

BS Industrial Engineering

Annual Program Report Template

Year:	2022 (Submitted 3/8/23)
Program:	BS Industrial Engineering
Contact Person (include email & phone#)	James Curry

Summary of Continuous Improvement Efforts since Last Report

Provide a brief description of how assessment results have been used for program improvement. Point to a specific example of how an assessment provided the program with data it could use for improvement and what that improvement was, if possible, also show evidence of the improvement. You may look at data from the two previous academic years to support this case.

Respond here:

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The department has implemented ten major recent improvements to the program. The ten improvements are as follows:

1. **Adopting a New Textbook for Senior design**
2. **Improving Design Process for Senior Design**
3. **Citation of References for senior design**
4. **Identification of Regulations in Senior Design**
5. **Lab Writeups for Work Design**
6. **INEN 4345 Computer Integrated Manufacturing 2D to 3D drawing**
7. **INEN 4345 added 3D Printing**
8. **Contest in INEN 4331 Technology Entrepreneurship**
9. **Include Contemporary Issues in INEN 4315 Reports**
10. **F2.08 requesting course level improvements.**
11. **INEN 4350 PIC Adopted a Systems Approach to making supply equal demand.**

1. **Adopting a New Textbook for Senior design**

Identification: Previous improvements were put in place to ensure teams covered ABET and departmental outcomes that were being somewhat neglected including societal impacts and environmental impacts. While all outcomes were being addressed, taking all projects together, individual teams still missed certain outcomes. Additionally, teams often struggled while trying to define their projects during the first semester. There was a need to provide more structure for teams while still leaving room for decision making and leadership.

Improvement: The instructor adopted many of the tools and strategies described in the book “Product Design and Development Handbook”, by Trimble and Shuaib. In terms of system design and planning, teams have a much more similar experience to one another, and all teams are required to cover activities that span the ABET and department outcomes. The book by Trimble and Shuaib is intended for product design projects, but the instructor was able to adapt it to cover the broad range of project types that the IE students pursue. A few examples of tools that were added to the course include house of quality, functional block diagram, and morphological analysis. In particular, students are now required to submit meeting minutes that include a Gantt chart updated each week to show hours pledged and hours worked, as well as cumulative chart that tracks the total hours worked by the team vs. their total pledged hours. These greatly help with team accountability.

Result: The course evaluations indicate a positive experience from the students and a number of faculty commented that students performed very well at the fall 2022 symposium. Teams who started using the new course format will finish their projects at the end of the spring 2022 semester and more results we be learned at that time.

2. Improving Design Process for Senior Design

Identification: In the 2019-2020 academic year, students’ ability to establish constraints in senior design (INEN 4323 & INEN 4385) were determined to be acceptable via our evaluation rubrics, but the course instructor indicated that many students struggled in this area.

Improvement: Exercises focusing on developing unambiguous, testable, project constraints will be incorporated into the fall semester of senior design (INEN 4323) with a refresher in the spring (INEN 4385). These will give students practice developing constraints for a variety of projects, and will include class discussion to help students calibrate themselves with their peers.

Result: At the beginning of the Fall 2020 Semester, in INEN 4323, all students were given an independent assignment to design a pencil holder. Students were required to write a report graded using the following rubric.

Item	Points
Design Concept Requirement/Constrain Analysis	10pts
Design Inputs	
Sufficient	15pts
Testable	15pts
Design Inputs Requirement/Constrain Analysis	10pts
Design Outputs	10pts
Verification Testing	
All Design Inputs are Tested	10pts
Tests are appropriate	10pts
Overall Quality of Work	20pts

The assignment was based on the FDA waterfall design process. Students were asked to identify requirements and constraints at the Design Concept and Design Input level. They were also required to articulate design inputs as a list of testable statements that aligned with their verification tests.

Students were also required to discuss three of their design inputs and corresponding verification tests.

In Spring 2021 (INEN 4385), concepts of requirements, constraints, design inputs, and verification tests were discussed independently with each team within the context of the teams specific project. Faculty scored the senior design teams based on their presentations given in spring after they had completed their projects. A standard rubric with a scale of 1 to 4 was used. The average overall score for Constraints was 3.17, well above our established threshold of 2.5. Related criteria include Objectives and Goals with an average score of 3.25 and Hypothesis Development 3.25.

3. Citation of References

Identification: In the 2019-2020 academic year, students' ability to cite sources in senior design (INEN 4323 & INEN 4385) were determined to be acceptable via our evaluation rubrics, but according to the course instructor many students were not academically prepared and only became successful after receiving intervention support via emails and online meetings with the instructor

Improvement: Exercises focusing on citation styles, proper formatting of references and in-text citations, and use of bibliography software will be incorporated into the fall semester of senior design (INEN 4323) with a refresher in the spring (INEN 4385).

Result: At the start of the Fall 2020 semester (INEN 4323) students were given an assignment in which they had to write a one page report based on one of the senior design projects from the previous year. They were required to cite at least 6 sources using APA style. The assignment included instruction on using Zotero for reference management as well as online tools.

Use of proper in-text citation and references were reviewed as part of the fall report and the final report in the spring.

Faculty scored the senior design teams based on their presentations given in spring after they had completed their projects. A standard rubric with a scale of 1 to 4 was used. The average overall score for Citation was 3.08, which was well above the 2.5 threshold for needs improvement.

4. Identification of Regulations in Senior Design

Identification: The 2019-2020 academic senior design projects (INEN 4323 & INEN 4385) were determined to be acceptable via our rubric with regard to ABET Outcome 2 which generally relates to economic, cultural and environmental impact. Likewise identification of regulations and standards under Outcome 1 was also evaluated as acceptable. Some projects focused heavily in these areas, while others addressed them indirectly or not at all. Addressing or not addressing these areas had more to do with the topic chosen than the quality of the project.

Improvement: To insure students have the opportunity to showcase their abilities in this area, all teams will be required to include an assessment of the global, economic, environmental, societal, health & safety, and cultural impact of their project as well as an assessment of regulations and standards relating to the topic of their project in their Fall and Spring reports.

Result: All teams were required to include a section on Social and Environmental Impact in their reports. Each team was encouraged to consider direct and indirect ramifications of their project. They were encouraged to consider laws, regulations, and standards that could relate to their project. They were also encouraged to consider the environmental impact as well as social impact of their project.

Faculty scored the senior design teams based on their presentations given in spring after they had completed their projects. A standard rubric with a scale of 1 to 4 was used. The average overall score for relevant criteria were as follows:

- Regulations and Standards: 3.25
- Global and Welfare: 3.15
- Environmental: 3.13
- Societal: 3.23
- Health and Safety: 3.17
- Cultural: 3.19
- Identifies global, economic, environed, and societal issues: 3.34

All were well above the 2.5 threshold for needs improvement.

5. Lab Writeups for Work Design

Identification – 1

Laboratories are required in the course. Students have struggled with writing an Executive Summary. Executive Summaries are an essential skill that needs to be mastered for their capstone project and working in industries.

Improvement

A new laboratory was created for students to practice and improve writing an Executive Summary.

Result

The new Executive Summary laboratory average grade was 83 for the Spring 2022 semester and 86 for Fall 2022. Comparing these scores to the Executive Summary portion of the first laboratory assignment in Fall 2021, there was a 55% improvement. The Executive Summary lab was successful in achieving the goal of improving the student's skills in writing an Executive Summary.

6. INEN 4345 Computer Integrated Manufacturing 2D to 3D drawing

Identification : Almost all modern CAD/CAM systems are built upon feature-based parametric 3D modeling approach, 2D drawings become a less used design tool. While in manufacturing industry, 2D engineering drawings still play an important role in the communication between designer and machinists, especially on the dimensions and tolerances. Proper training on 2D drawing is important but not adequately addressed.

Improvement : The course material has been revised with emphasis on design methodology and drafting specifications so that students can be more job ready for design and manufacturing related jobs. The general principle on design for manufacturing and design for assembly were introduced to students.

Results of improvement: The instructor require students to make 2D drawing for every 3D modeling assignment (2 per week). The quality of the drawing keep improving week over week. This practice also help students improve their skills in reading 2D drawings, is expected to have positive impact on their competitiveness in job search for design/manufacturing jobs.

7. INEN 4345. 3D Printing

Identification 4: 3D printing becomes increasingly important in not only prototyping, but also in production. However, this relatively new manufacturing technology was not included in the course before. The new release of the CAD/CAM software such as Fusion 360 start to integrate 3D printing function in recent years, which make it much easy and nature to add this important content in the course.

Improvement 4: 3D printing using Fusion 360 was added to the course, so that students understand the working principle of 3D printing, as well as the steps it involves to turn the design model into the CNC codes that drive the 3D printer to make the part layer by layer.

Results of improvement 4: The addition of the 3D printing was well received by students. In the course project, some students used 3D printing in their manufacturing process planning.

8. Contest in INEN 4331 Technology Entrepreneurship

Identification: The instructor developed the Technology Entrepreneurship course to provide engineering students with knowledge about how technology-based startup companies are founded and grow. The course was originally developed in collaboration with the Center for Innovation Commercialization and Entrepreneurship (CICE), and was intended to be a starting point for students to become engaged in CICE events and activities. Unfortunately, due primarily to COVID, most activities never came about and CICE was recently restructured and brought under the new Entrepreneurship Institute at LU. There was a need to work with the new executive director and other stakeholders to connect the course into the Entrepreneurship Institute ecosystem.

Improvement: Through a series of meetings over Summer of 2022 the instructor, along with collaborators at the Entrepreneurship Institute and community stakeholders, developed a plan to coordinate course activities with events such as the Entrepreneurship Institute speaker series and, most importantly, the new Cardinal Ideas Pitch Deck Competition.

Result: Students taking the course worked in small teams to develop an initial idea into a product design, and then into a business model. The pitch deck competition was timed to correspond with the point in the course when students were making their pitch decks, in this way all the teams could apply to enter the competition. Teams who were not accepted were still allowed to give practice talks, while those who were accepted competed for \$10,000 in prizes! Students not only learned about entrepreneurship, but also learned about the resources and connections available to them through the Entrepreneurship Institute, and they will be invited to future events such as an entrepreneurship bootcamp and an entrepreneurship field trip planned for spring 2023.

9. Include Contemporary Issues in INEN 4315 Reports

Identification 1: INEN 4315 “Industrial Management” is for the online BSIE, BSIE 2+2 and BSIT programs. It is an ABET listed course and topics are related to contemporary issues, life-long learning, ethics and impacts of engineering solutions. All these topics were covered with Project 1 (Ethics related project) and Project 2 (contemporary issues). However, the instructor had seen some obstacles finishing these two projects on time based on students’ evaluations.

Improvement 1: To ensure clear understanding of Project 1 and 2, the instructor recorded lecture videos and provided some example projects from previous years. It was given good, medium and bad examples of the previous projects. Additionally, another ethics video had been prepared for Project 1. All the project expectations were listed and explained, and a brief template had been prepared.

Result of Improvement 1: The students are positive about the changes. They were able to review the videos about projects. Their quality of the projects significantly improved.

10. F2.08 Requesting Course Level Improvements

Identification: Faculty were not documenting improvements in courses.

Improvement: Required faculty to document improvements in annual performance review (F2.08) under teaching section. For year 1, I asked all faculty to go 4 years back. In future years, new improvements plus tracking results of existing improvements will be included. The improvements are used a significant part of the annual evaluation (teaching section is 50% for most faculty).

Result: Documented 30 pages of course level improvements. These improvements are shared among the faculty to share best practices and understand updates in courses at the instructor level.

11. INEN 4350 PIC Adopted a Systems Approach to making supply equal demand.

Identification

The lecture talks about individual ways to make supply equal demand, but do not fully describe how you can use multiple approaches to achieve this goal. Also, the interrelationships between lead time, inventory, price, capacity and demand were not fully presented.

Improvement

Redesigned several lectures in the course including the introduction lecture to discuss multiple ways to make supply equal demand. The theme is now the multiple ways to make supply equal demand with one lecture on price (revenue management) and marketing. The class introduce this theme in the first lecture the slide appears in multiple lectures.

Result

The student evaluations in the course are generally positive and the change did not impact the evaluations.

Program Highlights Since Last Report

Identify and briefly discuss any programmatic curriculum changes made since the last report (e.g. new courses, course changes, SLO changes, course deletions).

No major course changes. INEN 4399 ST: Logistic Geography was taught (primarily BSIT). Many course level improvement listed above.

Table 1. Assessment Results and Analyses for Current Cycle.

STAGE 1: PLAN				STAGE 2: DO		STAGE 3: STUDY
Departmental Student Learning Goal	Program Student Learning Outcome	Assessment	Assessment Method/Location	Benchmark Expectations	Data Results	Actions/Goals Based on Data Results* What do the data tell you? How will you use this data? How were data from the last cycle used to make changes during this cycle, and What were the results of those changes?
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Math and Engineering Formulation	Senior Design Project	Final Report	2.5	2.74	Meet goals but one the low side. Will continue to work on formulations in senior design. Was addressed by improvement plans 1 and 2.
1. an ability to identify, formulate, and solve complex	Diagrams and Sketches Use	Senior Design Project	Final Report	2.5	3.13	Ok in area.

engineering problems by applying principles of engineering, science, and mathematics						
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Terminology and Notation	Senior Design Project	Final Report	2.5	3.08	Ok in area.
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Strategy and Procedures	Senior Design Project	Final Report	2.5	2.88	Ok in area.
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Constraints	Senior Design Project	Final Report	2.5	2.67	Weak area just above minimum standard. Will continue to work on constraints. Was addressed by improvement plan 1 and 2.
1. an ability to identify, formulate, and solve complex engineering problems by applying principles	Objective and Goals	Senior Design Project	Final Report	2.5	2.81	Weak area just above minimum standard. Will continue to work on constraints. Was addressed by improvement plan 1 and 2.

of engineering, science, and mathematics						
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Regulations and Standards	Senior Design Project	Final Report	2.5	2.81	Weak area just above minimum standard. Will continue to work on constraints. Was addressed by improvement plan 1 and 2.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Global and Welfare	Senior Design Project	Final Report	2.5	3.08	Ok
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Economic	Senior Design Project	Final Report	2.5	3.01	Ok

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Environmental	Senior Design Project	Final Report	2.5	2.74	Weak area just above minimum standard. Will continue to work on constraints. Was addressed by improvement plan 1 and 2..
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Societal	Senior Design Project	Final Report	2.5	2.98	Weak area just above minimum standard. Will continue to work on constraints. Was addressed by improvement plan 1 and 2.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Health and Safety	Senior Design Project	Final Report	2.5	3.03	Ok
2. an ability to apply engineering design to produce solutions that meet specified	Cultural	Senior Design Project	Final Report	2.5	3.11	Ok

needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors						
3. an ability to communicate effectively with a range of audiences	Organization	Senior Design Project	Final Report	2.5	2.83	Weak area just above minimum standard. Will continue to work on constraints. Was addressed by improvement plan 1 and 2..
3. an ability to communicate effectively with a range of audiences	Amount of Information	Senior Design Project	Final Report	2.5	3.05	Ok.
3. an ability to communicate effectively with a range of audiences	Quality of Information	Senior Design Project	Final Report	2.5	2.84	Was addressed by citation improvements in senior design and work design improvements.
3. an ability to communicate effectively with a range of audiences	Mechanics	Senior Design Project	Final Report	2.5	2.97	Ok
3. an ability to communicate effectively with a range of audiences	Paragraph Construction	Senior Design Project	Final Report	2.5	2.99	Ok
3. an ability to communicate effectively with a range of audiences	Diagrams and Illustrations	Senior Design Project	Final Report	2.5	3.14	Ok
3. an ability to communicate effectively with a range of audiences	Speaks Clearly	Senior Design Project	Final Report	2.5	3.42	Strong area for department. Has been for many years.

3. an ability to communicate effectively with a range of audiences	Posture and Eye Contact	Senior Design Project	Final Report	2.5	3.41	Strong area for department. Has been for many years.
3. an ability to communicate effectively with a range of audiences	Content	Senior Design Project	Final Report	2.5	3.18	Strong area for department. Has been for many years.
3. an ability to communicate effectively with a range of audiences	Volume	Senior Design Project	Final Report	2.5	3.31	Strong area for department. Has been for many years.
3. an ability to communicate effectively with a range of audiences	Preparedness	Senior Design Project	Final Report	2.5	3.25	Strong area for department. Has been for many years.
3. an ability to communicate effectively with a range of audiences	Enthusiasm	Senior Design Project	Final Report	2.5	3.38	Strong area for department. Has been for many years.
3. an ability to communicate effectively with a range of audiences	Organization	Senior Design Project	Final Report	2.5	3.21	Strong area for department. Has been for many years.
3. an ability to communicate effectively with a range of audiences	Graphics	Senior Design Project	Final Report	2.5	3.28	Strong area for department. Has been for many years.
3. an ability to communicate effectively with a range of audiences	Elocution	Senior Design Project	Final Report	2.5	3.33	Strong area for department. Has been for many years.
4. an ability to recognize ethical and professional responsibilities in engineering	Ethical and professional responsibilities	Senior Design Project	Final Report	2.5	3.16	Ok

situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts						
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	Identifies global, economic, environmental, and societal issues	Senior Design Project	Final Report	2.5	2.92	Ok
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	Considers Stakeholders	Senior Design Project	Final Report	2.5	3.06	Ok

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Contributions	Senior Design Project	Final Report	2.5	3.08	Ok
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Quality of Work	Senior Design Project	Final Report	2.5	3.13	Ok
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Problem-solving	Senior Design Project	Final Report	2.5	2.98	Ok

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Attitude	Senior Design Project	Final Report	2.5	3.29	Ok
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Preparedness	Senior Design Project	Final Report	2.5	2.94	Ok
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Pride	Senior Design Project	Final Report	2.5	3.15	Ok
5. an ability to function effectively on a team whose members together	Working with Others	Senior Design Project	Final Report	2.5	2.98	Ok

provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives						
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Time-management	Senior Design Project	Final Report	2.5	2.98	Ok
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Focus on the task	Senior Design Project	Final Report	2.5	2.99	Ok
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive	Leadership	Senior Design Project	Final Report	2.5	2.9	Ok

environment, establish goals, plan tasks, and meet objectives						
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Mentor / Instructor	Senior Design Project	Final Report	2.5	3.28	Ok
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Data Collection	Senior Design Project	Final Report	2.5	3.26	Ok
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Variables	Senior Design Project	Final Report	2.5	3.15	Ok
6. an ability to develop and conduct appropriate experimentation,	Description of Procedure	Senior Design Project	Final Report	2.5	3.06	Ok

analyze and interpret data, and use engineering judgment to draw conclusions						
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Hypothesis Development	Senior Design Project	Final Report	2.5	2.89	Was addressed by improvement plan 1.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Conclusion/Summary	Senior Design Project	Final Report	2.5	2.89	Ok
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	Recognize need to learn	Senior Design Project	Final Report	2.5	3.22	
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	Ability to learn	Senior Design Project	Final Report	2.5	3.18	
7. an ability to acquire and apply new knowledge as	Citation	Senior Design Project	Final Report	2.5	3.01	

needed, using appropriate learning strategies.						
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Table 2. Continuous Improvement Results Since Last Report

Stage 4: ACT		
Actions/Goals Based on Data Results <i>*Copy last cycle's actions/goals and report on progress toward continuous improvement on those here.</i>	Status <i>C=Complete</i> <i>P=Progressing</i> <i>N=No Action Taken</i>	Discussion of Status <i>If C, describe efforts that led to accomplishment of actions/goals.</i> <i>If P, provide update on progress made toward accomplishing actions/goals and what tasks remain</i> <i>If N, discuss why action toward accomplishing actions/goals has been delayed and what work will be initiated toward accomplishment.</i>
Due to a lack of documented improvements, all faculty are now requested to have improvements in F2.08	C	This year F2.08 had over 30 pages of improvements. The top improvements related to this degree are in this report.
See improvements in courses in the first section.		