

Outcome 4. The students must have acquired the ability to work individually, on teams, and on multi-disciplinary teams to identify, formulate and solve problems using industrial engineering knowledge, skills and tools.

The assessment is performed with respect to the key abilities that the students are expected to acquire in specific courses that have been identified with respect to this outcome.

Course	Key abilities	Performance indicators
IENG 220, 455, 471, 472	Work effectively in a team	Students will be able to work effectively in a project team with a cooperative spirit and willingness to contribute. Students will be able to communicate in a written report in a scientific manner.
IENG 302, 377, 471, 472	Work effectively in a multi-disciplinary team	Students will be able to solve different design problems (302). Students will be able to analyze and select the correct design material by cost, weight and volume (302). Students will be able to work effectively in project teams consisting of more than one type of engineering major and can analyze and present an economic analysis of an engineering project (302, 377). Students will be able to work in multi-disciplinary teams to design and develop four EXCEL spreadsheets for use in a future project which includes developing basic design performance expressions for both strength and stiffness calculations (302). Students will be able to work in multi-disciplinary teams to utilize the four EXCEL spreadsheets designed and developed in a previous project to solve four different design problems for analyzing and selecting the correct design material by cost, weight and volume (302). Students will be able to work successfully with multi-disciplinary teams on developing and completing the senior design project (471, 472)
IENG 350, IENG 446	Identify, formulate, and solve problems	Students will be able to identify, formulate, and solve operations research and/or facility layout problems using optimization tools and/or software. Students will be able to identify the appropriate tools for solving facility layout problems.

Tools used:	Course assessment rubrics by faculty.
Data Collection:	The data are collected every semester based on the course offerings. The assessment of the key abilities is being done through the performance indicators using a scale from 1 to 5 with 1 representing the least desirable attribute and 5 representing the most.
Frequency of data collection:	The data are collected every time courses are taught.
Data Analysis:	The data obtained are analyzed every year.
Closing the loop:	This outcome is subject to review every year based on performance criteria and metrics; and specific action items are developed, if necessary, to revise the content of the courses. The analyzed data are presented to the faculty in meetings and discussed.

Performance criteria:

- a) Students must be able to demonstrate the ability to work individually, on teams, and on multi-disciplinary teams to identify, formulate and solve problems using industrial engineering knowledge, skills and tools through performance indicators centered on key abilities in specific courses.

Metrics:

- a) At least 70% of the students must be able to demonstrate the fulfillment of the outcome in course assessments by obtaining a score of 3 or higher in each key ability being assessed.

Assessment Tool:

Course Assessment by Faculty

IENG XXX OUTCOME BASED ASSESSMENT

This course relates to outcomes 1,3, 4, and 5. The syllabus shows the breakdown of these outcomes into key abilities expected from the students. In teaching this course during Fall XXXX, the assessment of student performance was done with respect to projects (4), exams (3), and presentation (1). The outcome 1 was assessed 6 times, outcome 3 was assessed 6 times, outcome 4 was assessed 7 times, and outcome 5 was assessed 4 times during the course. The table summarizes the outcomes and their key abilities with respect to which “closing the loop” was done.

Outcome #	Student key abilities requiring “closing” the loop” effort
1	Ability to use materials handling systems design concepts (2)
3	Ability to make oral presentation (1)
4	Ability to work in a project team (1)
4	Ability to formulate and solve problems (2)
4	Ability to communicate in written report (2)

The numbers in the parenthesis indicates the number of instances at which the “closing the loop” was required for the key abilities. It can be observed that the ability to communicate in a written report is of a major concern that needs to be addressed, along with the ability to formulate and solve problems in the material handling systems design domain. Hence, when the course is taught next time, the following will be done to “close the loop”.

Efforts for “closing the loop”

1. Special emphasis will be placed on the importance of communicating findings using a written report. Examples of good reports will be showcased and compared with reports that are less than satisfactory. Techniques and skills in writing good technical reports will be emphasized.
2. Systems design methodology pertaining to materials handling, already covered in the course, will be subject to enhancement and increase in scope.
3. More example problems will be presented in class to illustrate effective problem formulation and solution strategies.
4. Team dynamics and its importance will be covered in more detail.
5. Specific information will be presented to showcase the importance of effective oral presentation.

IENG XXX Special Topic Presentations

The topics chosen by the students were as below.

1. Lean Manufacturing
2. Eco-Industrial Parks
3. JIT Systems
4. Conveyor Systems Applications
5. ASRS Systems
6. Materials Management in Hospitals
7. Bar Coding Technology Applications
8. Automated Palletizers
9. Automated Trailer Loading and Unloading
10. Historical Evolution of Layouts
11. Belt Conveyor Systems
12. Radio Control Technology Applications

This presentation maps to Outcome 3. The key ability expected from the students would be to make an effective oral presentation.

Assessment of student performance

For the key ability “content and quality of slides”, 53% of the students have obtained a score of 3 or above. Since this is below the established metric of 70%, corrective action is required. For the key ability “time management”, 73% of the students have obtained a score of 3 or above, hence requiring no corrective action. For the key ability “speaking skill”, 67% of the students have obtained a score of 3 or higher, hence requiring corrective action. For the key ability “relevance to topic”, 73% of the students have obtained a score of 3 or higher, hence requiring no corrective action. The content of the slides can improve. The students are not fully aware how to design the slides for a ten-minute presentation to capture the details of the topic they have chosen. The material content was somewhat trivial in some instances while in others the text and graphics quality were not up to standard expectations. On the whole the time management was good in all presentations. Some students do not maintain good eye contact with the audience and some of them just read from prepared material. In most cases the presentations were relevant in terms of the chosen topic although in a couple of cases material not within the scope of the chosen topic was presented.

Efforts for “Closing the Loop”

Although this was the last class of the course, the following will be done when the course is taught next time to address the required corrective action.

1. Discuss the process and importance of researching a topic and developing slides for effective time managed presentations.
2. Show video presentations of effective presentations made on technical topics.
3. Illustrate the importance of effective presentation skills for an engineering professional.

IENG XXX COURSE ASSESSMENT RUBRIC

Project on flow, space, activity relationships and personnel requirements

Project assessed student performance with respect to outcomes 4 and 5

Scale: Excellent - 5, Good - 4, Satisfactory - 3, Below average – 2, Poor – 1

O1 – Outcome 1, O2 – Outcome 2, O3 – Outcome 3, O4 – Outcome 4, O5 – Outcome 5

Student name/Team members	Ability to use facilities planning methodologies (O1)	Ability to use materials handling systems design concepts (O1)	Ability to analyze and interpret system data (O3)	Ability to develop practical and cost effective recommendations (O3)	Ability to conduct an analysis of different alternatives (O3)	Ability to make oral presentation (O3)	Ability to gather information from a variety of sources (O3)	Ability to work in a project team (O4)	Ability to formulate and solve problems (O4)	Ability to communicate in written report (O4)	Ability to develop flow and space requirements to develop activity relationships for developing and/or improving facilities design (O5)
Number of students with a score of 3 or above											
Percentage of students with a score of 3 or above											

Assessment of student performance

The students worked in teams of two. This project focused on determining flow from system data and also on determining personnel based requirements in a factory. There were some complaints from the students on the effectiveness of working in a team and this showed in the quality of the project. In the problem on determining personnel requirements some of the students had done the formulation well while others needed to show improvement in this regard. The activity relationships problem was solved well by most of the students. For the key ability “ability to work in a project team”, 69% of the students had a score of 3 or above. For the key ability “Ability to formulate and solve problems”, 69% of the students had a score of 3 or above. Hence both these key abilities pertaining to outcome 4 need corrective actions. For the key ability “Ability to develop flow and space requirements to develop activity relationships for developing and/or improving facilities design” pertaining to outcome 5, 85% of the students had a score of 3 or above hence requiring no corrective action as this falls above the established metric of 70%.

Efforts for “closing the loop”

The project was given back to the students and discussed. The importance of formulating the solution was emphasized and the students were given a small quiz to reinforce this concept. A whole class period was devoted to systematically explain the details regarding a successful formulation strategy. The quiz was immediately discussed in class. The aspects relating to building team effectiveness was discussed.

Assessment of student performance

The students worked in teams of two. This project focused on using the MCRAFT software to design and develop layout recommendations based on flow data between departments. In general the quality of the written report could have been improved. The explanations were not clear and in some cases there was not any explanation of approach at all. The students did not for the most part evaluate alternate layouts by varying the input data within allowable ranges. In some cases printouts from the software were not enclosed. For the key ability “Ability to communicate in a written report” pertaining to outcome 4, 62% of the students had obtained a score of 3 or above, hence requiring corrective action.

Efforts for “closing the loop”

The project was given back to the students and discussed. The importance of effective written communication was emphasized. Examples of sample technical reports were discussed. The generation of alternate layouts using MCRAFT was shown using a computer with a projection screen. The alternate layouts were compared and selection criteria were discussed. It was decided to emphasize the quality of written reports whenever any future projects were given out.

Assessment of student performance

The students worked in teams of two. This project focused on developing the flow data from department to department in a job shop from a process plan for an actual product named as a Powerarm. The major weaknesses as seen from this project were related to applying and synthesizing information presented in class for developing flow data using materials handling systems design concepts. Some of the students were not able to analyze their results in terms of practicality or cost effectiveness. In general, the students worked well in a team format and were able to gather information from various sources to supplement the data provided. In some reports, the written communication can be improved. Once again some of the students generated very few alternate solutions to the problem for the report. For the key ability “Ability to use materials handling systems design concepts” pertaining to outcome 1, 62% of the students had obtained a score of 3 or above. For the key ability “Ability to communicate in written report” related to outcome 4, 62% of the students obtained a score of 3 or above. Hence corrective actions are required for the improvement of these key abilities.

Efforts for “closing the loop”

The project was given back to the students and discussed. The importance of effective written communication was emphasized. Examples of sample technical reports were discussed. Examples of solutions to the project that were possible but were not practical or cost effective were presented to illustrate the need for the students to apply their engineering judgment in generating solutions. Systems design concepts were discussed and reemphasized for almost a half of a class period.

Number of students with a score of 3 or above											
Percentage of students with a score of 3 or above											

Assessment of student performance

This exam was focused on fundamentals of product, process, and schedule design information analysis, the pre-requisite for facilities planning and materials handling systems design activities. The major weaknesses of the students centered on the inability of break down problems and formulate a solution strategy, especially for non-numerical general problems. This was especially true in problems where the information needed to be synthesized and taken to the next level for obtaining a solution. The solution strategies found by some students lacked in practical and cost effective aspects. However, for all the key abilities pertaining to outcomes 1, 3, and 4, at least 70% of the students had obtained a score of 3 or above, hence requiring no significant corrective actions.

Efforts for “closing the loop”

The exam was given back to the students and discussed. Examples and non-numeric open ended problems ere presented in class and solved. The need for synthesizing information and developing solution strategies was emphasized. These weaknesses will be addressed by a review session prior to the second examination.

Number of students with a score of 3 or above											
Percentage of students with a score of 3 or above											

Assessment of student performance

This exam was focused on layout development and the types of layouts used in industry. The most commonly made mistakes related to determination of layout configuration from basis process data. However, for all the key abilities pertaining to outcomes 1, 3, 4, and 5, at least 70% of the students had obtained a score of 3 or above, hence requiring no significant corrective actions.

Efforts for “closing the loop”

The exam was given back to the students and discussed. Industrial examples relating to product layout, process layout, cellular layouts, and fixed position layouts were presented and discussed. The pros and cons of each layout type were emphasized with respect to changes in product variety and volume.

Number of students with a score of 3 or above											
Percentage of students with a score of 3 or above											

Assessment of student performance

This exam was focused on material handling systems design as well as applying facilities planning methodologies. In general some weakness was noticed in the area of students learning to apply facilities planning methodologies learnt in class as well as selecting material handling systems for particular industrial situations. When the problems needed some amount of formulation in order to solve them, some students lacked this key ability. The relatively straightforward problems in the area of flow and space based activity relationships were solved by most of the students. For the key ability “Ability to use materials handling systems design concepts”, related to outcome 1, 62% of the students obtained a score of 3 or above, hence requiring corrective actions. For the key ability “Ability to formulate and solve problems” pertaining to outcome 4, 62% of the students obtained a score of 3 or above, hence requiring corrective actions.

Efforts for “closing the loop”

As this was the final exam, the following will be emphasized when the course is taught next time.

1. The students should be exposed to more numerical problems solved in class in order for them to clearly understand facility design concepts and their relationship to various elements of the product, process, and system parameters.
2. The steps in breaking down facility planning and materials handling design problems and determining solutions will be emphasized more using examples in the industrial domain.
3. The importance of effective formulation to obtain good solutions to problems will be emphasized with more examples.

Assessment of student performance and “closing the loop”

This was the last project in the course and clear improvements are seen to emerge in the students. The project requires the students to synthesize the information learnt in the course and apply it to the design problem. The project required the student to design a warehouse system to accommodate effectively designed unit loads based on product information. Student performance in all the key abilities related to outcomes 1, 3, and 4 is well above the established metric of 70%. Hence no corrective action is required at this time.