2017 ASSESSMENT REPORT AND PLAN

North Dakota State University
Department of Industrial and Manufacturing Engineering
August 2017
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1 Introduction
The Department of Industrial and Manufacturing Engineering started implementing the current ABET Assessment Plan in the 2013-2014 academic year. The ABET-mandated continuous improvement process during the 2016-17 academic year focused on three major categories, also illustrated in Figure 1:

1. **Implementation** of the suggested improvements in the teaching/learning process resulting from the evaluation of the 2014-2015 assessment results;
2. **Evaluation** of the assessment results collected during the 2015-2016 academic year;
3. **Assessment** of selected student outcomes in 2016-2017 and presenting the assessment results to the IME faculty.

In addition, the assessment plan for the 2017-18 academic year is developed and presented to the IME faculty during the IME department retreat on August 14, 2017.

The following sections provide more details about the activities in each one of these three categories.

2 Implementation of the Evaluation Results for Outcomes Assessed in 2014-2015
In accordance with the IME Assessment Plan, four student outcomes were assessed during the 2014-15 academic year (descriptions are abbreviated):

- **a)** Ability to apply knowledge of mathematics, science, and engineering;
- **d)** Ability to function on multi-disciplinary teams;
- **g)** Ability to communicate effectively;
- **j)** Knowledge of contemporary issues.

Details about the assessment results are available in the 2015 Assessment Report. These assessment results were evaluated in 2015-2016 as described in the 2016 Assessment Report. During the evaluation process, faculty were required to identify specific measures for improving student learning in the areas where the major problems were identified and describe these measures in the 2015-2016 Faculty Course Assessment Reports (FCAR). Most, but not all, of these measures were implemented in 2016-2017. For example, to address the deficiency in performance indicator **a1) ability to apply knowledge of mathematics**, and more specifically, statistics, a faculty group led by Dr. Vogiatzis analyzed the syllabi of these courses where the subject matter is covered and evaluated the course content for rigor, competency gaps, and overlapping areas. Dr. Vogiatzis presented the committee findings in the 2016 Faculty Retreat. Implementing the results from this study is still an ongoing effort, which will require a significant overhaul in a number of core courses and will probably take more than one academic year.
Regarding the specific measures outlined in the 2015-2016 FCARs, faculty implemented those to various degrees. The instructor in IME 335, Welding Technology, adopted a new textbook, which he found that worked much better than the text used for the last two years. The faculty who teaches IME 480, Production & Inventory Control revised the course content by removing content delivered in other IME courses and introducing more in-class activities, case studies, and video lectures along with more advanced topics in inventory management and routing.

Another concern was outcome j) knowledge of contemporary issues. As examples of implementing the measures outlined in the FCARs with regard to this concern, the course instructor in IME 330, Manufacturing Processes, modified the course syllabus to include a new topic in contemporary issues in manufacturing technology. The new syllabus was implemented in 2016-2017 academic year. The instructor in IME 460, Evaluation of Engineering Data, included in his class discussion topics and problems on contemporary application of statistics in engineering. IME 480, Production & Inventory Control added topics on sustainability, green supply chain, and incentives for green production. Globalization was another main theme throughout this course; this was further reinforced with the creation and use of exercises that ensure students work with addressing issues that arise when working with industries in different states, countries, and continents.

3 Evaluation of the 2015-2016 Assessment Results
In accordance with the IME Assessment Plan, four student outcomes were scheduled for assessment during the 2015-2016 academic year (descriptions are abbreviated):

b) Ability to design and conduct experiments, as well as to analyze and interpret data;

e) Ability to identify, formulate, and solve engineering problems;

h) Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and social context;

k) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Details about the assessment results collected during the 2015-2016 academic year are available in the 2016 Assessment Report. As a part of the continuous improvement process, these assessment results were discussed during the 2016-2017 academic year by the IME faculty. The minutes from these meetings will be available at the time of the ABET visit along with other supporting materials. The Department decided to focus the discussion on the outcomes where deficiencies were highlighted in the assessment process: outcome b), outcome e), and outcome k).

3.1 Synopsis of the evaluation discussions
September 26, 2016: The fall ABET meeting focused on the results for outcome b) Ability to design and conduct experiments, as well as to analyze and interpret data. The results for the performance indicators in this outcome, reported in the 2016 Assessment Report, meet/exceed the performance target in the IE&M program. However, the results for the Manufacturing Engineering programs are well below the target. In this meeting faculty analyzed this outcome with an objective identifying the reasons for this discrepancy. The only differences between the two programs is in the course work related to this outcome. The MfgE-specific courses that cover outcome b) are IME 380, 430, 431. It was decided to examine these courses by an ad-hoc committee lead by Dr. Khoda in order to identify competency gaps and overlaps. Faculty were asked to send course materials and syllabi for these courses to Dr. Khoda for examination by committee. This
The committee has yet to finalize its work. In addition, Dr. Yadav, Interim Chair, suggested to work individually with faculty to develop specific measures for improving student learning in outcome b).

February 2, 2017: The discussion in this meeting was focused on how to improve student learning in student outcomes e) Ability to identify, formulate, and solve engineering problems, and k) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

For outcome e), it was decided to put an emphasis on solving real-life engineering problems in our curricula: lectures, labs, seminars. The faculty should evaluate student learning based on their ability to solve engineering problems by designing goal-oriented tests, homework assignments, course projects, etc. This should be done with an emphasis on the five fundamental steps of problem solving: problem definition, developing strategies, developing solutions, implementing solution, and evaluating outcomes.

Regarding Outcome k), some of the suggestions were to introduce more lab experience in our curricula, provide students with more hands-on experience in using lab equipment, and introduce the use of the IME lab equipment in the capstone by offering at least 2 internal capstone projects. This measures will be further discussed during the retreat in August 2017.

Faculty were required to provide specific measures in their FCARs of how to improve student learning in these outcomes. Examples from the 2016-2017 FCARs include:

**IME 330, Manufacturing Processes:** this class includes a laboratory component. In the first three labs students conduct experiments to reinforce the theoretical knowledge acquired in the lecture class and learn more about the fundamental principles of the metal machining process. To address the deficiency in Outcome b) and improve student experience in these labs, starting from the next semester students will be asked not only to present the results from the lab experiments in their reports but also to analyze the relation between the critical process variables and their effect on the outcomes of a basic metal machining process.

**IME 335, Welding Technology:** The course instructor will add some more lab work for those advanced students who finish early and would like to spend more time in the lab. He will also reorganizing the lab to improve safety and teaching efficiency.

**IME 460, Evaluation of Engineering Data:** The course instructor outlined a number of action items for course improvement in his FCAR.

**IME 480, Production & Inventory Control:** the instructor will consider a new textbook that is focused towards more senior engineering students, rather than the one currently used, which focuses on the business aspects and downplays the importance of engineering problem solving, engineering statistics, and mathematical modeling. He will also create a group case study project and will introduce more practice problems and extra credit opportunities for students that are interested in special, advanced topics.
4 Results from the 2016-2017 Assessment

4.1 Outcomes assessed

The student learning outcomes assessed in 2016-2017 are shown in Table 1 along with the related performance indicators. Table 2 maps these outcomes and the courses where the assessment data were collected for both IME programs. The specific direct and indirect assessment tools and the rubrics used to assess each student outcome are discussed in details in Appendix B of the IME Assessment Plan.

Table 1. Student outcomes and performance indicators assessed in 2016-2017.

<table>
<thead>
<tr>
<th>Student Outcome</th>
<th>Performance Indicator</th>
</tr>
</thead>
</table>
| c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | c1. Develops a design strategy based on project and client needs and constraints.  
c2. Identifies the constraints in the design problem, and establishes criteria for acceptability and desirability of solutions  
c3. Supports the design procedure with documentation and references |
| f) an understanding of professional and ethical responsibility | f1. Understands professional responsibility (e.g., safety, environmental, legal, regulatory, intellectual property, project management, risk management) and applies related issues to practical situations  
f2. Understands and applies engineering code of ethics to practical situations |
| i) a recognition of the need for, and an ability to engage in lifelong learning | i1. Participates in learning activities outside of the classroom, including participation in professional and technical societies and meetings, learning communities, industry experiences, etc.  
i2. Recognizes how the college experience contributes to understanding the need to continuously update professional skills to solve new problems |

Table 2. Course mapping (2016-2017).

<table>
<thead>
<tr>
<th>Where data is collected</th>
<th>Semester</th>
<th>Program</th>
<th>Course instructor</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDC Online: Student exit survey</td>
<td>Both</td>
<td>IE&amp;M/MfgE</td>
<td>Om Yadav</td>
<td>x x x</td>
</tr>
<tr>
<td>IME489: Capstone scoring by industry panel</td>
<td>Both</td>
<td>IE&amp;M/MfgE</td>
<td>Dennis Steinman</td>
<td>x x</td>
</tr>
<tr>
<td>IME489: Capstone scoring by faculty</td>
<td>Both</td>
<td>IE&amp;M/MfgE</td>
<td></td>
<td>x x x</td>
</tr>
<tr>
<td>IME489: Capstone student survey</td>
<td></td>
<td></td>
<td></td>
<td>x x x</td>
</tr>
<tr>
<td>IME311: Work/Station Design</td>
<td>Spring 2017</td>
<td>IE&amp;M/MfgE</td>
<td>Kambiz Farahmand</td>
<td>x</td>
</tr>
<tr>
<td>IME431: Production Engineering</td>
<td>Spring 2017</td>
<td>MfgE</td>
<td>David Wells</td>
<td>x*</td>
</tr>
<tr>
<td>IME456: Program and Project Mgmt.</td>
<td>Fall 2016</td>
<td>IE&amp;M/MfgE</td>
<td>James Misialek</td>
<td>x</td>
</tr>
<tr>
<td>IME485: Facilities Layout and Design</td>
<td>Spring 2017</td>
<td>IE&amp;M</td>
<td>Bashir Khoda</td>
<td>x</td>
</tr>
</tbody>
</table>

*assessed in IME 311; § data was not processed because wrong assessment forms were used by the instructor

4.2 Assessment results

Results for student outcomes (c), (f), and (i) are reported separately in the following pages. All supporting documentation, including the raw data files, will be available at the time of the ABET visit. These results are presented to the IME faculty in the August 2017 Faculty Retreat. The review and evaluation of these results by the IME faculty is planned for the 2017-2018 academic year as a part of the continuous improvement process.
Student outcome (c): an ability to design a system, component, or process

<table>
<thead>
<tr>
<th>Performance indicator</th>
<th>Where data are collected*</th>
<th>Assessment instruments</th>
<th>Target</th>
<th>Results (1-4/%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Direct</td>
<td>Indirect</td>
<td>IE&amp;M**</td>
</tr>
<tr>
<td>c1. Develops a design strategy based on project and client needs and constraints.</td>
<td>IME485 (IE&amp;M) IME311</td>
<td>Faculty assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IME489§</td>
<td>Capstone scoring by faculty</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GDC</td>
<td>Capstone scoring by industry experts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c2. Identifies constraints on the design problem, and establishes criteria for acceptability and desirability of solutions</td>
<td>Same as c1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c3. Supports design procedure with documentation and references</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Data collected for both programs unless indicated otherwise; § data was not processed because wrong forms were used in the assessment
** STD – standard deviation; N – number of responses red indicates below target

Figure 2. Results for Outcome c) for both programs showing distribution of scores (top) and average results vs. the performance target (bottom).
### Student outcome (f): Performance indicators and assessment methods

<table>
<thead>
<tr>
<th>Performance indicator</th>
<th>Where data are collected*</th>
<th>Assessment instruments</th>
<th>Target</th>
<th>Results (1-4/%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td>Indirect</td>
<td>IE&amp;M**</td>
<td>MfgE**</td>
</tr>
<tr>
<td>f1. Understands profes-sional responsibility and applies related issues to practical situations</td>
<td>IME456 Faculty assessment</td>
<td>Capstone scoring by faculty, Capstone student survey</td>
<td>3.4 (85%)</td>
<td>3.5 (87%) N = 81 STD = 0.63</td>
</tr>
<tr>
<td></td>
<td>IME489§ Capstone scoring by industry experts</td>
<td></td>
<td></td>
<td>3.5 (87%) N = 81 STD = 0.63</td>
</tr>
<tr>
<td></td>
<td>GDC Student exit survey</td>
<td></td>
<td></td>
<td>3.5 (87%) N = 81 STD = 0.63</td>
</tr>
</tbody>
</table>

* Data collected for both programs unless indicated otherwise; § data was not processed because wrong forms were used in the assessment
** STD – standard deviation; N – number of responses

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**Figure 3.** Results for Outcome f) for both programs showing distribution of scores (top) and average results vs. the performance target (bottom).
### Student outcome (i): Performance indicators and assessment methods

<table>
<thead>
<tr>
<th>Performance indicator</th>
<th>Where data are collected*</th>
<th>Assessment instruments</th>
<th>Target</th>
<th>Results (1-4/%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i1. Participates in learning activities outside of the classroom</td>
<td>IME311 Faculty assessment</td>
<td>Direct</td>
<td>3.2</td>
<td>3.3 (82%) N = 45 STD = 0.82</td>
</tr>
<tr>
<td></td>
<td>IME489 Faculty assessment</td>
<td>Indirect</td>
<td>3.2 (80%)</td>
<td>3.2 (79%) N = 35 STD = 0.86</td>
</tr>
<tr>
<td></td>
<td>GDC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i2. Recognizes how the college experience contributes to understanding the need to continuously update professional skills</td>
<td>Same as i1.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Data collected for both programs unless indicated otherwise; § data was not processed because wrong forms were used in the assessment

** STD – standard deviation; N – number of responses

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**Figure 4. Results for Outcome i) for both programs showing distribution of scores (top) and average results vs. the performance target (bottom).**
4.3 Comparison with the assessment result from 2013-2014
The same student outcomes, c), f), and i), were originally assessed in 2013-2014, the first year of the previous 3-year assessment cycle and the first academic year in which the current IME Assessment Plan was implemented. These results are compared in Figure 5 to the results from the current assessment year, 2016-2017, which is the first year in the next 3-year cycle.
Figure 5. Comparison of the assessment results for student outcomes c), f), and i) from 2013-2014 and 2016-2017.

The comparison results in Figure 5 will be discussed in detail in the 2017 Faculty Retreat. A quick observation indicates that there is a significant improvement compared to the previous assessment cycle, however, the results are still below the target for performance indicator c3) Supports the design procedure with documentation and references. This result will be the focus of the next year’s evaluation activity.

4.4 Reflection on the assessment process

Compared to previous years, the engagement of the IME faculty in the continuous improvement process was largely effective in collecting assessment data and adequate in evaluating assessment results, but still lacking in formulating and implementing measures aimed at improving student learning in the problematic areas. With regard to assessment, one major problem from the previous year where some of the results were not presented separately for each performance indicator and/or for each program was largely solved by working individually with the faculty and providing them with more detailed instructions and assessment materials. One of the important goals for the assessment coordinator in 2017-2018 will be to continue working closely and individually with the faculty to assist them in the assessment process. This will be especially important with regard to the new faculty who have joined the department recently. Also, the importance of using the FCARs for documenting the course-specific measures aimed at improving student learning must be emphasized.
5 Continuous Improvement Process in 2017-2018

5.1 Implementation of the evaluation results for outcomes assessed in 2015-2016

As described in Section 3, in 2016-2017 course instructors were required to identify specific measures for improving student learning in outcomes b), e), h), and k) assessed in 2015-2016 and to outline these measures in their FCARs with a targeted implementation in the teaching process in 2017-2018.

5.2 Preparation for the 2015-2016 assessment results evaluation

The results presented in Section 4 will be discussed and evaluated by the IME faculty during the 2017 Faculty Retreat and throughout the 2017-2018 academic year. The summary of this discussions along with the suggested program improvements will be included in the 2018 Assessment Report. Outlined below are some immediate observations that would serve as a starting point in this discussion.

Student learning outcome c) an ability to design and conduct experiments, as well as to analyze and interpret data.

The target in this outcome is set at 3.4 (85%). The results for the performance indicators in this outcome showed an improvement compared to the previous assessment cycle and meet/exceed the performance target in both programs with the exception of performance indicator c3) Supports the design procedure with documentation and references. The department will analyze in depth the results and will identify the reasons for this continuing discrepancy. This should include a review of the course content in these courses where the outcome c) is covered (IME330, IME311, IME380, IME430, IME431, IME 470, IME 472, IME482, IME456, IME 485, and IME489).

Student learning outcome f) an understanding of professional and ethical responsibility.

The target in this outcome is set at 3.4 (85%). The results for the performance indicators in this outcome showed improvement compared to the previous assessment cycle exceeding the performance target in both programs. The Department may consider increasing the current target to 3.5 (88%) for the next assessment cycle. A higher target would encourage and stimulate the efforts of the faculty in this area.

Student learning outcome i) a recognition of the need for, and an ability to engage in life-long learning.

The target in this outcome is set at 3.4 (85%). The results for the performance indicators in this outcome showed improvement compared to the previous assessment cycle and meet/exceed the performance target in both programs.

5.3 Assessment plan for 2017-2018

The department assessment plan for 2017-2018 is presented by the assessment coordinator for discussion in the 2017 Faculty Retreat.

5.3.1 Student outcomes and performance indicators to be assessed

According to the IME Assessment Plan and as shown in Figure 1, in 2017-2018 the department will assess student outcomes a), d), g), and j). These outcomes along with the performance indicators are shown in Table 3. The coverage map for these outcomes is shown in Table 4.
Table 3. Student outcomes and performance indicators to be assessed in 2016-17.

<table>
<thead>
<tr>
<th>Student Outcome</th>
<th>Performance Indicator</th>
</tr>
</thead>
</table>
| a) an ability to apply knowledge of mathematics, science, and engineering      | a1. Applies knowledge of mathematics (e.g., statistics, differential mathematics, linear algebra)  
  a2. Applies knowledge of science (e.g., mechanics, chemistry, physics)  
  a3. Applies knowledge of engineering (e.g., quality assurance and control, manufacturing systems, inventory control, simulation, facilities layout for IE&M and process and production engineering, CAD/CAM, manufacturing systems for MfgE) |
| d) an ability to function on multi-disciplinary teams                          | d1. Contributes to team meetings  
  d2. Facilitates contributions of team members  
  d3. Contributes individually outside of team meetings  
  d4. Fosters constructive team climate  
  d5. Responds to conflict                                                                                                                                                                                                                                                                                |
| g) an ability to communicate effectively                                       | g1. Demonstrates effective oral presentation skills – organization, content, and delivery  
  g2. Demonstrates effective written communication skills – style, organization, use of graphs and tables                                                                                                                                                                                                                                                   |
| j) a knowledge of contemporary issues                                          | j1. Demonstrates knowledge of current trends, complex problems, and career opportunities in his/her field of study  
  j2. Demonstrates awareness of contemporary issues facing society and various perspectives, such as engineering, economic, political, environmental, legal, professional, ethical, global, and/or cultural  
  j3. Discusses contemporary issues and offer insight into the issues as they relate to the engineering profession                                                                                                                                                                                                                                               |

Table 4. Course mapping (2017-2018).

<table>
<thead>
<tr>
<th>Where data is collected</th>
<th>Semester</th>
<th>Program</th>
<th>Instructor</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDC Online: Student exit survey</td>
<td>both</td>
<td>IE&amp;M/MfgE</td>
<td>Om Yadav</td>
<td>x x x x</td>
</tr>
<tr>
<td>IME489: Capstone rubric scoring by industry</td>
<td>both</td>
<td>IE&amp;M/MfgE</td>
<td>Dennis Steinman</td>
<td>x x x</td>
</tr>
<tr>
<td>IME489: Capstone rubric scoring by faculty</td>
<td>both</td>
<td>IE&amp;M/MfgE</td>
<td>Val Marinov</td>
<td>x x x x</td>
</tr>
<tr>
<td>IME489: Capstone student survey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IME330: Manufacturing Processes</td>
<td>S 2018</td>
<td>IE&amp;M/MfgE</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>IME431: Production Engineering</td>
<td>S 2018</td>
<td>MfgE</td>
<td>TBD</td>
<td>x</td>
</tr>
<tr>
<td>IME456: Program and Project Mgmt.</td>
<td>F 2018</td>
<td>IE&amp;M/MfgE</td>
<td>Jim Misialek</td>
<td>x x x</td>
</tr>
<tr>
<td>IME460: Evaluation of Engineering Data</td>
<td>F 2018</td>
<td>IE&amp;M/MfgE</td>
<td>Kambiz Farahmand</td>
<td>x</td>
</tr>
<tr>
<td>IME461: Quality Assurance and Control</td>
<td>S 2018</td>
<td>IE&amp;M/MfgE</td>
<td>Yiwen Xu</td>
<td>x x</td>
</tr>
<tr>
<td>IME480: Production Inventory Control</td>
<td>F 2018</td>
<td>IE&amp;M</td>
<td>Chrys Vogiatzis</td>
<td>x</td>
</tr>
</tbody>
</table>

During the assessment planning meeting in the beginning of each semester the faculty in the department responsible for collecting assessment data will be provided with individual worksheets with more details about their responsibilities in the assessment process, including the recommended assessment tools.