, staffed by professional reference assistants. In addition to face-to-face reference assistance in the library, a virtual reference service is also provided.

The libraries provide a robust instructional program with over 100 face-to-face instructional sessions reaching students and faculty. An online expert system provides automated assistance locating technical information.

F. Overall Comments on Facilities

Safety policies establish that general safety procedures have to be provided on posters in every lab in order to increase the students' awareness of safety. Labs have qualified staff to manage and maintain laboratory equipment. Students working in laboratories, whether for instructional or research purposes, are instructed in the safe operation of equipment. On a daily basis, before students run an experiment or use any equipment, assistants check the accuracy and quality of instructional laboratory equipment, and look for any potential issues that could be considered a safety concern. Instructors, assistants and students are encouraged to report any possibly dangerous procedures or incidents.

FIMCP has a Safety Committee which oversees the safe operation of all the department's facilities. Additionally, ESPOL's Office of Environmental Health and Safety conducts inspections of all the department's facilities. Furthermore, the Guayaquil Fire Department conducts inspections of the facilities to guarantee compliance with fire safety codes.

CRITERION 8. INSTITUTIONAL SUPPORT

A. *Leadership*

The College of Mechanical and Production Sciences Engineering is led by Prof. Jorge Duque. He serves as Dean and has done so for one year. He is the head of the College Board and he is responsible for ensuring the quality and continuity of the programs. Prof. Duque has experience when it comes to ABET accreditation; while he was Mechanical Engineering Program Coordinator, he succeeded in getting the ME program accredited.

The Dean appoints Program Coordinators, in that sense, Program coordinators become leader in academic and administrative affairs and reports directly to the Dean and the College Board. The coordinator is a full-time faculty member.

The IE coordinator's responsibilities covers annual academic planning, budgeting, leading faculty meetings, handling students' applications related to curriculum completion certificates, program shifting, etc. Additionally, the IE coordinator collaborates with the program's ABET Coordinator to plan program assessment and evaluation tasks. Overall, the IE coordinator is the point of contact for the program and is the main responsible of supervising the status of decisions made during faculty meetings about the future of the program.

B. *Program Budget and Financial Support*

1. Budget process

Like other Ecuadorian public universities, ESPOL relies on government funding as the most important component of its annual budget. Additionally, as an "A" accredited university, ESPOL receives additional financial support from the Ecuadorian Government.

Governmental regulations dictate that all public universities submit their budgets for governmental approval. ESPOL's budgeting process involves the reviewing of each academic and non-academic units' budget. For this matter, our Dean requires all program coordinators to get a list of the needs for the incoming year, in terms of maintenance and expansion of laboratories, including all fees and expenses of professional development activities. The Dean compiles these needs and submits the IE program´s budget to the Rector.

Although the IE Program highly depends on ESPOL's support, it does count with other revenue derived from seminars and consultancy activities (both public and private).

The Table 8-1. Shows 2015 and 2016 budgets.

Table 8-1. Budget

Budget	**2015**	**2016**
Salaries	$ 806.941,79	$ 847.288,88
Professional Development	$ 62.451,79	$ 65.574,38
Maintenance and small spare parts	$ 8.716,16	$ 9.151,97
General office supplies	$ 1.067,20	$ 6.683,00
Travel costs for conference & meetings.	$ 2.338,97	$ 2.455,92
Scholarships of excellence	$ -	$ 15.000,00
Utilities, Internet and Security	$ 64.051,00	$ 67.253,55
In-site visits transportation	$ -	$ 11.756,41
	$ 945.566,91	**$ 1.025.164,11**
Investment	**2015**	**2016**
Buildings		$ -
Computers	$ -	$ 1.435,00
Lab equipment	$ 7.947,71	$ 36.664,00
Textbook	$ -	$ 28.354,00
Software (licenses)		$ 78.013,55
Total	**$ 7.947,71**	**$ 144.466,55**
Overall budget	**$ 953.514,62**	**$ 1.169.630,66**

2. **Teaching support provided by ESPOL.**

Teaching and laboratory assistants (TA) are available for many courses. The number of assistantships available is based on the characteristics of the courses. Some criteria used to allocate assistantships are: complexity, number of practical sessions, among others. The total number of teaching-assistant-hours and laboratory assistants assigned depends on the annual budget. Courses with laboratory or practical credits have priority for allocation of teaching assistants. The Associate Dean analyzes the needs of assistantships and he/she is responsible for calling and selecting of the applicants at the beginning of each semester.

The Associate Dean coordinates all activities related to the TAs selection, training and evaluation. The selection of TAs is based on applicant`s GPA. Some of the TAs duties might be to offer students problem solving sessions, assist students during office hours, help faculty during lab/computing practices and grade homework assignments. During this writing, there are ten partial-time teaching assistants and five part-time laboratory assistants, resulting in 150 hours per week of assistantships.

Pedagogical guidance for TAs is provided by the Center for Educational Research. They help TAs with high-quality learning experiences, as well as facilitating their professional development.

Additional teaching support is offered at ESPOL's Center for Educational Research. There is a formal program to address the professional development of the faculty. Funding for this program is provided by ESPOL.

3. Resources to acquire, maintain, and upgrade the infrastructures, facilities, and equipment used in the program.

The Mechanical and Production Sciences Engineering works with the ESPOL administration to obtain funds as needed. These funds are allocated on an annual basis. Prior to the funding cycle, academic programs, research centers and laboratories might request resources, so they make proposals to Deans or Directors. The proposals are reviewed and the funding request is made to the Office of the Rector. Once the request is approved, the Office of Planning, Budgeting, and Procurement are responsible for allocating the funds. Funds are allocated considering the priorities of the departments.

4. Assess the adequacy of the resources described in this section with respect to the students in the program being able to attain the student outcomes.

The IE program considers that the resources described in this section are suitable to allow undergraduate students to attain all student outcomes. The program is still growing, and more resources will be required to increase the number faculty members and capacities.
As it was mention before, the construction of the Human Factors, Ergonomics and Work Measurement is ongoing. The goal is to enhance learning experiences.

C. Staffing

The staff seems adequate in both number and training. Staff categories are discussed below.

- *Administrative:* The Dean and Associate Dean have two full-time administrative assistants to help manage their schedule and projects. The IE program Coordinator has also an administrative assistant. Part-time student assistants are also employed for general office support duties. The adequacy of the administrative staff is outstanding.

- *Technical Support:* The Office of Research and the Center for Educational Research provide technical support for the research and educational laboratories in ESPOL. The adequacy of the technical support staff is good.

- *Computing:* Computing and information technology support is provided by one Computer Specialists. The adequacy of the computing/IT support is poor.

Staff Retention

ESPOL is under salary and wage increase restrictions. However, the wage is still competitive in the local market. There is not a formal plan for retention of non-academic staff.

Training

Human Resources Department offers numerous opportunities for staff training. The idea behind those opportunities is to increase staff satisfaction and productivity.
Describe the adequacy of the staff (administrative, instructional, and technical) and institutional services provided to the program. Discuss methods used to retain and train staff.

D. Faculty Hiring and Retention

The recruitment process of faculty (lecturers / researchers) is regulated by the LOES (High Education Organic Law, in Ecuador), its bylaw (Faculty Promotion), and the Bylaw of Career and Promotion of Faculty at ESPOL (4311). Additionally, these legal codes specify the requirements for faculty to achieve tenure, higher academic levels and professorship

The process of recruitment of tenure-track faculty starts within the program. The Program Coordinator, in consultation with area leaders requests the hiring of faculty either as a request for a particular position or as a part of a plan for filling a number of positions for the upcoming academic year. In this context, a yearly academic planning is proposed by the Program Coordinator, who submits it for the consideration of the College Board. The College Board then submits the request to the Academic Board for reviewing. In funding is available, the Governing Board calls for public academic contests. The conduction of each contest is responsibility an evaluation committee formed by three full-time professors from ESPOL and two external professors from other Ecuadorian universities.

After the evaluation committee conducts an exhaustive evaluation of each candidate's academic merits and reports the results to the Governing Board, the board declares a winner and grants appointment.

Regarding faculty retention strategies, ESPOL promotes the participation of faculty in academic meetings/conferences when faculty members present results of their academic work, and covers the expenses associated with such participation. ESPOL also promotes the involvement of their faculty in high level consulting work with the industry. Under this scheme, faculty members are not only able to improve their income but also to increase their professional expertise. In turn, this may lead to better research opportunities for the involved faculty, and hence could lead to scientific or technical publications, a key requirement for career advancement. In this regard, ESPOL is continuously searching for opportunities to ensure our faculty properly progress towards tenure status; and hence, be able to perceive salaries at the top of the scale.

Moreover, ESPOL grants temporary licenses to faculty invited by the central or local governments to collaborate in ministries or other type of public positions. In this way, the institution seeks to encourage faculty members to gain professional experience and connections with the engineering world.

E. Support of Faculty Professional Development

The Director of Foreign Relations (RELEX for its Spanish acronym) is in constant communication with academic staff regarding funding opportunities, international degree offerings, and workshops, seminars, internships and congresses calls that enhance the academic development of faculty. Furthermore, faculty members seeking connections with peers have the support of a network of prior contacts built up by RELEX.

As complement to what was described earlier on the Criterion 6 of this report, ESPOL's faculty also receive institutional financial support for traveling to participate in technical events and conferences, local seminars, professional development activities as well as for sabbatical leaves. According to ESPOL's regulations, sabbatical leaves are only for tenured faculty. Every tenured faculty member may apply for a sabbatical leave of up to one year, after six years of uninterrupted work at the university. The institution provides financial support to cover travel and living expenses during that period. Usually, due to budget limitations, the university grants these leaves to one member of the whole FIMCP College at a time.

ESPOL has a support program for their Tenure Track professors that wish to become PhD. ESPOL finances all the expenses at international well recognized universities that are among 200 Shanghai index.

PROGRAM CRITERIA

1. Curriculum

The ABET program criteria for industrial engineering programs require that curriculum must prepare graduates to design, develop, implement, and improve integrated systems that include people, materials, information, equipment and energy. The curriculum must include in-depth instruction to accomplish the integration of systems using appropriate analytical, computational, and experimental practices.

Student experience and the learning environment are enhanced throughout the IE curriculum:

1. The foundations of engineering practice are taught in the basic mathematics and science courses (including Calculus, Physics, Linear Algebra, and Chemistry).
2. General engineering analysis is supported by Materials Sciences, Business Economics, Statics, Dynamics, Thermofluids, and Electromechanical Practices. This provide students with knowledge of materials, information, equipment and energy
3. Computing courses provide the appropriate analytical, computational and experimental tools. (including, Digital Collaboration Tools, Fundamentals of Computing, Computer-aid design)
4. Industrial Processes course provides students with an introductory understanding of systems and how they work.
5. Descriptive Statistics and Probability, Inferential Statistics, Statistical Quality Control, and Design of Experiments provide in-depth instruction in statistical analysis and experimentation tools.
6. Introduction to Optimization, and Stochastic Processes and Queuing Theory provide in-depth knowledge in Operations Research.
7. Methods Engineering starts building the notion of Design in Industrial Engineering, considering processes, operation analysis (people, material, information and equipment), time-motion study techniques, work design and simplification, including some lean process improvement tools.

The curriculum next requires further in-depth learning covering the four curricular areas: (1) Production Control Systems, (2) Operations Research, (3) Logistics and (4) Safety, Quality and Human Resources Systems Management.

(1) Production Control Systems

Strengthens the productive structure of the enterprises, identifying the vulnerable points that deplete their performance, viable schemes for the optimal management of the executive resources through modern planning methods and production programming, in such way that the implementation of the ones mentioned above increases the productivity in the industrial local sector.

(2) Operations Research

Contribute transversally to the needs of the local and provincial environments, by emphasizing in the optimization of the productive operations and services as an strategy to reinforce the competitiveness of private enterprises by means of simplification and improvement of the organizational processes and the efficient management of the public resources in order to satisfy the needs of the most vulnerable sectors of the population.

(3) Logistics

Contributes directly to the necessities of the local and provincial surroundings, acknowledging the importance of maintaining productive and ecofriendly operations, as well as encouraging the collaboration in between all the links of the national supply chain: suppliers, manufacturers, distributors and retailers, as an strategy in order to: strength the competitive position in the Ecuadorian industry in front of all the contemporary challenges just like globalization, reinforce it against the unexpected changes in international prices of raw materials, therefore protect and promote employment in the local sector

(4) Safety, Quality and Human Resources Systems Management

It contributes to meeting the needs of the provincial and local environment to obtain products and services of high quality, by training future professionals to design production processes and innovative services and employ technological tools to achieve higher performance operations as well as promoting quality as a vital aspect for the strengthening of the productive matrix, considering sustainable processes that actively involve the people to be immersed in them.

2. Faculty

Evidence is provided in Criterion 6 that the faculty understand professional practice and maintain currency. IE faculty attends professional conferences, give presentations and some of them publish papers and conduct research. As well, all faculty members are Professional Engineers, so interactions with industry are frequent.

ESPOL faculty has the responsibility and sufficient authority, with appropriate oversight, to define, revise, implement, and achieve program objectives.