**University of Puerto Rico at Mayaguez**
**College of Engineering**
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# Departmental Plan for the Assessment of Student Learning

## Bachelor of Science in Industrial Engineering

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# 1. Introduction

The Industrial Engineering Department of the University of Puerto Rico at Mayagüez (UPRM) is committed to offering an education of academic excellence and to the development of professionals of excellence. This can only be sustained through a process of continuous improvement addressing industry needs and technology breakthroughs. The experience of our students, industrial engineering employers and alumni through their professional career is very important to us. Our alumni achievements and success is an indicator of our success as an academic institution. As part of our process of continuous improvement, the Industrial Engineering Department conducts an annual assessment of the academic program based on program learning outcomes. This document describes the methodology, tools and strategies designed to conduct the annual assessment.

# 2. Purpose of the Plan

The objective of this plan is to give structure to a process for the assessment of student learning based on learning outcomes. The plan has been designed to facilitate the process of data gathering, analysis of results and feedback of results to faculty members. It is part of a process implemented at the Industrial Engineering Department for the continuous improvement of our academic program.

# 3. Applicability

This plan applies to all curricular activities of the Department of Industrial Engineering at UPRM, its faculty, students and support staff.

# 4. Key Terms Definitions

Our assessment plan was developed based on the criteria of our main professional accreditation agency (ABET). The assessment is based on student outcomes rather than inputs. Outcomes are defined at different levels:

- **Program Educational Objectives**: Statements that describe the expected accomplishments or performance of industrial engineering graduates during the first few (3) years after graduation.

- **Program Outcomes:** Industrial Engineering program student learning outcomes and goals. Statements that describe what industrial engineering students are expected to know and be able to do by the time of graduation.

- **Course Learning Outcomes/Goals:** Statements that describe what students are expected to know and be able to do by the end of each specific course in the industrial engineering curriculum.

- **Engineering (ABET's) Outcomes:** ABET's (A-K) Criterion 3 Outcomes which define what students within the college of engineering should demonstrate before they graduate.

## 5. Constituencies

The major constituents of the Industrial Engineering Program are current **students**, **faculty**, **alumni**, and **employer**s of our alumni. The student's professional careers are shaped fundamentally by the educational experiences provided by the program. The faculty designs and implements the curriculum. The professional success of the alumni, to a great extent, is caused by the effectiveness of the education, values, and attitudes instilled by the curriculum they were subjected to. The attainment of the business objectives of the employers, in turn, is significantly affected by the quality of the graduates they hire from our program.

## 6. Mission Statements

The mission and vision statements of the Industrial Engineering Department were established through the involvement of faculty, students, and members of our advisory board.

**Vision**

"Be the best alternative for the Hispanic bilingual community in:

- Forming professionals of excellence in IE and related areas through innovative educational curricula and real life learning experiences.
- Providing leading outreach and technology transfer activities by taking advantage of the unique industrial concentration existing in Puerto Rico.
- Performing research for industrial, government, and service partners in line with their operational excellence and innovation needs."

**Mission**

"Serve society through the formation of professionals of excellence, performing research, and service in Industrial Engineering and related fields by means of innovative and creative processes with highly motivated human resources in a favorable work environment."

# 7. Program Educational Objectives (PEO's)

The Educational Objectives of the Industrial Engineering Department were established as part of a departmental strategic planning effort with input from the significant constituencies. These were originally formulated by a committee and approved by the department's faculty, and have been discussed and modified through departmental meetings, Industrial Advisory Board meetings, and departmental retreats at which input from all constituencies was considered.

The Industrial Engineering program prepares professionals in industrial engineering with the capacity to apply their knowledge, skills, attitudes, and the most recent technological developments to the solution of problems of society. The profile of the graduate of the IE program states the following:

> *Graduates from the Industrial Engineering program are instrumental in planning, designing, implementing and evaluating products, services, and systems that integrate people, materials, equipment, and information for the progress and improvement of the quality of life of humankind. They insure that these products, services, or systems can be provided economically with the required level of quality necessary for satisfying society's needs. The Industrial Engineer draws upon knowledge and skills mostly from the areas of mathematics and the physical, social, physiological and computer sciences, together with principles and methods of engineering analysis and design.*

Within that framework, with input from its significant constituencies, the Industrial Engineering Department has established a set of Program Educational Objectives. It is understood that Program Educational Objectives are the expected accomplishments during the first few years after graduation.

The major constituents of the Industrial Engineering Program affected by the educational objectives include students, faculty, alumni, and employers. The student's professional careers are shaped fundamentally by the educational experiences provided by the program. The faculty designs and implements the curriculum. The professional success of the alumni, to a great extent, is caused by the effectiveness of the education, values, and attitudes instilled by the

curriculum they were subjected to. The attainment of the business objectives of the employers, in turn, is significantly affected by the quality of the graduates they hire from our program.

The Program Educational Objectives of the Industrial Engineering undergraduate program are the following:

1. Our graduates will demonstrate extensive training and education in the Industrial Engineering areas including:
    - Design of work facilities and systems
    - Statistical quality control and improvement systems
    - Automated computer-based control systems
    - Manufacturing systems
    - Economic evaluation

2. “Our graduates will require minimal additional training to adjust to professional life and will be ready to tackle real-world problems as soon as they graduate due to a rich industrial experience gained through participation in
    - Student projects in industry
    - Internships and cooperative education (COOP)
    - Other interaction with professional and industrial organizations.”

3. Our graduates will function effectively in a setting with ethical, social, and environmental sensibilities, be able to communicate effectively, and become leaders in industry.

4. Our graduates will have the ability to work in multi-disciplinary teams.

5. Our graduates will have an understanding of the need to continue to develop entrepreneurial skills.

With these educational objectives as a guide, the Industrial Engineering Program at the UPRM has been designed to provide students with a well-balanced education stressing classical industrial engineering design complemented with additional sophisticated analytical techniques. A strong emphasis is placed upon the fundamentals of the profession, laboratory experiences, real life problem solving, and the use of the computer as an engineering tool. Graduates of the program are prepared to enter the profession upon leaving college, and the most talented are encouraged to pursue graduate studies either in industrial engineering or a related field.

# 8. Program Outcomes (PO's)

Program Outcomes describe what students are expected to know and are able to do by the time of graduation. They are the immediate tangible result that a student should have obtained by having gone through the established curriculum, in this case for the degree of Bachelor of Science in Industrial Engineering. Assessment tools have been developed to determine the level of achievement of the program outcomes. These are mostly focused on the performance of the students in their coursework, and their perception in the mastery of the material covered.

The Industrial Engineering department with input from its constituencies has established the following program outcomes.

1. **Design a work facility or system**
   All IE graduates should be able to design a work facility or systems that minimizes costs and cycle times, maximizes quality, promotes order, and provides a safe and comfortable environment.

2. **Design and implement quality control systems**
   Most IE graduating students should be able to design and implement quality control systems to ensure the consistent delivery of products and services that meet customer specifications.

3. **Design computer-based control and information systems**
   Many IE graduating students should understand and be instrumental in the design, development and use of computer-based control and information systems.

4. **Plan and control a production system**
   All graduating students should have a clear understanding of the elements of a production system, and be able to plan its requirements, develop the appropriate production schedules, and control its execution.

5. **Evaluate the economics of engineering solutions**
   All IE graduating students should be able to evaluate the economic aspects of engineering solutions, emphasizing estimating the cost of producing a product or providing a service, and analyzing the economic implications of engineering design alternatives.

6. **Develop models to experiment, evaluate, or solve a problem**
   All IE graduating students should be able to formulate and develop mathematical, statistical, simulation, or physical models to experiment, evaluate existing and proposed systems, or solve a particular problem.

7. **Use engineering design process from IE point of view**
   All IE graduating students should be able to use the engineering design process from the industrial engineering point of view, that is, identify and define a problem whose solution will have the greatest impact in the organization, gather and organize relevant data and information, perform the appropriate analysis and draw relevant conclusions, generate and evaluate alternative solutions, select and implement a solution, and finally produce concise and clear documentation of problems, solutions, and procedures. The graduates should have developed the skills and curiosity to gather information that is not readily available or that is not obvious.

8. **Use modern telecommunication and computer technology**
   All IE graduating students should be able to use modern telecommunications and computer technology and software tools, to search for information, analyze data, design solutions, communicate with peers, and document the present results of projects.

9. **Present information to individuals or to an audience**
   All IE graduating students should be able to present information in a clear and concise manner using the most appropriate media and technology, either individually or to an audience, to peers, project teammates, management, or laypeople.

10. **Establish goals and work to reach them**
    All IE graduating students should be able to establish goals and objectives, and to work independently and/or as part of a team to reach them. The graduates should be capable of acquiring new knowledge and developing new skills when the requirements to reach a goal call for it.

11. **Understand and practice leadership**
    All IE graduating students should be able of demonstrating their leadership skills when the circumstances call for call for someone with their background and training. The graduate should be capable of occupying leadership positions in professional, community, and government organizations. They should be able to comment and express their opinion regarding technological and socio-humanistic aspects of the profession.

# 9. Course Learning Outcomes/Goals (CLO's)

The Industrial Engineering Department has developed and published Course Learning Outcomes for each course taught within the department. These are consistent with the program educational objectives and program outcomes. Course outcomes are published within each Course Syllabus. An example of a Syllabus is presented in Appendix 1.

# 10. Relationship of Learning Outcomes at Different Levels

Program outcomes and educational objectives were designed to be consistent with the mission of the UPRM, the college of Engineering and the Industrial Engineering Department.

## a) Alignment of Program Educational Objectives with the Mission Statements

Table 10.1 summarizes the relationship between the Program Educational Objectives and the mission statements, which are also presented below:

*Mission Statement of the University of Puerto Rico at Mayagüez*

> *"Within the philosophical framework established by the University of Puerto Rico Act, the Mayagüez Campus directs its efforts towards the development of educated, cultured citizens, capable of critical thinking, and professionally qualified in the fields of agricultural, social, and natural sciences, engineering, humanities, and business administration. They should be able to contribute in an efficient manner to the economic and social development of the Puerto Rican and international community. This process is aimed at endowing our alumni with a strong technical and professional background and to instill a strong commitment to Puerto Rico and the hemisphere. Our alumni should have the necessary skills and knowledge to participate effectively in the search for solutions to the problems facing us, to develop and transfer technology as well as to uphold the essential attitudes and values of a democratic society."*

*Mission Statement of the College of Engineering*

> *"Provide Puerto Rico, our neighbors, and the rest of the world with professionals having a strong education in engineering and related areas,*

*with rich environmental, ethical, cultural, and social sensitivities; with capacity for critical thinking and for becoming leaders in their fields.*

*It is also our mission to conduct research, expand and disseminate knowledge, promote an entrepreneurial spirit, provide service to the community, and pursue the innovation and application of technology for the benefit or our global society, with particular emphasis on Puerto Rico."*

*Mission of the Industrial Engineering Department*

*"Serve society through the formation of professionals of excellence, performing research, and service in Industrial Engineering and related fields by means of innovative and creative processes with highly motivated human resources in a favorable work environment."*

### b) Alignment of Program Educational Objectives with ABET's A-K Criterion 3

To comply with ABET's Criterion 3 in *Criteria for Accreditation of Engineering Programs*, the Industrial Engineering educational objectives were aligned with ABET's (a) through (k) criteria. This alignment is summarized in Table 10.2. Examples of the metrics and documentation used for the assessment of ABET's A-K Criterion 3 have been included in Appendix 2.

### c) Alignment of Program Outcomes and ABET's a-k Outcomes

Due to the importance of maintaining the ABET accreditation it was also made sure for the IE Program Outcomes chosen to encompass and relate to the outcome requirements of Criterion 3 (a-k) as demonstrated in Table 10.3. As can be seen in the table even though the program outcomes are unique they are directly related to ABET's a-k outcomes.

### d) Alignment between Program Outcomes and Program Educational Objectives

It is understood that the program outcomes should lead to the achievement of the educational objectives. So, in formulating the Program Outcomes care was taken to establish a direct relationship with the Program Educational Objectives. This relationship is summarized in Objectives in Table 10.4.

**Table 10.1 Relationship between the Program Educational Objectives and the Mission Statements**

| Educational Objective | Department Mission | Engineering College Mission | UPRM Mission |
|---|---|---|---|
| Our graduates will demonstrate extensive training and education in the Industrial Engineering areas including:<br>Design of work facilities and systems<br>Statistical quality control and improvement systems<br>Automated computer based control systems<br>Manufacturing systems<br>Economic evaluation. | Excellent industrial engineering professionals should be able to apply concepts to solve problems.<br>This attitude and motivation contributes to the formation of excellent industrial engineering professionals. | High quality engineers capable of critical thinking are the ones that can apply the concepts to solve engineering problems effectively. | A professionally qualified person should be able to apply the knowledge in their field. Our alumni should have the necessary skills and knowledge to participate effectively in the search for solutions to the problems facing us. |
| "Our graduates will require minimal additional training to adjust to professional life and will be ready to tackle real-world problems as soon as they graduate due to a rich industrial experience gained through participation in<br>• Student projects in industry<br>• Internships and cooperative education (COOP)<br>• Other interaction with professional and industrial organizations." | Serve society through the formation of professionals of excellence through innovative and creative processes. | Provide professionals having a strong education in engineering and related areas, with rich environmental, ethical, cultural, and social sensitivities; with capacity for critical thinking and for becoming leaders on their fields. | Graduates should be able to contribute in an efficient manner to the economic and social development of the Puerto Rican and international community. |
| Our graduates will function effectively in a setting with ethical, social, and environmental sensibilities, be able to communicate effectively, and become leaders in industry. | Society is the main stakeholder and should be served complying with a code of ethics and graduates should be able to present the results of their professional work. | Provide society with professionals having a strong education in engineering and related areas, with rich environmental, ethical, cultural, and social sensitivities. | Our alumni should have the necessary skills and knowledge to participate effectively in the search for solutions to the problems facing us and to uphold the essential attitudes and values of a democratic society. |
| Our graduates will have the ability to work in multi-disciplinary teams. | Excellent industrial engineering professionals should be able to apply concepts to solve problems working in teams. | Well-prepared engineers are able to work as part of a team by having a strong education in engineering and related areas, with rich environmental, ethical, cultural, and social sensitivities; with capacity for critical thinking and for becoming leaders on their fields. | Well-developed, educated and cultured citizens in a democratic society work effectively in teams. |
| Our graduates will have an understanding of the need to continue to develop entrepreneurial skills. | Excellent industrial engineers should instill an entrepreneurial spirit to be able to provide solutions. | The College of Engineering promotes the entrepreneurial spirit to bring innovation. | An entrepreneurial spirit is instrumental in economic and social development. |

## Table 10.2 Educational Objectives of the Industrial Engineering Department vs. ABET Criterion 3

| | Educational Objectives | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| | Demonstrate extensive training and education in IE areas including design of work facilities and systems, statistical quality control and improvement systems, automated computer based control systems, manufacturing systems, and economic evaluation. | Require minimal additional training to adjust to professional life and will be ready to tackle real-world problems as soon as they graduate due to a rich industrial experience gained through participation in student projects in industry, internships and cooperative education (COOP), and other interaction with professional and industrial organizations. | Function effectively in a setting with ethical, social, and environmental sensibilities, be able to communicate effectively, and become leaders in industry. | Have the ability to work in multi-disciplinary teams. | Our graduates will have an understanding of the need to continue to develop entrepreneurial skills. |
| a. Ability to apply mathematics, science, and engineering. | X | | | | |
| b. Ability to design and conduct experiments, as well as to analyze and interpret data. | X | | | | |
| c. Ability to design a system, component, or process to meet desired needs. | X | | | | |
| d. Ability to function on multidisciplinary teams. | | X | X | X | X |
| e. Ability to identify, formulate, and solve engineering problems. | X | X | | | |
| f. Understanding of professional and ethical responsibility. | X | X | X | X | |
| g. Ability to communicate effectively. | | X | X | X | X |
| h. Broad education necessary to understand the impact of engineering solutions in a global and societal context. | X | X | X | | |
| i. Recognition of the need for, and an ability to engage in life-long learning. | X | X | | | X |
| j. Knowledge of contemporary issues. | X | X | X | | |
| k. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. | X | X | | | |

## Table 10.3 Program Outcomes vs ABET's A-K Outcomes

| | Program Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| ABET's Criterion 3 | Design a work facility or system. | Design and implement quality control systems. | Design computer-based control and information system | Plan and control a production system. | Evaluate the economics of engineering solutions. | Develop models to experiment, evaluate or solve problems. | Use engineering design process from IE point of view. | Use modern telecommunication and computer technology. | Present information to individuals or to an audience. | Establish goals and work to reach them. | Understand and practice leadership. |
| a. Ability to apply mathematics, science, and engineering. | X | X | X | X | X | X | | | | | |
| b. Ability to design and conduct experiments, as well as to analyze and interpret data. | X | X | | X | X | X | | | | | |
| c. Ability to design a system, component, or process to meet desired needs. | X | X | X | X | | | X | | | X | X |
| d. Ability to function on multidisciplinary teams. | X | | | | | | | | | | |
| e. Ability to identify, formulate, and solve engineering problems. | X | X | X | X | | X | X | | | | |
| f. Understanding of professional and ethical responsibility. | X | X | X | | X | X | | | | | X |
| g. Ability to communicate effectively. | | | | | | | | X | X | | X |
| h. Broad education necessary to understand the impact of engineering solutions in a global and societal context. | X | X | X | | | | X | | | X | X |
| i. Recognition of the need for, and an ability to engage in life-long learning. | | | | | | | | | | X | |
| j. Knowledge of contemporary issues. | X | X | X | | X | | X | X | | | |
| k. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. | X | X | X | X | | X | | X | | | |

**Table 10.4 Educational Objectives vs. Program Outcomes.**

| | | Educational Objectives | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| | | Demonstrate extensive training and education in IE areas including design of work facilities and systems, statistical quality control and improvement systems, automated computer based control systems, manufacturing systems, and economic evaluation. | Require minimal additional training to adjust to professional life and will be ready to tackle real-world problems as soon as they graduate due to a rich industrial experience gained through participation in student projects in industry, internships and cooperative education (COOP), and other interaction with professional and industrial organizations. | Function effectively in a setting with ethical, social, and environmental sensibilities, be able to communicate effectively, and become leaders in industry. | Have the ability to work in multi-disciplinary teams. | Our graduates will have an understanding of the need to continue to develop entrepreneurial skills. |
| 1 | Design a work facility or system. | X | X | | | |
| 2 | Design and implement quality control systems. | X | X | | | |
| 3 | Design computer-based control and information system | X | X | | | |
| 4 | Plan and control a production system. | X | X | | | |
| 5 | Evaluate the economics of engineering solutions. | X | | | | |
| 6 | Develop models to experiment, evaluate or solve problems. | X | X | | | |
| 7 | Use engineering design process from IE point of view. | X | X | X | | |
| 8 | Use modern telecommunication and computer technology. | | | | | |
| 9 | Present information to individuals or to an audience. | | X | X | | X |
| 10 | Establish goals and work to reach them. | | X | X | X | X |
| 11 | Understand and practice leadership. | | | X | X | X |

# 11. Alignment of the Curriculum with ABET's Criterion 3 and Department Program Outcomes

The Industrial Engineering Department examined all core and elective courses in curriculum to ensure total coverage of proposed student learning outcomes and ABET's EC 2000 outcomes criteria. This coverage is reflected on each individual syllabus. Tables 11.1 and 11.2 provide a mapping of the program outcomes and ABET's Criterion 3 to all department core and elective courses.

(Faltan los cursos de 1er a 3er año)

Table 11.1 Alignment of the Department Course and Program Outcomes

| | | DEPARTMENT COURSES | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CORE COURSES | | | | | | | | | | | | | | | | | ELECTIVES | | | | | | | | | | | | | | |
| | Program Outcome | 4009:Work Meas. | 4010: Prob. | 4015:Eng.Ec. | 4020:Stat. | 4021:Det.OR | 4022:Prob.OR | 4029: Behavior | 4035: HRP | 4039:Prod.I | 4040: Layout | 4057:Real Time | 4075: Prod II | 4077: Work Design | 4078:Quality | 4079: Design | 4085:Accounting | 4086: Cost | 4016: Safety | 4017: Inf. Systems | 4018: Simulation | 4027: DOE | 4046: IE Practice | 4995: COOP | 4996: Special Topics | 5595: Service Ind. | 4810: Conc. Eng. | 5505: TQM | 5565: Reliability | 5575: Scheduling | | | |
| 1 | Design a work facility or system. | X | | | | | | X | X | | X | | | X | | | | | X | | | | | | | | | | | | | |
| 2 | Design and implement quality control systems. | | X | | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | |
| 3 | Design computer-based control and information system | | | | | | | | | | | X | | | | | | | | X | | | | | | | | | | | | |
| 4 | Plan and control a production system. | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | X |
| 5 | Evaluate the economics of engineering solutions. | | | X | | | | | | | | | | | | | X | X | | | | | | | | | | | | | | |
| 6 | Develop models to experiment, evaluate or solve problems. | | | | X | X | X | | | | | | | | | | | | | | X | X | | | | | | | | | | |
| 7 | Use engineering design process from IE point of view. | X | | | | | | | | | X | | | X | | X | | | | | | | X | | | X | X | | | | | |
| 8 | Use modern telecommunication and computer technology. | X | X | X | X | X | X | | | X | X | X | X | X | X | X | | | | X | X | X | | | | | X | X | X | X | | | |
| 9 | Present information to individuals or to an audience. | X | | | | | | | | | X | X | X | X | | X | | | | | X | | X | | | | | | | | | |
| 10 | Establish goals and work to reach them. | X | | | | | | | | | X | X | | X | | X | | | | | | | X | X | X | | X | X | | | | |
| 11 | Understand and practice leadership. | X | | | | | | | | | X | X | | | | X | | | | | | | | | | | X | X | | | | |

Table 11.2 Alignment of the Department Courses and ABET's Criterion 3

| | ABET's Criterion 3 | 4009:Work Meas. | 4010: Prob. | 4015:Eng.Ec. | 4020:Stat. | 4021:Det.OR | 4022:Prob.OR | 4029: Behavior | 4035: HRP | 4039:Prod.I | 4040: Layout | 4057:Real Time | 4075: Prod II | 4077: Work Design | 4078:Quality | 4079: Design | 4085:Accounting | 4086: Cost | 4016: Safety | 4017: Inf. Systems | 4018: Simulation | 4027: DOE | 4046: IE Practice | 4995: COOP | 4996: Special Topics | 4501: Service Ind. | 4810: Conc. Eng. | 5505: TQM | 5565: Reliability | 5575: Scheduling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **a** | An ability to apply knowledge of mathematics, science, and engineering. | **1** | **1** | **1** | **1** | **1** | **1** | | | **1** | **1** | **1** | | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | | **1** | **1** | **1** | **1** | | **1** | **1** |
| **b** | An ability to design and conduct experiments, as well as to analyze and interpret data. | | | | **1** | | | | | | | | | | | **1** | **1** | | | | **1** | **1** | | **1** | **1** | | | | **1** | |
| **c** | An ability to design a system, components, or process to meet desired needs. | | | | **1** | **1** | | | **1** | | **1** | **1** | | **1** | **1** | **1** | | | | **1** | | **1** | | **1** | **1** | **1** | **1** | | **1** | |
| **d** | **An ability to function on multidisciplinary teams.** | **1** | | | | | | | | | **1** | | | | | **1** | | | | | | | **1** | **1** | | | **1** | | | |
| **e** | An ability to identify, formulate, and solve engineering problems. | | **1** | **1** | **1** | **1** | **1** | | | **1** | **1** | **1** | | | **1** | **1** | **1** | **1** | | **1** | **1** | **1** | | **1** | **1** | | **1** | **1** | **1** | |
| **f** | **An understanding of professional and ethical responsibility.** | **1** | | | | | | **1** | **1** | | | | | **1** | | | | | | | | | | | | | | | | |
| **g** | **An ability to communicate effectively.** | **1** | | | | | | **1** | | | **1** | **1** | | | **1** | **1** | | | | | | | | | | | | | | |
| **h** | **The broad education necessary to understand the impact of engineering solutions in a global and societal context.** | **1** | | | | | | | | | **1** | **1** | | **1** | | **1** | | | **1** | | | | **1** | **1** | **1** | | **1** | **1** | | |
| **i** | **A recognition of the need for, and an ability to engage in life-long learning.** | | | **1** | | | | **1** | | | **1** | **1** | | | | **1** | | | | | **1** | | **1** | **1** | | | **1** | | | |
| **j** | **A knowledge of contemporary issues.** | | | | | | | **1** | | | | | | | | **1** | | | | | | | | | | | | | | |
| **k** | An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. | **1** | **1** | **1** | **1** | **1** | **1** | **1** | | **1** | **1** | **1** | | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | | **1** | **1** | | | **1** | **1** | |

# 12. Assessment Process

The quality of our program is assessed on a yearly basis through an implemented process of continuous improvement. Data for the assessment is gathered at different stages of the student's career: at freshman year, throughout the curriculum, at graduation time, and 3 years after graduation.

Tools used for data gathering and assessing the level of achievement of ABET's Criterion 3 and program outcomes are presented in Tables 12.1 and 12.2. The major tools used for the assessment of program educational objectives are the: alumni survey, employer survey and inputs from the advisory board. Examples of the assessment tools are included Appendix 3.

The assessment process at course level is shown in Figure 1. The preparation of surveys is performed by personnel at the Center of Academic Research (CAR). Surveys are distributed to students by the course professor and sent back to CAR for the tabulation of results. Once results have been tabulated, these are sent back to the professor for his analysis. The professor is responsible for the identification of areas in need of attention and the design and implementation of corrective actions. Documentation of results is kept in a course portfolio at the CAR office. Documents required from each course in the curriculum are presented in Table 12.3.

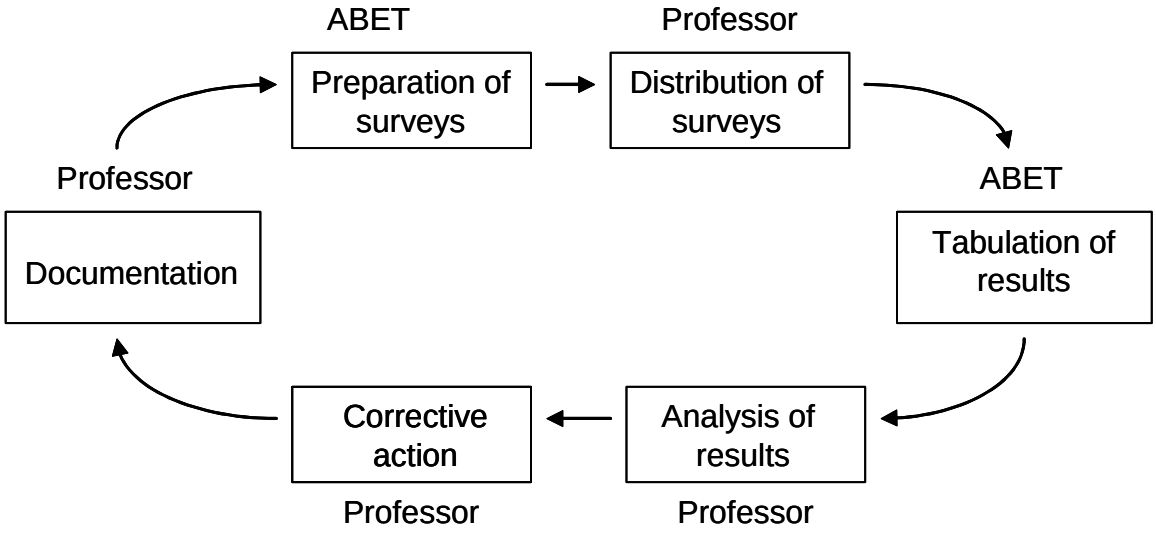


**Figure 1 Course Assessment Process**

The assessment process at the program level and post graduation is depicted in Figure 2. Data is collected and analyzed to determine the level of achievement of program outcomes and educational objectives. Results from the assessment are presented to faculty members at department meetings where action plans are delineated to address the identified areas of opportunity for

improvement. Documentation of the assessment process is kept in portfolios at the CAR office. Table 12.4 shows the timing strategy for all assessment tools.

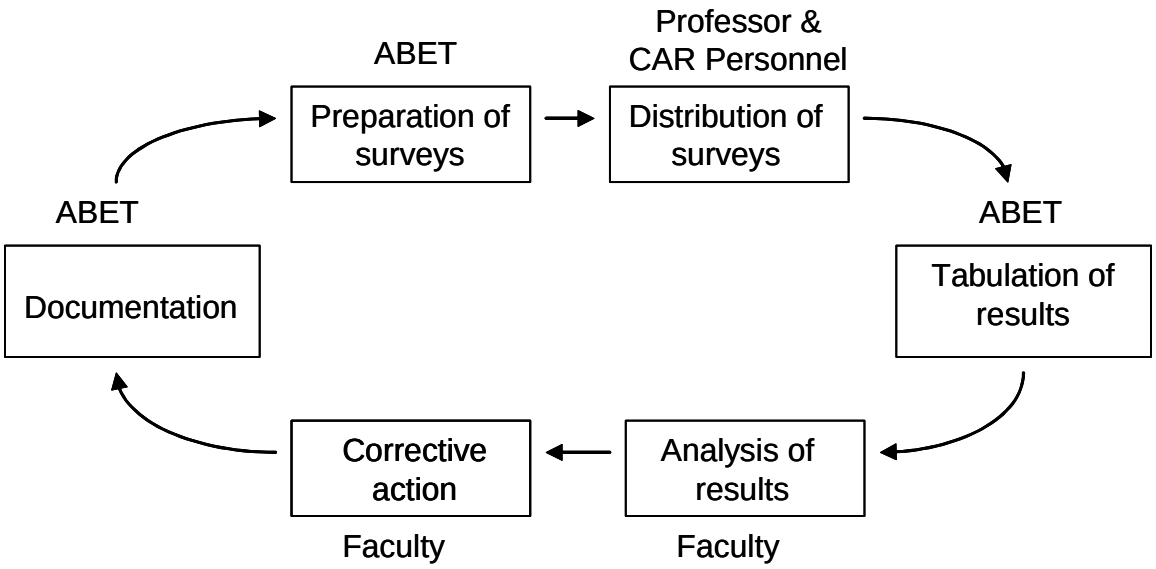


**Figure 2 Assessment Process at Program Level and Post Graduation**

## Table 12.1 Tools for the Assessment of ABET's A-K Criterion 3

| | ABET's A-K Criterion 3 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | An ability to apply knowledge of mathematics, science, and engineering. | An ability to design and conduct experiments, as well as to analyze and interpret data. | An ability to design a system, components, or process to meet desired needs. | An ability to function on multidisciplinary teams. | An ability to identify, formulate, and solve engineering problems. | An understanding of professional and ethical responsibility. | An ability to communicate effectively. | The broad education necessary to understand the impact of engineering solutions in a global and societal context. | A recognition of the need for, and an ability to engage in life-long learning. | A knowledge of contemporary issues. | An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. |
| **Assessment Tools** | a | b | c | d | e | f | g | h | i | j | k |
| **Pre-Engineering** | | | | | | | | | | | |
| Pre-Engineering Survey | X | X | | X | X | X | X | | | | |
| Ethics Integration Assessment Form | | | | | | X | | | | | |
| **Course Assessment** | | | | | | | | | | | |
| Laboratory Reports (copies of) | X | X | | X | X | | X | | | X | X |
| Exams, Homeworks, ect. (copies of) | X | X | X | | X | | X | | | X | X |
| Written Reports (copies of) | X | X | X | | X | | X | | | | |
| Video of Presentations | | | | | | | X | | | | |
| Professor Project Evaluation Form | | | | | | | | | | | |
| Written Reports | X | X | X | | X | | X | | | | |
| Oral Presentation | | | | | | | X | | | | |
| A-K | X | X | X | | X | X | X | X | X | X | X |
| Company Project Evaluation Form | | | | | | | | | | | |
| Written Reports | X | X | X | | X | | X | | | | |
| Oral Presentation | | | | | | | X | | | | |
| A-K | X | X | X | X | X | X | X | X | X | X | X |
| Multidisciplinary Teamwork | | | | X | | | | | | | |
| Course Skills Assessment Form | X | X | X | X | X | X | X | X | X | X | X |
| EIT Exam Statistics | X | | | | X | X | | | | | |
| **Program Assessment** | | | | | | | | | | | |
| Ethics Integration Assessment Form | | | | | | X | | | | | |
| Undergraduate Research Exp. Assess. Form | X | X | X | | X | | X | | | | |
| Graduating Student Exit Survey-Part I | X | X | X | X | X | X | X | X | X | X | X |
| Graduating Student Exit Survey-Part II | X | X | X | X | X | X | X | X | X | X | X |
| Internship Assessment Form (Student) | | | | X | X | | | | | X | |
| Internship Assessment Form (Professor) | | | | X | X | | | | | X | |
| COOP Supervisory Evaluation Form | | | | X | X | | | | | X | |
| COOP Student Evaluation Form | | | | X | X | | | | | X | |
| Student Resume (Special Format) | | | | | | | | X | | | |
| **Post Graduation** | | | | | | | | | | | |
| Alumni Survey | X | X | X | X | X | X | X | X | X | X | X |
| Employers Survey | X | X | X | X | X | X | X | X | X | X | X |
| Advisory Board Input | X | X | X | X | X | X | X | X | X | X | X |

## Table 12.2 Tools for the Assessment of Program Outcomes

| | Program Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **Assessment Tools** | Design a work facility or system. | Design and implement quality control systems. | Design computer-based control and information system | Plan and control a production system. | Evaluate the economics of engineering solutions. | Develop models to experiment, evaluate or solve problems. | Use engineering design process from IE point of view. | Use modern telecommunication and computer technology. | Present information to individuals or to an audience. | Establish goals and work to reach them. | Understand and practice leadership. |
| **Course Assessment** | | | | | | | | | | | |
| Laboratory Reports (copies of) | | | | | | | | | X | | |
| Exams, Homeworks, ect. (copies of) | X | X | X | X | X | X | X | | X | | |
| Written Reports (copies of) | X | X | X | X | X | X | X | | X | | |
| Video of Presentations | | | | | | | | | X | | |
| Professor Project Evaluation Form | X | X | X | X | X | X | X | X | X | X | |
| Written Reports | | | | | | | | | X | | |
| Oral Presentation | | | | | | | | | X | | |
| Company Project Evaluation Form | X | X | X | X | X | X | X | X | X | X | |
| Written Reports | | | | | | | | | X | | |
| Oral Presentation | | | | | | | | | X | | |
| Multidisciplinary Teamwork | | | | | | | | | | | |
| Course Skills Assessment Form | X | X | X | X | X | X | X | X | | | |
| EIT Exam Statistics | X | X | X | X | X | X | X | | X | | |
| **Program Assessment** | | | | | | | | | | | |
| Undergraduate Research Exp. Assess. Form | X | X | X | X | X | X | X | X | X | X | X |
| Graduating Student Exit Survey-Part I | X | X | X | X | X | X | X | X | X | X | X |
| Graduating Student Exit Survey-Part II | X | X | X | X | X | X | X | X | X | X | X |
| Internship Assessment Form (Student) | X | X | X | X | X | X | X | X | X | X | X |
| Internship Assessment Form (Professor) | X | X | X | X | X | X | X | X | X | X | X |
| COOP Supervisory Evaluation Form | X | X | X | X | X | X | X | X | X | X | X |
| COOP Student Evaluation Form | X | X | X | X | X | X | X | X | X | X | X |
| Student Resume (Special Format) | | | | | | | | | | | X |
| **Post Graduation** | | | | | | | | | | | |
| Alumni Survey | X | X | X | X | X | X | X | X | X | X | X |
| Employers Survey | X | X | X | X | X | X | X | X | X | X | X |
| Advisory Board Input | X | X | X | X | X | X | X | X | X | X | X |

## Table 12.3 Document Requirements by Course in the Curriculum

| | CURRICULUM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CORE COURSES | | | | | | | | | | | | | | | | | | ELECTIVES | | | | | | | | | | | |
| DATA SOURCE | UNIV-004 | 4009:Work Meas. | 4010: Prob. | 4015:Eng.Ec. | 4020:Stat. | 4021:Det.OR | 4022:Prob.OR | 4029: Behavior | 4035: HRP | 4039:Prod.I | 4040: Layout | 4057:Real Time | 4075: Prod II | 4077: Work Design | 4078:Quality | 4079: Design | 4085:Accounting | 4086: Cost | 4016: Safety | 4017: Inf. Systems | 4018: Simulation | 4027: DOE | 4046: IE Practice | 4995: COOP | 4996: Special Topics | 4501: Service Ind. | 4810: Conc. Eng. | 5505: TQM | 5565: Reliability | 5575: Scheduling |
| **SURVEYS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PRE-ENGINEERING SURVEY | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ETHICS INTEGRATION ASSESSMENT FORM | 1 | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| COURSE SKILLS ASSESSMENT FORM | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | 1 |
| STUDENT EVALUATION OF TEACHING | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| UNDERGRADUATE RESEARCH EXPERIENCE ASSESSMENT FORM | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | | | | | |
| INTERNSHIP ASSESSMENT FORM (STUDENT) | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | | | | | |
| INTERNSHIP ASSESSMENT FORM (PROFESSOR) | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | | | | | |
| COOP SUPERVISORY EVALUATION FORM | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| COOP STUDENT EVALUATION FORM | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| GRADUATING STUDENT SURVEY (4079) | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| PROFESSOR PROJECT EVALUATION FORM ** | | 1 | | | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | | | 1 | | | | 1 | 1 | 1 | | | | | 1 | | | 1 |
| COMPANY EVALUATION FORM ** | | 1 | | | | 1 | 1 | 1 | 1 | | 1 | | 1 | | | 1 | | | | | 1 | 1 | | | | | 1 | | | |
| STUDENT RESUME (4079) | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| **OTHER DOCUMENTATION** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VIDEO OF ORAL PRESENTATION ** | | 1 | | | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | | | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | 1 |
| PROJECT WRITTEN REPORT ** | | 1 | | | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | | | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | 1 |
| LABORATORY REPORTS ** | | 1 | | | | | | | | | 1 | 1 | | 1 | 1 | | | | | | | | | | | | | | | |

**Table 12.4 Timing Strategy for the Assessment of Outcomes**

| Assessment Tool | Timing Strategy | Responsibility |
|---|---|---|
| **Pre-Engineering** | | |
| Pre-Engineering Survey | UNIV-004 Freshman Orientation Course | Departmental Counselor |
| Ethics Integration Assessment Form. | UNIV-004 Freshman Orientation Course | Departmental Counselor |
| **Course Assessment** | | |
| Laboratory Reports | Laboratory Courses End of semester | Laboratory Instructor |
| Exams, Homework, Etc. | End of semester | Professor/Instructor |
| Written Reports | End of semester | Professor/Instructor |
| Video of Presentations | End of semester | Professor/Instructor |
| Professor Project Evaluation Form | Courses with project work End of semester | Professor/Instructor |
| Company Project Evaluation Form | Courses with project work End of semester | Professor/Instructor |
| Course Skills Assessment Form | All courses End of semester | Professor/Instructor |
| Student Evaluation of Teaching | All courses End of semester | IE Department Personnel |
| FE Exam Statistics | COE Dean Office | CAR Personnel |
| **Program Assessment** | | |
| Ethics Integration Assessment Form. | Capstone course End of semester | Professor |
| Undergraduate Research Experience Assessment Form | End of semester | Professor |
| Graduating Student Exit Survey I | Capstone course End of semester | Professor |
| Graduating Student Exit Survey II | Capstone course End of semester | Professor |
| Internship Assessment Form (Student) | End of semester | Professor |
| Internship Assessment Form (Professor) | End of semester | Professor |
| COOP Supervisory Evaluation Form | End of semester | Professor |
| COOP Student Evaluation Form | End of semester | Professor |
| Student Resume (Special Format) | Capstone course End of semester | Professor |
| **Post Graduation** | | |
| Alumni Survey | 3rd year alumni February – every year | CAR Personnel |
| Employers Survey | Every odd – year | CAR Personnel |
| Advisory Board Input | Annual Meeting | CAR Personnel |

## a) Description of Assessment Tools

The tools used for the assessment process were developed by faculty members with inputs from students and the advisory board.

- **Evaluation of Student Performance in the Classroom** – This type of assessment is heavily based on students' grades in exams, quizzes, homework, and course project work among others. Examples of each are kept in course binders/portfolios at the Industrial Engineering Center for Academic Research. Another source of information are the videos of student s' oral presentations as evidence of communication skills.

- **Student Evaluations of Teaching (SET)** – This is a standard assessment tool used throughout the university. Students rate the effectiveness of the course instructor and appropriateness of materials and facilities. Even though results are not used directly for the assessment of learning outcomes, it facilitates the identification of areas in need of improvements.

- **Student Exit Survey** – This survey contains a set of questions to assess the level of student learning as well as the level of satisfaction with the quality of the program and facilities.

- **Alumni Survey** – The industrial Engineering Department conducts annually a survey among the alumni. The survey is sent to alumni who graduated three years ago. Responses are used to determine the effectiveness of our program in preparing them for positions in the manufacturing or service industry or for graduate school.

- **Employer Survey** – Our department conducts a survey among employers every other year on odd years. Results from the survey are used to measure the degree of satisfaction with our program, and to identify program strengths and areas of opportunity for improvement.

- **Course Skills and Assessment Form** – This form is filled by students in every industrial engineering course they take. The survey is distributed close to the end of the semester. Results are summarized by personnel at the CAR office and returned to the professor for the identification of areas in need of attention. The original surveys and a copy of results will be kept at the CAR office.

- **Internship/Undergraduate Research/COOP Surveys:** These surveys are used to evaluate the student's experience in internships, undergraduate research and COOP experience. Supervisors are asked to evaluate the student's performance and the student is asked to evaluate the supervisor's performance.

## b) Metric Goals

Most of the assessment tools were designed with answers on a scale from 1 to 4, where 1 is strongly disagree and 4 is strongly agree. Currently, our goal is to achieve an overall or grand score of at least 3 on the educational objectives and program goals.

There has been an increasing tendency of students taking the fundamentals of engineering (FE) exam during their last year of graduation. Results from the FE exam will be used to compare our performance against the national performance. The metrics will be first the percentage of students passing the test and second the performance index of specific subjects as follows:

$$P_i = \frac{\%\ questions\ correctly\ answered\ by\ RUM\ \ IE\ students\ in\ topic\ i}{\%\ questions\ correctly\ answered\ by\ National\ IE\ students\ in\ topic\ i}$$

## c) Evidence on the Achievement of Learning Outcomes

Documentation as evidence of the assessment process will be kept at the IE CAR Office. The type of documentation to be filed is as follows:

**Course Level:**

1. Course Syllabus
2. Examples of student work (tests, assignments, written reports, videos of oral presentations, etc.).
3. Copies of completed assessment tools with summaries of results.
4. Other material important to support the assessment process.

**Program Level:**

1. Documentation and results from: graduating student exit survey, ethics integration assessment form, undergraduate research assessment form, internship assessment forms, and COOP evaluation forms.
2. Statistics from the Fundamentals of Engineering Exam.
3. Documentation and results from student resumes.
4. Copies of the minutes of the Department's Faculty Meetings, course committees, and Advisory Board meetings where assessment results were considered and actions taken.
5. Copies of curriculum development and revisions.

**Post-Graduation Level:**

1. Alumni survey documentation and results.
2. Employer survey documentation and results.

## d) Reporting and Utilization of Assessment Results

A summary of assessment results at the course level will be prepared and submitted to each professor during the second month of the following school semester. A summary of assessment results at the program level will be prepared on a yearly basis and presented to faculty members at the second department's meeting of the following academic year.

## e) Process for Reviewing the Plan

This plan will be reviewed during the consideration of assessment results. Changes will be made to the plan to either simplify the process if deemed appropriate or the incorporate new approaches to improve the performance of the assessment process.

## APPENDICES

1. EXAMPLE OF A COURSE SYLLABUS.

2. METRICS AND DOCUMENTATION FOR SOME OF ABET'S A-K CRITERION 3.

3. EXAMPLES OF ASSESSMENT TOOLS.

## APPENDIX 1: EXAMPLE OF A COURSE SYLLABUS

**University of Puerto Rico. Mayagüez Campus**
**College of Engineering.**
**Industrial Engineering Department**

# Course Syllabus

## General Information

Course Number: ININ 4009
Course Title: **Work Measurement**
Credit-Hours: Four

## Course Description

Theory and practice of work measurement systems; time studies using direct observations; standard data; predetermined time systems and work sampling; formula construction, line balancing, learning curves and wage payment plans.

## Prerequisites

ININ 4077 - Work System Design
ININ 4020 or ININ 4012- Applied Industrial Statistics

## Textbook and References

- Niebel, B.W., and Frievalds, A., 2003, **Methods Standards and Work Design**, 11th Edition, WI, New York: McGraw-Hill.
- Stephan, K., 1999, Work Design, Industrial Ergonomics, 5h Edition, Publishing Horizons, Inc.

## Purpose

This course is a requirement in completing a bachelor's degree in industrial engineering. It has been primarily designed for majors in industrial engineering. However, it is appropriate for anyone with interest in the areas of work measurement systems, labor requirements planning, evaluation of production line capacity, and line balancing. The purpose of this course is to prepare students in the determination of labor standards, to become aware of the factors having a significant impact on operator performance, to measure labor efficiency, and performance, and to perform line balancing. This course is a prerequisite for InIn 4040, Facility Layout and Design.

## Course Goals

After completing the course, the student should be able to:

- Understand the elements of a production system.
- Analyze, evaluate, improve, and standardize manual labor operations.
- Develop labor time standards through time studies with chronometers.
- Predetermined time systems, or work sampling.
- Develop and use standard data systems.
- Apply learning curves to new processes.

- Understand the impact and design of wage payment plans.
- Perform line balancing.
- Design work systems based on efficiency and ergonomic considerations.
- Gather, organize, analyze, and present information related to a manufacturing or service process that is not readily available or not obvious.
- Propose and evaluate engineering design alternatives and their implications.

**Requirements**

All students are expected to come to class all the time, on time, and prepared; do all assigned readings and related work; actively participate in class discussions; and satisfy all assessment criteria to receive credit for the course.

**Laboratory Work:**

Laboratory work has been designed to give students the opportunity to apply concepts in the areas and time studies, performance rating evaluation, predetermined times systems, work sampling and learning curves.

Cellular phones, radios, tape recorders, and other audio or video equipment are not permitted in the lab or classroom at any time. Smoking is not permitted in any area other than those areas designated for smoking.

**Department and Campus Policies**

**Class attendance**: Class attendance is compulsory. The University of Puerto Rico, Mayagüez Campus, reserves the right to deal at any time with individual cases of non-attendance. Professors are expected to record the absences of their students. Frequent absences affect the final grade, and may even result in total loss of credits. Arranging to make up work missed because of legitimate class absence is the responsibility of the student. (Bulletin of Information Undergraduate Studies)

**Absence from examinations**: Students are required to attend all examinations. If a student is absent from an examination for a justifiable reason acceptable to the professor, he or she will be given a special examination. Otherwise, he or she will receive a grade of zero of "F" in the examination missed. (Bulletin of Information Undergraduate Studies)

**Final examinations**: Final written examinations must be given in all courses unless, in

the judgment of the Dean, the nature of the subject makes it impracticable. Final examinations scheduled by arrangements must be given during the examination period prescribed in the Academic Calendar, including Saturdays. (see Bulletin of Information Undergraduate Studies).

**Partial withdrawals**: A student may withdraw from individual courses at any time during the term, but before the deadline established in the University Academic Calendar. (see Bulletin of Information Undergraduate Studies).

**Complete withdrawals**: A student may completely withdraw from the University of Puerto Rico, Mayagüez Campus, at any time up to the last day of classes. (see Bulletin of Information Undergraduate Studies).

**Disabilities**: All the reasonable accommodations according to the Americans with Disability Act (ADA) Law will be coordinated with the Dean of Students and in accordance with the particular needs of the student.

**Ethics:** Any academic fraud is subject to the disciplinary sanctions described in article 14 and 16 of the revised General Student Bylaws of the University of Puerto Rico contained in Certification 018-1997-98 of the Board of Trustees. The professor will follow the norms established in articles 1-5 of the Bylaws.

**Campus Resources**

General Library and University Computer Center is available to obtain professor's reference materials.

**General Topics**

| Lecture | Topic | Reading |
|---|---|---|
| 1 | Introduction to time study | T. Ch 9, R1. Ch 26 |
| 2-5 | Time study equipment and procedure | T. Ch 9, R1. Ch 27 |
| 6-8 | Performance rating | T. Ch 10, R1. Ch 27 |
| 9-12 | Allowances | T. Ch 11, R1. Ch 31 |
| 13 | The standard time | T. Ch 11 |
| 14-16 | Learning curves | T. Ch 18, R1. Ch 28 |
| 17-20 | Work Sampling | T. Ch 14, R1. Ch 8 |
| 21-31 | Synthetic basic motion time | T. Ch 13, R1. Ch 29<br>Instructor Notes |
| 32-36 | Standard data | T. Ch 12, R1. Ch 30 |
| 37-38 | Wage Incentive Plans | T. Ch 17<br>Instructor Notes |
| 39-42 | Line Balancing - Traditional Production Lines | T. Ch 2, R1. Ch 14<br>Instructor Notes |
| 43-44 | Establishing standards on indirect and expense work | T. Ch 15. R1. Ch 23 |

All readings from Niebel and Frievalds, 2003

Coordinator: Noris Torres

mcv/rev. December 2003

| | | InIn 4009: Work Measurement | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ABET 2000 Criteria | Understand the elements of a production system | Develop time standards through time studies with chronometers, predetermined time systems, or work sampling. | Analyze, evaluate, improve, and standardize manual operations. | Develop and use standard data systems. | Apply learning curves to new processes. | Understand the impact and design of wage payment plans. | Perform line balancing. | Design work systems based on efficiency and ergonomic considerations. | Gather, organize, analyze, and present information related to a manufacturing or service process that is not readily available or obvious. | Propose and evaluate engineering design alternatives and their implications. |
| | a. knowledge math/science/eng | X | X | X | X | X | X | X | X | X | X |
| | b. conduct experiments | | | | | | | | | | |
| | c. design | | X | | | | | | X | X | X |
| | d. multidisciplinary teams | | X | X | | | | | X | X | X |
| | e. engineering problems | | X | X | X | X | X | X | X | X | X |
| | f. ethics | | | | | | | | | X | X |
| | g. communication | | | | | | | | | X | |
| | h. global impact | | | | | | X | | | | X |
| | i. lifelong learning | | X | | | | | | | X | |
| | j. contemporary issues | | | | | | | | | | |
| | k. modern tools | | X | | | X | | X | X | | |
| Assessment method | Assignments | | X | | | X | | X | X | | |
| | Exams (midterms, quizzes) | X | X | X | X | X | X | X | X | | |
| | Exit interviews | | | | | | | | | | |
| | Laboratory Reports | X | X | X | | X | | | | | |
| | Oral questions | | | | | | | | | | |
| | Portfolios | | | | | | | | | | |
| | Project Presentations | X | | X | | | | X | X | X | X |
| | Project Reports | | X | X | | X | | X | X | X | X |
| | Questionnaires | | | | | | | | | | |
| | Simulations and games | | | | | | | | | | |

## APPENDIX 2: METRICS AND DOCUMENTATION FOR SOME OF ABET'S A-K CRITERION 3.

| Universidad de Puerto Rico<br>Recinto Universitario de Mayagüez<br>P.O. Box 9043<br>Mayagüez PR 00681-9043 |  | University of Puerto Rico<br>Mayagüez Campus<br>P.O. Box 9043<br>Mayagüez PR 00681-9043 |
|---|---|---|
| Departamento de Ingeniería Industrial | Tels. (787) 265-3819<br>(787) 832-4040 Exts. 3208, 3204<br>Fax (787) 265-3820 | Industrial Engineering Department |

## ABILITY TO FUNCTION ON MULTI-DISCIPLINARY TEAMS

Our program offers students many opportunities to develop multi-disciplinary teamwork skills. The major mechanism is through course projects and participation in multidisciplinary professional associations like the Society of Hispanic Professional Engineers (SHPE) and the American Society for Quality (ASQ). Statistics presented in the documentation binder for life-long learning shows that 55% of year 2002 graduates were members of SHPE, and 12% of graduates were members of ASQ.

IE course projects are done in companies located in the vicinity of our campus. Throughout the semester, students interact and work with company personnel with a great diversity of academic preparation. Information needed for the completion of the project may be requested from the cost and accounting department; production planning department; industrial, mechanic, or electrical engineers; or from supervisory personnel. Core courses with projects in industries are ININ 4009 (Work Measurement), ININ 4040 (Facility and Layout Design), and ININ 4079 (Design Project). Examples of project written reports and company evaluations will be included in course binders. Proposals for projects in ININ 4040 will be kept in the course binder.

An IE elective course considered highly multidisciplinary is ININ 4810, Concurrent Engineering. This course was designed to provide students with an interdisciplinary experience in the field of product design, manufacturing, market

research, and business planning. Students registered in this course could be from any department within the College of Engineering or from the School of Business. This course requires a project worked in groups including between three and five students, with participation form multiple disciplines dependent on the project challenges. Statistics of students who graduated in year 2002 show that 19% IE graduates took ININ 4810. Demand for this course has been increasing in the past year and it might be changed into a required IE course. Project posters are available for evaluation.

Other IE electives where students work in projects in industry are ININ 4046 (Engineering Practice), ININ 4996 (Special Topics in IE), ININ 4998 (Undergraduate Research), and ININ 4995 (Cooperative Education). Statistics on broad education show that 71% of year 2002 graduates participated either in ININ 4995 or did undergraduate research work. Five percent of graduates worked in special topics. Project posters are available for evaluation.

| | | |
|---|---|---|
| Universidad de Puerto Rico<br>Recinto Universitario de Mayagüez<br>P.O. Box 9043<br>Mayagüez PR 00681-9043 |  | University of Puerto Rico<br>Mayagüez Campus<br>P.O. Box 9043<br>Mayagüez PR 00681-9043 |
| Departamento de Ingeniería Industrial | Tels. (787) 265-3819<br>(787) 832-4040 Exts. 3208, 3204<br>Fax (787) 265-3820 | Industrial Engineering Department |


## ABILITY TO COMMUNICATE EFFECTIVELY

The first step for the development of communication ability is through language courses. Our program requires students to take 18 credit hours in languages. They have to approve 6 credit hours in Spanish and 12 credit hours in English. In the curricular revision we are working on, students will be required to take the courses Technical Writing and Public Speaking. Students will be required to take 6 credit hours in advanced English followed by those two courses.

The second step for the development of communication ability is through practice. The University of Puerto Rico, Mayagüez Campus, has the privilege and advantage of having a great number of service as well as manufacturing companies in its vicinity. The Industrial Engineering Department has enriched its curriculum by offering students as many work experiences as possible through course projects. For the completion of a course project students are required to make an oral presentation and hand in a written report. This is done not only for the professor, but also at the company where the project was performed. Through these experiences our students develop and keep refining their communication skills.

Courses with projects include ININ 4009, ININ 4040, ININ 4057 and our capstone course ININ 4079. The documentation available on communication skills include

videos of student presentations. It also includes written reports, evaluation of written reports and oral presentations, and company project evaluations. The latter are kept in the rack of binders for course documentation at the Industrial Engineering Center for Academic Research Office.

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Industrial Engineering Department

## BROAD EDUCATION NECESSARY TO UNDERSTAND THE IMPACT OF ENGINEERING SOLUTIONS IN A GLOBAL AND SOCIETAL CONTEXT

Our Industrial Engineering program requires students the completion of a total of 174 credit hours in five years. The curriculum includes 15 credit hours for Socio-Humanistic electives, 12 credit hours for free electives, and 6 credit hours for IE department electives. Course electives in the curriculum give students the opportunity to study psychology, social sciences, economy, marketing, ethics, history, the study of cultures and many other aspects so essential for their understanding of the impact of engineering solutions in a global and societal context. An analysis to identify the most frequently taken free, socio-humanistic and department electives was done using those students who graduated in December 2000 and May 2001. A summary of results is presented in the next pages. We have included for your information the course syllabus for those courses where the percentage of students taking the course is 10% or higher.

Issues of impact of engineering solutions are also covered in all IE courses with a design component such as ININ 4009 (Work Measurement), ININ 4077 (Work Systems Design), ININ 4040 (Facility and Layout Design), and ININ 4079 (Design Project). Courses with a design component require knowledge in current issues such as OSHA Act, ADA Act, Codes of Ethics, Safety Regulations, and Human Behavior.

## SUMMARY OF FREE ELECTIVES AND SOCIO-HUMANISTICS TAKEN BY OUR STUDENTS:

TOTAL NUMBER OF GRADUATES: 81
2001-2002 (August to December 2001 and January to May 2002)

| Course | Description | Free electives or Socio-Humanistics | | | % of Graduates |
|---|---|---|---|---|---|
| | | First Semester 2001-2002 | Second Semester 2001-2002 | Total | |
| PSIC 3001 | Principles of Psychology I | 13 | 27 | 40 | 49 |
| SOCI 3285 | Social Dynamics (Dinámica de Grupo) | 10 | 19 | 29 | 36 |
| ADMI 3007 | Introduction to Computer Data Processing | 12 | 16 | 28 | 35 |
| ECON 3022 | Principles of Economics Macroeconomics | 16 | 11 | 27 | 33 |
| PSIC 3002 | Principles of Psychology II | 7 | 18 | 25 | 31 |
| CISE 3049 | Keyboarding and Typewriting | 7 | 17 | 24 | 30 |
| ITAL 3071 | Italian I | 10 | 11 | 21 | 26 |
| ININ 4995 | Engineering Practice for Coop Students | 9 | 10 | 19 | 23 |
| HIST 3241 | History of Puerto Rico II | 11 | 7 | 18 | 22 |
| CISO 3121 | An Introduction to the Study of the Social Sciences | 6 | 9 | 15 | 19 |
| EDFU 3001 | Human Growth and Development I | 4 | 11 | 15 | 19 |
| FILO 3167 | Symbolic Logic | 9 | 6 | 15 | 19 |
| HIST 3242 | History of Puerto Rico II | 5 | 10 | 15 | 19 |
| ECON 3085 | Economic and Social Development of Puerto Rico | 10 | 4 | 14 | 17 |
| FILO 3157 | Introduction to Logic | 4 | 10 | 14 | 17 |
| ITAL 3072 | Italian II | 6 | 8 | 14 | 17 |
| ADMI 3100 | New Business Development | 5 | 8 | 13 | 16 |
| PSIC 4116 | Psychology of Human Sexuality | 4 | 9 | 13 | 16 |
| TEAT 3081 | Acting I | 0 | 12 | 12 | 15 |
| FILO 4045 | Ethics in Engineering | 5 | 6 | 11 | 14 |

| Course | Description | Free electives or Socio-Humanistics | | | % of Graduates |
|---|---|---|---|---|---|
| | | First Semester 2001-2002 | Second Semester 2001-2002 | Total | |
| FRAN 3141 | French I | 3 | 7 | 10 | 12 |
| ININ 4029 | Human Behaviour in Work Organizations | 0 | 10 | 10 | 12 |
| PSIC 3027 | Childhood Psychology | 2 | 8 | 10 | 12 |
| EDFU 3007 | Social Foundations of Education | 5 | 4 | 9 | 11 |
| ININ 4046 | Industrial Engineering Practice | 2 | 6 | 8 | 10 |
| PSIC 3006 | Social Psychology | 3 | 5 | 8 | 10 |
| FRAN 3142 | French II | 4 | 3 | 7 | 9 |
| HUMA 3111 | Introduction to Western Culture I | 4 | 3 | 7 | 9 |
| ALEM 3041 | German I | 4 | 2 | 6 | 7 |
| CISO 3122 | An Introduction to the Study of the Social Sciences | 2 | 4 | 6 | 7 |
| ECON 4028 | Economics of Natural Resources | 6 | 0 | 6 | 7 |
| EDFU 3002 | Human Growth and Development II | 2 | 4 | 6 | 7 |
| FRAN 3143 | French III | 4 | 2 | 6 | 7 |
| ININ 4035 | Human Resources Planning | 0 | 6 | 6 | 7 |
| ITAL 3073 | Italian III | 3 | 3 | 6 | 7 |
| MERC 3115 | Principles of Marketing | 1 | 5 | 6 | 7 |
| PSIC 3015 | Theories of Personality | 0 | 6 | 6 | 7 |
| ARTE 3055 | Calligraphy | 3 | 2 | 5 | 6 |
| ARTE 3276 | Art Appreciation | 2 | 3 | 5 | 6 |
| ECON 4085 | International Economic | 4 | 1 | 5 | 6 |
| EDFI 3305 | Folk Dances | 1 | 4 | 5 | 6 |
| EDFI 3645 | First Aid and Security | 1 | 4 | 5 | 6 |
| EDFI 3665 | Recreational Sports | 0 | 5 | 5 | 6 |
| FILO 4160 | Philosopgy of Technology | 2 | 3 | 5 | 6 |
| ININ 4027 | Design and analysis of engineering experiments | 0 | 5 | 5 | 6 |
| PSIC 3040 | Personal Development | 0 | 5 | 5 | 6 |
| ALEM 3043 | German III | 4 | 0 | 4 | 5 |
| ARTE 3226 | History of Art in Puerto Rico | 1 | 3 | 4 | 5 |

| Course | Description | Free electives or Socio-Humanistics | | | % of Graduates |
|---|---|---|---|---|---|
| | | First Semester 2001-2002 | Second Semester 2001-2002 | Total | |
| ECON 3091 | Micro-Economic Theory | 2 | 2 | 4 | 5 |
| EDFU 4025 | School health education | 2 | 2 | 4 | 5 |
| HIST 3112 | History of the United States of America | 0 | 4 | 4 | 5 |
| ALEM 3042 | German II | 3 | 0 | 3 | 4 |
| ALEM 3044 | German IV | 3 | 0 | 3 | 4 |
| ALEM 4001 | German Literature | 3 | 0 | 3 | 4 |
| CIPO 3011 | Introduction to Political Sciences | 1 | 2 | 3 | 4 |
| EDFI 3076 | Introduction to Physical Fitness | 1 | 2 | 3 | 4 |
| EDFI 3295 | Elementary Tennis | 0 | 3 | 3 | 4 |
| EDFI 4225 | Lifeguarding | 2 | 1 | 3 | 4 |
| EDFU 4006 | This child and his social milieu | 0 | 3 | 3 | 4 |
| EDFU 4019 | Philosophical Foundation of Education | 2 | 1 | 3 | 4 |
| FRAN 3144 | French IV | 2 | 1 | 3 | 4 |
| HIST 3201 | History of the Modern World II | 1 | 2 | 3 | 4 |
| HUMA 3112 | Introduction to Western Culture II | 3 | 0 | 3 | 4 |
| ININ 4017 | Computer-based Information Systems | 1 | 2 | 3 | 4 |
| INGE 3012 | Engineering Graphics II | 2 | 1 | 3 | 4 |
| INGE 3017 | Computer Aided Graphics | 0 | 3 | 3 | 4 |
| INGL 3191 | Conversational English | 0 | 3 | 3 | 4 |
| INGL 3227 | Phonetics of English | 0 | 3 | 3 | 4 |
| INGL 3236 | Technical Report Writing | 2 | 1 | 3 | 4 |
| ITAL 3074 | Italian III-IV | 2 | 1 | 3 | 4 |
| MUSI 3135 | Music Appreciation | 0 | 3 | 3 | 4 |
| PSIC 4009 | Industrial and Organizational Psychology | 1 | 2 | 3 | 4 |
| ADMI 3125 | | 0 | 2 | 2 | 2 |

## SUMMARY OF DEPARTMENT ELECTIVES TAKEN BY OUR STUDENTS:

| Course | Description | Department Electives | | Total | % of Graduates |
|---|---|---|---|---|---|
| | | First Semester 2001-2002 | Second Semester 2001-2002 | | |
| ININ 4027 | Design and Analysis of Engineering Experiments | 16 | 20 | 36 | 44 |
| ININ 5505 | Total Quality Management | 7 | 23 | 30 | 37 |
| ININ 4501 | Design and Management of Service Processes | 6 | 21 | 27 | 33 |
| ININ 4810 | Concurrent Engineering | 5 | 14 | 19 | 23 |
| ININ 4016 | Industrial Safety | 5 | 12 | 17 | 21 |
| ININ 4018 | System Simulation with Digital Computers | 3 | 12 | 15 | 19 |
| ININ 4017 | Computer-based Information Systems | 7 | 7 | 14 | 17 |
| ININ 5565 | Mesurement and Prediction of Product Reliability | 6 | 2 | 8 | 10 |
| ININ 5575 | Sequencing and Scheduling of Resources | 0 | 6 | 6 | 7 |
| ININ 4996 | Special Problems | 2 | 2 | 4 | 5 |
| ININ 6030 | Advance Economics for Engineers | 0 | 3 | 3 | 4 |
| ININ 6016 | Human Factors Engineering | 0 | 1 | 1 | 1 |
| ININ 6045 | Materials Handling Systems | 1 | 0 | 1 | 1 |

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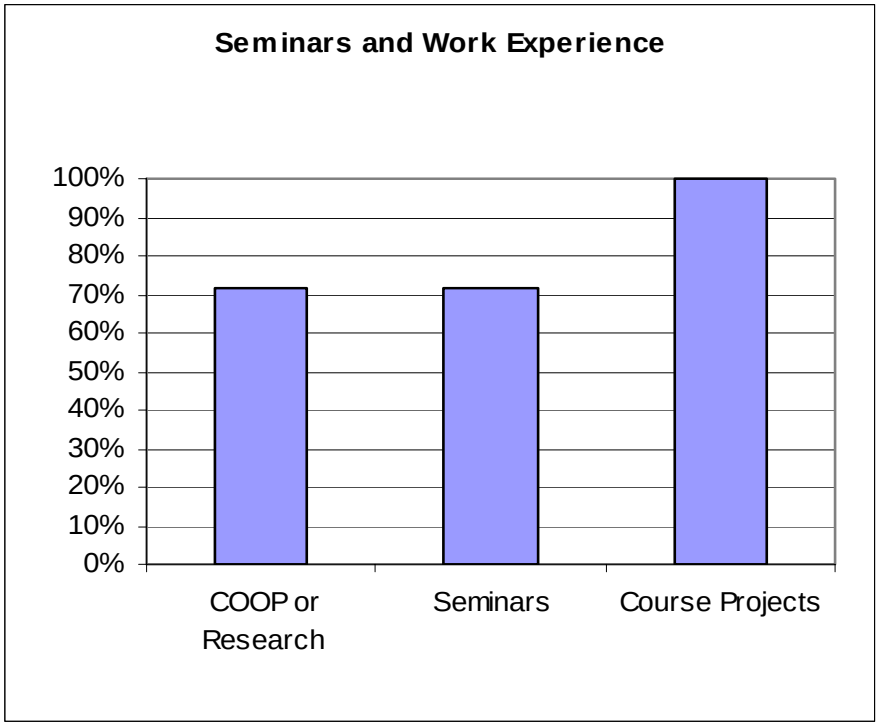
# LIFE-LONG LEARNING

The main vehicle to promote life-long learning in our program is through the extensive use of open-ended engineering projects. In most cases, through this type of projects students face the need to develop new skills and acquire new knowledge for project completion. Examples of courses with open-ended projects are core courses INEG 4057, INEG 4040, and INEG 4079; and IE electives INEG 4810, INEG 4046, INEG 4995, and INEG 4018. Documentation is available in course binders.

Other activities documented that promote life-long learning are student attendance to seminars, participation in professional societies, and EIT (Engineer in Training) exam attendees. Statistics were obtained from resumes of 5$^{th}$ year students during the academic year 2001 – 2002. A summary of results is presented in the next pages.

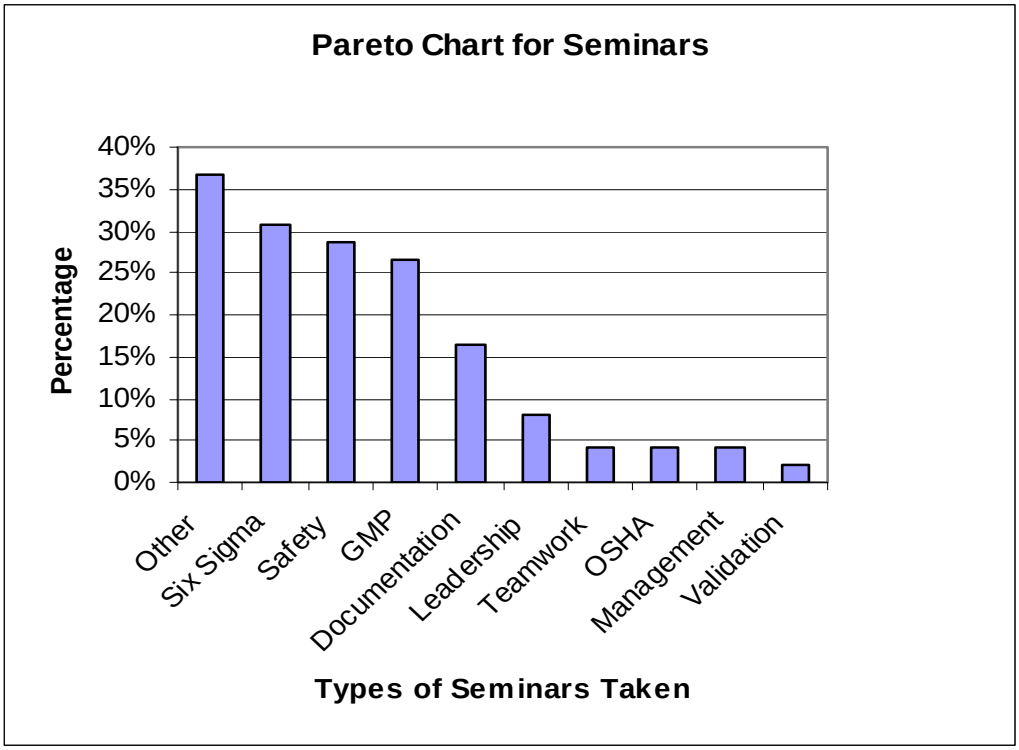
**PERCENTAGE STUDENTS PARTICIPATING IN COOP, RESEARCH WORK, COURSE PROJECTS AND SEMINARS:**

| COOP or Research | Seminars | Course Projects |
|---|---|---|
| 71% | 71% | 100% |



**SEMINARS TAKEN BY OUR STUDENTS EITHER IN OR OFF CAMPUS:**

| Seminars | | |
|---|---|---|
| GMP | Six Sigma | Leadership |
| 27% | 31% | 8% |
| Documentation | Teamwork | OSHA |
| 16% | 4% | 4% |
| Safety | Validation | Management |
| 29% | 2% | 4% |
| Other | | |
| 37% | | |

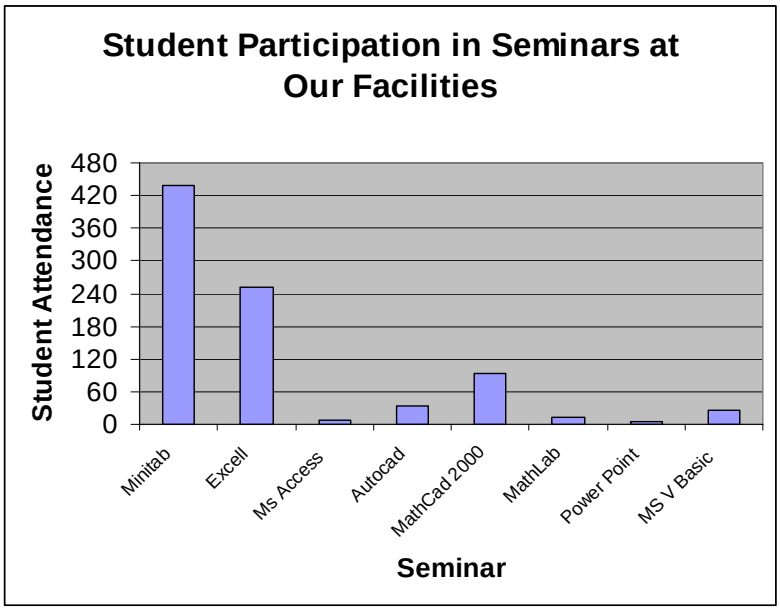


**STUDENT PARTICIPATION IN SEMINARS OFFERED IN OUR COMPUTER FACITILIES:**

**Distribution of Undergraduate Students:**

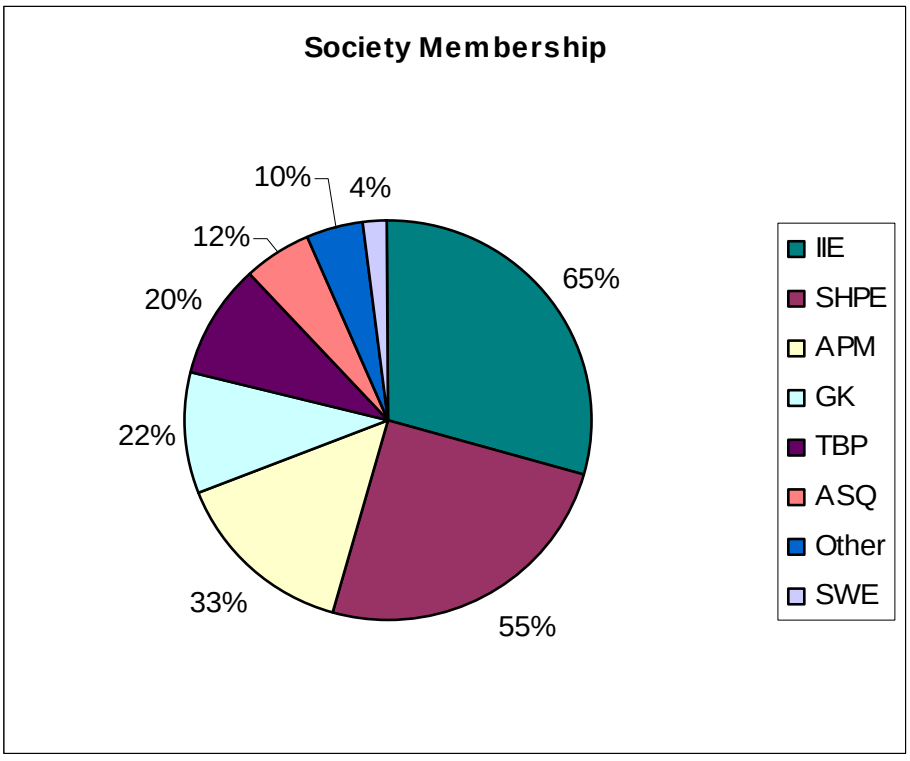
| Academic Year | Number of Students |
|---|---|
| 1st | 112 |
| 2nd | 102 |
| 3rd | 86 |
| 4th | 83 |
| 5th | 221 |

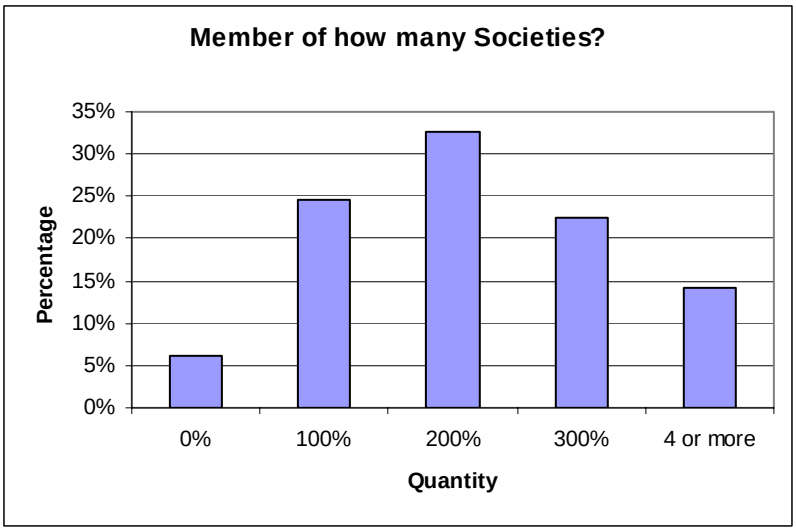
| | Number of Students Attending | | | | |
|---|---|---|---|---|---|
| Seminar | Fall 2000 | Spring 2001 | Spring 2002 | Total | % Number of Students |
| Minitab | 99 | 153 | 186 | 438 | 50 |
| Excell | 103 | 111 | 38 | 252 | 29 |
| Ms Access | | | 9 | 9 | 1 |
| Autocad | | 10 | 25 | 35 | 4 |
| MathCad 2000 | 15 | 79 | | 94 | 11 |
| MathLab | | 13 | | 13 | 1 |
| Power Point | 2 | 4 | | 6 | 1 |
| MS V Basic | | 25 | | 25 | 3 |
| Total | 219 | 395 | 258 | 872 | 100 |



**STUDENT PARTICIPATION IN SOCIETIES:**

| Society | Student Participation | Full Name of Society |
|---|---|---|
| IIE | 65% | Institute of Industrial Engineers |
| SHPE | 55% | Society of Hispanic Engineers |
| APM | 33% | Alpha Pi Mu |
| GK | 22% | Golden Key |
| TBP | 20% | Tau Beta Pi |
| ASQ | 12% | American Society for Quality |
| Other | 10% | Other |
| SWE | 4% | Society of Women Engineers |






**NUMBER OF STUDENTS APPLYING FOR THE EIT EXAM:**

**Graduating Student Exit Survey Results**
**SPRING 2001**
**Engineering in Training Exam**

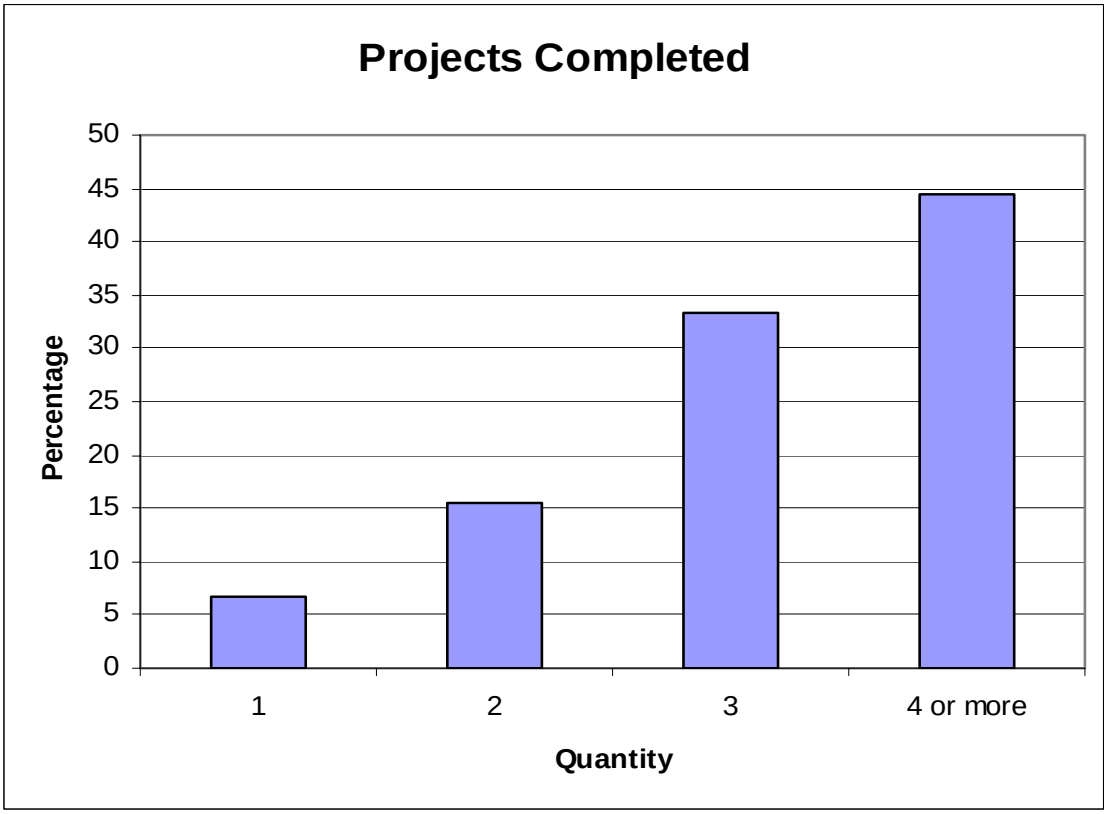
| | |
|---|---|
| Have not taken | 41.7% |
| Taken once and failed | 0.0% |
| Taken more than once and failed | 0.0% |
| Taken once and passed | 25.0% |
| Taken more than once and passed | 4.2% |
| Expect to take it next year | 29.2% |
| | 100.0% |

**Graduating Student Exit Survey Results**
**FALL 2001**
**Engineering in Training Exam**

| | |
|---|---|
| Have not taken | 61.5% |
| Taken once and failed | 0.0% |
| Taken more than once and failed | 0.0% |
| Taken once and passed | 0.0% |
| Taken more than once and passed | 0.0% |
| Expect to take it next year | 38.5% |
| | 100.0% |

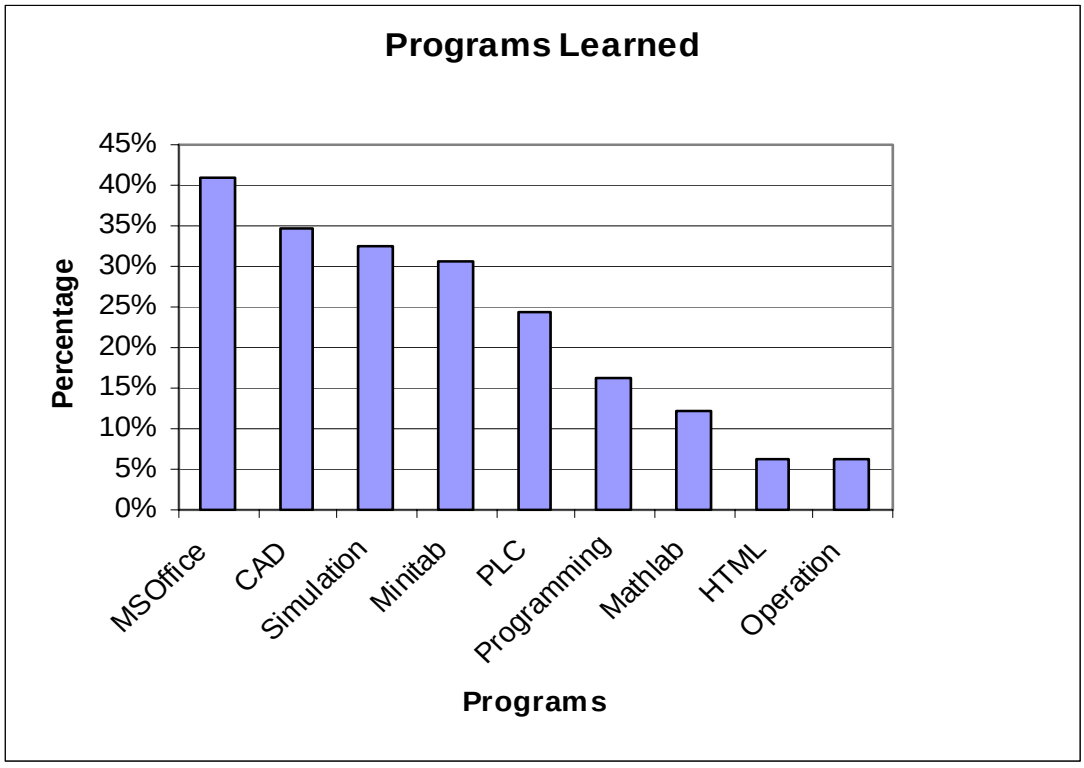
**NUMBER OF PROJECTS COMPLETED BY OUR STUDENTS BY THEIR 5TH YEAR IN COLLEGE:**

| Number of projects | % of Students |
|---|---|
| 1 | 7 |
| 2 | 16 |
| 3 | 33 |
| 4 or more | 44 |



**PROGRAMMING SKILLS FROM STUDENT RESUMES:**

| Program Skills | | |
|---|---|---|
| MSOffice | Minitab | Simulation |
| 41% | 31% | 33% |
| PLC | CAD | Operation |
| 24% | 35% | 6% |
| Programming | HTML | Mathlab |
| 16% | 6% | 12% |



## APPENDIX 3: EXAMPLES OF ASSESSMENT TOOLS