CREATING MULTIPLE ASSESSMENTS FROM CLASSROOM ASSIGNMENTS

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ABSTRACT

The Mechanical Engineering Technology program of Purdue University at Columbus/Southeast Indiana is a small program with only two full-time faculty and typically has 4-8 graduates per year. In preparing for its first ever ABET accreditation evaluation in the fall of 2005, the faculty conducted a survey of graduates from the last three years and received nine responses. Such a small response contributed to the concern that this method of assessment might not provide much useful data regarding assessment of program outcomes and objectives. As a result of this and limited resources, the faculty of the MET program in Columbus focused their efforts on direct assessment of program outcomes by using classroom assignments, lab reports and exam questions. An example of an embedded assessment utilized by the MET faculty is a laboratory report. The Mechanical Engineering Technology program consists of many classes that have laboratory activities. The rubric used for lab reports is a fifteen part rubric that varies from 1 to 4. Lab reports are assessed for spelling/grammar, participation, calculations, appearance, analysis, summary, conclusions and drawings/diagrams among other categories. Assessments can be made of technical content (program outcome (PO 1), communications including written content and graphical communications (PO 3), experimental understanding and teamwork. While these assessments are useful for gauging learning and are used in the MET program continuous quality improvement process, they also make grading considerably easier.

A two-page form was also developed which summarized the assessment points for each program outcome. The first page of the form includes the mission statements of Purdue University, the MET program objectives, the MET program outcomes, the core learning objectives of the particular course in which the assessment is performed and the details of the assessment point. These details include the specific core learning objective, the applicable program outcome and the rubric for the assessment. The second page of the form includes the results of the assessment, those teaching techniques that the faculty member wants to retain and those that he wants to change.

I. INTRODUCTION

The introduction of the TC2K criteria [1] by the Technology Accreditation Commission of ABET placed significantly more emphasis on learner-centered instruction and on measuring learning. This approach coincides closely with the growth of continuous quality improvement processes in manufacturing and other industries. Rather than focusing on the input to the learning process, e.g. faculty, textbooks, syllabi, this approach involves measuring the output of the process, e.g. student learning. To establish a continuous quality improvement process and prepare for a TC2K evaluation visit in 2005, the Mechanical Engineering Technology faculty of the Purdue University College of Technology at Columbus/SE Indiana labored to develop assessment practices that fit and made sense to their institution.

At many institutions with large enrollments in engineering technology programs, assessment techniques such as surveys, performance on standardized exams and other similar tools are effectively used. Many of these can be found in a cd-rom [2] developed by Rogers in 2004. This work sought to “bring common sense into the assessment of educational programs”. Fortunately and unfortunately, the Purdue University College of Technology at Columbus/SE Indiana typically has small classes, often with only 8-12 students, and has graduating classes that are usually smaller. While small classes are beneficial to the students and faculty in many ways, they do not lend themselves to survey-type assessment techniques. With that in mind, the MET faculty sought to develop a continuous quality improvement process that utilized multiple assessments of classroom activities to measure learning.

II. MAKING THE CASE FOR ASSESSMENTS

The continuous improvement process is not a particularly new idea. In fact, land grant universities were established by the Morrill Act of 1862 and the summary below clearly indicates that universities should provide a yearly report of the progress of each college. These statements below are from Section 5, paragraph 4 of this act.

> “An annual report shall be made regarding the progress of each college, recording any improvements and experiments made, with their cost and results, and such other matters, including State industrial and economical statistics, as may be supposed useful; one copy of which shall be transmitted by mail free, by each, to all the other colleges which may be endowed under the provisions of this act, and also one copy to the Secretary of the Interior.” [3]

More than 140 years later, the Accreditation Board for Engineering and Technology (ABET) listed the following as part of the criteria for accrediting engineering technology programs:

> “Each program must utilize multiple assessment measures in a process that provides documented results to demonstrate that the program objectives and outcomes are being met. [1].”

Lightner and Meznarich in their recent work [4] also state that “most planners agree an organization that does not undergo periodic examinations will not grow, and most likely will decline.”

Given the three references above, it is clear that measuring improvement is not only critical to a continuous improvement process but also that it provides demonstrative evidence of improvement to various stakeholders and accrediting bodies and is critical to the health of the organization. The dilemma for programs that don’t have large number of students and graduates like the MET program at the Purdue University College of Technology in Columbus is how to best use limited resources to accomplish these objectives.

III. ASSESSMENT PROCESS DEFINED

According to Olds, Moskal, and Miller [5], assessment “refers to the act of collecting data or evidence that can be used to answer classroom, curricular, or research questions. Assessment methods are procedures used to support the data collection process. Evaluation refers to the interpretations that are made of the evidence collected about a given question.” Their work divided assessments into two primary categories: descriptive and experimental. The objective of a descriptive study is to examine and explain the current state of a statistic while the experimental study aims to determine the effectiveness of a planned change in a course or curriculum. The assessments utilized by the MET program and discussed in this paper are experimental.

The work by Lightner and Meznarich [4] categorize assessments as either direct or indirect measures of student learning. Typically, surveys of students, faculty, alumni and industrial partners qualify as indirect measures of student learning since they relate opinions or thoughts about knowledge, skills, attitudes, learning experiences, and perceptions and are largely subjective. Two students may feel quite different about whether they have learned the core learning objectives of a course. Similarly, managers at two different companies may have different perspectives on whether a graduate in their employ is an effective communicator. As a result, these surveys are considered indirect measures of learning.

Direct measures of learning assess student performance of identified learning or program outcomes, such as written or oral communication, teamwork, lifelong learning and various technical engineering skills. They very often require rubrics and standards of performance and are suitable for quantitative analyses. All of the assessments discussed in this work that are performed in the MET program at the Purdue University College of Technology in Columbus are direct assessment measures.

Roselli and Brophy [6] in their 2006 work discuss experiences with formative assessment in the engineering classroom. Formative assessment, as opposed to summative assessment, provides immediate and anonymous feedback to students in the classroom. This type of assessment is often facilitated by handheld electronic devices that allow students to answer multiple-guess questions and have the answers transmitted for immediate display on a computer. The correct answer is discussed after the teacher displays the class results, which are anonymous. The advantage of this, according to Roselli and Brophy, is that misunderstandings and misconceptions are managed quickly and effectively. Their argument is that summative assessments, which are derived from homework, exams and other assignments, do “provide information about students’ understanding of domain knowledge, but are usually not systematically used as a learning opportunity for students.” [6] They contend that summative assessments are often not returned to the students in a timely manner to provide effective feedback. The author has experienced this circumstance. Assessments and assignments returned too late annoy students and do not provide much of a learning opportunity. Promptly returned assignments, particularly written assignments, are an important part of the learning process. The assessments discussed in this work are summative assessments.

IV. INDIRECT, DESCRIPTIVE ASSESSMENT METHODS

A review of current literature suggests that surveys, which are indirect, summative and descriptive assessments, are the most-used assessment technique. Lightner and Meznarich [4] employ in their work surveys of students, graduates and employers. Students are surveyed (called a student confidence scale) upon graduation to determine how confident they feel they are prepared to enter the workplace. The individual questions are related to various student outcomes like teamwork, communication (oral and written), professional behavior as well as technical concepts. Evaluation of these assessments leads to changes in teaching style, course learning objectives and, possibly, curriculum changes.

Employers of graduates in Lightner and Meznarich’s study are surveyed to “provide information about the graduate in terms of their initial hire position, current position, the degree to which they have increased responsibility, work performance, productivity, business techniques, personal characteristics, and the employers overall satisfaction with the graduate.” Evaluation of these employer surveys is most likely to produce changes in curriculum as programs respond to recommendations from the employers.

In this 2007 work by Lightner and Meznarich [4], graduates are also surveyed one and five years after graduation. “This survey is used to help gauge the success and advancement of graduates in the workplace and to evaluate the strengths and weaknesses of the program from the graduate’s perspective.” Information about the quality of instruction, quality of facilities, equipment and academic services are extracted from these completed surveys.

Other descriptive and indirect assessment methods are discussed in the work by Olds, Moskal, and Miller [5]. These include personal interviews, focus groups, conversational analysis, observation, ethnographies and meta-analysis. Interviews and focus groups represent an approach to gathering data that cannot be observed while conversational analysis and observation are methods for capturing data that can be observed. Ethnographies require the researcher to become part of the society and to do detailed research of the society. Meta-analysis is a way to look across several investigations to draw conclusions. None of these are utilized by the MET program in Columbus.

V. DIRECT ASSESSMENTS

Direct assessments are very often related to exams, laboratory assignments or reports and homework assignments. Lightner and Mezharich [4] in their work at the University of Nebraska at Kearney describe a comprehensive exam that is given to all graduating seniors to determine their level of technical and non-technical competency. This exam was first given at their institution in the spring of 2005. Previous to this, a nationally normed exam was used. The motivation for developing a unique comprehensive exam was the concern that the “one size fits all exam” didn’t really fit their program. Hence, they developed a comprehensive exam. Since the exam had only been administered once prior to their work, no detailed analysis was included. A similar exam was discussed among faculty and administrators of the MET program in Columbus but was not instituted due to concerns about limited faculty resources.

The civil and geological engineering department at New Mexico State University uses the subject-specific Fundamentals of Engineering (FE) examination as an outcomes assessment tool for student learning. This effort is described by Nirmalakhandan, Daniel, and White [7]. In this work, they mention that the “FE exam results can be used for internal assessments as well as for comparisons against peer institutions. One of the uses of the results would be in comparing the performance of students in an institution against the peer performance on a subject bases to gauge the effectiveness of individual or series of courses. When compared over a period of time, the results can be used to evaluate impacts of continuous quality improvement efforts.” While this particular assessment is effective, it’s not an alternative for two-year AS degree programs in engineering and technology.

Another type of direct assessment that is used by the MET program is termed the “randomized controlled trial” by Olds, Moskal, and Miller [5]. It is “one of the more effective methodologies for comparing different instructional formats.” This could be as simple as using a different pedagogy to teaching core learning objectives of individual classes, which is used extensively in this paper. This assessment could also be more complex if the effect of instituting a new curriculum is desired. In either case, the assessments are a direct measure of students’ attainment of program outcomes.

Another popular direct assessment tool recommended by Rogers [2] especially for written communication is the portfolio. Johnson[8] in her work describes how students are instructed to post various documents in an online portfolio. Writing, content, audience awareness, and document design are among the eleven variables assessed in the process. Johnson suggests that the effort is sustainable because only a random sampling of the student work is assessed each semester. This can also be an effective tool if students are asked to accumulate documents in an online location throughout their field of study, providing evidence of improvement as they proceed from freshmen though graduation. Again, this tool was not used by the MET program at Purdue-Columbus due to concerns about faculty resources.

VI. WEB-BASED ASSESSMENT TOOLS

As assessment and continuous improvement have become part of the culture of engineering and technology programs, some organizations have developed web-based tools to facilitate the process. Aller, Kline, Tsang, Aravmuthan, Rasmusson, and Phillips have developed a tool called WeBAL at Western Michigan University and have described it in a 2005 paper [9]. According to the authors, "The assessment library (WeBAL) (http://www.wmich.edu/engineer/webal/webal.htm) is a Web-based online assessment system, available to any Internet user, that queries faculty needs for directing and assessing student performance and recommends instruments from a library of faculty-critiqued, classroom-tested assessment and evaluation documents." The WeBAL system has two distinct features: a library of assessment tools with accompanying explanations on how to use them, and a search mechanism used to direct faculty to assessment tools in the library that might be useful to their needs. Rubrics that make grading and assessing easier are also available to interested faculty. Currently, according to the creators of WeBAL, the assessment library focuses only on communication and teamwork but a larger expansion to include lifelong learning and the design process is planned.

Smaill [10] discusses the implementation and evaluation of a tool called OASIS (Online Assessment System with Integrated Study) that could be used with large classes. This tool contains a bank of questions from electrical engineering fundamentals. Students are encouraged to use the tool in practice mode before using the test mode. In practice mode, students choose a course, a topic and then questions from that topic. Using this mode, students gain familiarity with the environment and skills required for the test. The tests are then quickly graded by the online tool and the results are provided for the student almost immediately. Hopefully, this near instant feedback would allow students to correct their misunderstandings and misperceptions of the key concepts of the class. Written homework submitted to the instructor would be similar except that the feedback from grading the work will certainly not be immediate if at all. These assessments are used to track a student's understanding throughout the class as well as comparing student scores from semester to semester as faculty, pedagogy, and class environment changes. This appears to be a quite useful tool for supplementing or replacing written assignments.

VII. CLASSROOM ASSESSMENTS

The assessments detailed in the following sections are tied to classroom activities and assignments. They represent experimental, direct, summative assessments of learning outcomes and are really randomized controlled trials. Current literature on the details of classroom assessments is sparse but several good publications do provide some direction. Angelo and Cross [11] in 1993 published an outstanding reference that included helpful sections on how to get started with classroom assessments and included examples of many effective assessment practices. Additional resources in classroom techniques include publications by Walvoord [12] and Walvoord and Anderson [13]. These references were consulted to familiarize the MET faculty in classroom assessment.

Specific examples of classroom assessment include the testing method used by Bluestein [14] to test students' proficiency in prerequisite classes. A short, 10-problem multiple-choice test is given the first day of class. Initial results have not been encouraging. Ahmadian [15] described two examples of classroom assessment including very specific rubrics for laboratory assignments and for oral presentations. Both examples included multiple assessment points. For example, the oral presentation assessment included measures for the narrative, visual aids, organization and technical content.

Another element of classroom assessment is presented by Shaeiwitz, [16] who utilized example problems that students solved in teams and then presented on the board. This practice, also adopted by the author, allows for immediate feedback on students' progress.

The temptation to use grades as an assessment tool is great. Grades are a part of nearly every course. Pape and Eddy [17], though, discuss the problematic use of grades for assessment. As mentioned in other works [18], students may receive a passing grade in a class, yet never fully grasp the core learning objectives of the class, which are tied to program outcomes. Grading also varies from faculty member to faculty member and is just not reliable for assessing learning. However, an assessment that deals directly with a core learning objective and has a specific rubric is appropriate.

As described in this work, classroom assessment refers to lab reports, integrated project experiences, and individual exam questions. In most cases, the effort is to extract as much assessment information from a single classroom activity as possible. All assessments are tied to course core learning objectives. Examples of these assessments follow.

VIII. MET 214 – Machine Elements Assessments

A primary example of embedding multiple assessments in classroom work while efficiently using the instructor's resources was the assessment of a single problem on the final exam of MET 214, a course in the analysis and design of machine elements. The pertinent core learning objectives were:

1. Develop the ability to apply the principles and methods previously developed in statics, dynamics, and strength of materials to the selection of machine components.
6. Develop skill in using, reading, and interpreting necessary materials such as tables, charts, graphs, and industrial catalogs as a part of appropriate problem solution.
7. Demonstrate skill in and a commitment to accurate work by applying appropriate formulas to problem solutions in conjunction with an appropriate utilization of variable lists and appropriate variable units.

Each of these core learning objectives was assessed using a single problem on the final exam. The particular problem required the design of a shaft loaded with a belt drive and a pulley. The correct solution required the formation of proper shear and bending moment diagrams to determine the stress throughout the shaft. This formed the basis for assessing CLO 1 above and included the rubric in Table 1.

Table 1. The rubric for assessing CLO 1 for MET 214

0	Didn't attempt the problem.
1	Incorrectly determined horizontal and vertical reactions and drew either no or incorrect diagrams.
2	Correctly determined reactions and drew correct diagrams in one direction only.
3	Process was correct but missing forces caused incorrect reactions but diagrams were correct based on incorrect forces.
4	Process for answering all parts was correct but missed units or had a simple math error.
5	Correctly computed reactions; Correctly drew shear and bending moment diagrams in both directions

Similarly, the problem solution required the computation of a modified endurance strength that used 5 different parameters read from graphs or tables. This assessment included the rubric shown in Table 2.

Table 2. The rubric for assessing CLO 6 for MET 214

0	Didn't attempt the problem.
1	Missed four of the table/chart parameters
2	Missed three of the table/chart parameters
3	Missed two of the table/chart parameters
4	Missed one of the table/chart parameters
5	Correctly determined all table/chart parameters for problem solution

The third assessment for this problem involved the student's ability to properly organize a solution, use the proper formulae and units and create a logical flow for the solution that is understandable to anyone with an MET background. Table 3 presents the rubric used for that assessment.

Table 3. The rubric used to assess CLO 7 for MET 214

0	Didn't attempt the problem.
1	Entire solution was a mess with multiple formula and units errors.
2	Attempted problem but obtained no correct answers due to using one incorrect formula.
3	Applied formulas and units correctly but missed multiple answers (reactions, max shear/moment, endurance strength, and diameter) due to a math or units error.
4	Applied formulas and units correctly but missed one answer (reactions, max shear/moment, endurance strength, and diameter) due to a units or math error.
5	Correctly completed entire problem with proper formulas and units.

Appendix A contains the two-part form that summarizes the assessment of CLO 7 from MET 214. Part A of the form describes

1. Statements from the Purdue University mission statement
2. The MET program outcomes
3. The Core Learning Objectives of the course.
4. Details of the assessment.

The details of assessment include the particular CLO being assessed, the method of assessment and the criteria (rubric) used for the assessment. Part B of the form provides the assessment results and what the instructor wishes to continue and what he/she wishes to change to improve the assessment. In the particular case of CLO 7, an improvement in the rubric average was seen from 2005 to 2007. Requiring the GFSA (Given – Formulae – Solution – Answer) format in this and other classes has helped students to better organize their solutions. However, the desired average of 4.0 was not achieved. In fact, the rubric averages of all three assessments were less than the goal of 4.0. In each case, the average was adversely affected by students who did not attempt the problem. Since two of the three assessments directly related to skills that should have been acquired in a previous course, this measure shows an inadequacy in the learning of the prerequisites. The instructor must either spend time during this course to improve those skills or changes must be made to increase learning in the prerequisite courses.

In the past, there may have existed anecdotal evidence among instructors that students were not learning the objectives in prerequisite courses. Now, with the above-described assessment, a quantitative measure is produced that can be tracked as changes are made. This represents a significantly better approach to measuring learning.

IX. MET 230 – Fluid Power Assessments

Another approach to creating resource-efficient assessments is to include an essay question on an exam that tests an understanding of the technical content of an issue. The same essay provided by the student to answer the question can be assessed for written communication.

The particular CLO assessed was

> Demonstrate understanding of operational theory of *pressure* vs. *flow* relationships in pneumatic systems.

The activity for the assessment began with the instructor demonstrating an experiment to the class. Using a fluid circuit demonstrator, the instructor set the flow rate, which was computed using a venturi tube, and proceeded to use a differential manometer to measure the pressure difference between two pressure taps five feet apart on a one-inch diameter pipe. The experiment was then repeated with three other pipes of differing diameters. The students recorded the data and submitted a lab report summarizing the lab and specifying the two separate ways to compute the coefficient of friction from the data. The first involved using the pressure difference information to compute the friction coefficient. The second involved computing the Reynolds Number and combining that with the roughness of the pipe surface to estimate a friction value from the Moody diagram. Since the two values were rarely equal, the students were challenged to explain the difference.

The actual assessment was from an essay problem on the final exam. The question was worded as below:

> *Assume that we have a pipe of diameter D and length L with pressure taps at the beginning of the length and at the end of the length connected to a manometer. The flow in the pipe is Q. The setup is exactly like our lab for one of the 5 foot sections of pipe. Completely describe the two ways to compute friction factor.*

Students were encouraged to provide a comprehensive answer that consisted of more than two sentences so that a reasonable assessment of writing skills could occur. Unfortunately, this didn’t always happen.

The first assessment of this problem solution focused on the technical content of the essay. Table 4 gives the rubric used for the assessment. The author went through several versions of this rubric in deciding on the final form in Table 4. Clearly, designing rubrics is another element of the process that is subject to continuous improvement.

Table 4. The rubric used to assess CLO 3 for MET 230.

0	Couldn't describe either method of computing friction coefficient.
1	Completely omitted one approach and poorly described the alternative approach.
2	Poorly described both approaches to computing the friction coefficient.
3	Completely described one method but poorly described the second approach.
4	Somewhat described both methods but omitted a few important details.
5	Completely described both ways to compute friction coefficient.

The second assessment of this exam question concerned the writing content of the students' answers. For this case, the rubric in Table 5 was used. Many of the answers were quite short and properly judging the writing skills was problematic. Still, grammar mistakes, spelling mistakes, and incomplete sentences were apparent, even for short answers. It's reasonable to expect that students could better structure their writing on short answers but in many cases this wasn't true. As a result, the author felt that the assessment was legitimate.

Table 5. The rubric used to assess written essay skills.

0	Many grammatical, spelling, or punctuation errors with no complete sentences.
1	Many grammatical, spelling, or punctuation errors with some complete sentences.
2	A few grammatical, spelling, or punctuation errors but not all complete sentences.
3	A few grammatical spelling or punctuation errors with all complete sentences.
4	Almost no grammatical, spelling or punctuation errors with all complete sentences.
5	No grammatical, spelling or punctuation errors with all complete sentences.

MET 230 has been offered three times since the implementation of the continuous quality improvement plan developed by the MET department at Purdue University

College of Technology at Columbus/SE Indiana. The initial assessment in 2004 of the technical content of the essay answer produced a rubric average of 1.7, which was much lower than the desired value of 4.0. The author suspected that having the students watch the instructor perform the lab was possibly related to the low score. There is, however, only one machine for performing the experiment. Hence, the lab was conducted by the instructor. As a recommendation for the next offering of the course, 2005, the instructor offered on page 2 of the continuous improvement form that the students should complete the lab. In 2005 and 2007, the students were organized into groups of 3-4 and directed to accomplish the lab with an introduction from the instructor and the proper pre-lab materials as guides.

The assessment results from 2005 and 2007, as documented by the two-page form, are shown in Appendix B. The rubric average for technical content was 3.2 for 2005 and 3.3 for 2007 – a significant increase from 2004 and evidence that the suggested change worked well. Allowing the students to work the lab will continue in this class.

The assessment results for writing skills is less encouraging. From 2004 to 2007, the rubric average stayed about the same at 2.3. This is not adequate, particularly on such a short essay. Students will continue to receive many opportunities to write, possibly with more input from MET faculty on technical writing.

X. MET 214 – Capstone Project

An additional requirement in ABET TC2K criteria is the inclusion in the curriculum of a capstone project that "must draw together diverse elements of the curriculum and develop student competence in focusing both technical and nontechnical skills in solving problems."[1] In the MET program at Purdue University College of Technology at Columbus/SE Indiana, this project occurs in the Machine Elements course. In the spring semester of 2005 and 2007, students were required to specify a design of a machine, using fundamentals from several courses like statics, dynamics, strength of materials, production specifications and fluid power. Working in groups, the students were required to organize and submit a written report, present their design process in the class during an oral presentation, and discuss the ethical, global and lifelong learning implications of their work. Assessments occurred for technical content, oral and written communications. These projects can be easily extended to add elements of lifelong learning, ethics and teamwork. If those are added, then these assessments would cover all five of the program outcomes of the MET programs at Purdue University College of Technology at Columbus/SE Indiana.

Capstone projects or other similar projects that provide integrating experiences represent an outstanding opportunity to perform many assessments of program outcomes. If properly planned and organized, these projects can enhance the "soft skills" of the program, including communications, ethics, teamwork and lifelong learning.

XI. CONCLUSIONS

This report has focused on and shown several examples of generating multiple ABET-quality assessments from classroom assignments. Many programs, such as the Purdue University College of Technology at Columbus/SE Indiana, have small enrollments and small class sizes that make assessments relying on surveys and results from standardized exams impractical. However, the same small class sizes do facilitate employing more direct assessments of program outcomes. While these direct assessments certainly require effort to implement and organize, in some cases several assessments of one classroom activity can be performed, leading to an efficient use of program and faculty resources. This work has highlighted just a few of those opportunities at the MET program of Purdue University College of Technology at Columbus/SE Indiana.

XII. REFERENCES

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Purdue College of Technology at Columbus/SE Indiana
What and How of Assessment
Part A

Topics from the Purdue University at Columbus/SE Indiana Mission Statement	**Program or Area Learning Outcomes**	**Core Learning Objectives** Also indicate corresponding program or area outcome(s)	**Assessment of Core Learning Objectives**
The mission of Purdue University at Columbus/SE Indiana is: 1. To prepare its graduates to succeed as leaders, professionals, informed consumers, responsible citizens, and lifelong learners. 2. To admit to its programs an academically proficient population of students pursuing post-secondary education. 3. To reach out to an expanded audience of learners through residential and distance education utilizing a variety of learning media and technologies. 4. To play a leadership role in Indiana's economic and social development. 5. To promote human and intellectual diversity by providing equal access and opportunity to representatives of a rich variety of populations and cultures. *6.* To contribute to the welfare and advancement of human societies throughout the world.	*Upon completing their course of study in <u>Mechanical Engineering Technology</u> at Purdue College of Technology at Columbus/SE Indiana, students should be able to demonstrate:* 1. Apply knowledge, problem solving techniques, and hands-on skills in the areas of; design, product development, manufacturing processes, materials specification, fluid power, energy systems, and continuous improvement. 2. Recognize the need to continue professional development by engaging in lifelong learning. 3. Communicate with others in an effective manner. 4. Work effectively in diverse teams. 5. Fulfill the requirements of their profession while being aware of the accepted standards of integrity and ethical conduct.	**Course Title: Machine Elements** **Course Number: MET 214** Faculty Member: Professor Joe Fuehne Year: ___2007_____________________ Term: _☐__Fall _☒_Spring *Upon successful completion of this course, the student will:* 1. Developed the ability to apply the principles and methods previously developed in statics, dynamics, and strength of materials to the selection of machine components. 2. Developed applicable refinements of previous analytical skills from mathematics and MET prerequisite courses as utilized in new areas of application. 3. Developed new or more intensive problem solving skills to the course topics. 4. Learned terminology and facts related to covered topics and use them in formulating appropriate problem solutions. 5. Learned concepts and theories which underlie the development of covered topics and use the understanding thus gained to select appropriate solution methods for specific problem solutions. 6. Developed skill in using, reading, and interpreting necessary materials such as tables, charts, graphs, and industrial catalogs as a part of appropriate problem solution. 7. Demonstrate skill in and a commitment to accurate work by applying appropriate formulas to problem solutions in conjunction with an appropriate utilization of variable lists and appropriate variable units. 8. Synthesized previously learned computer skills with select course topics to develop problem solving computer software.	**Core Learning Objectives being assessed <u>this semester:</u>** CLO 7 – Demonstrate skill in and a commitment to accurate work by applying appropriate formulas to problem solutions in conjunction with an appropriate utilization of variable lists and appropriate variable units. **Methods of Assessment:** Final Exam question #4 asks students to determine the thickness of a shaft with applied loads. The problem is long, has several parts and requires the students to use several equations and various units and is a good assessment for accurate work. **Criteria:** 0. Didn't attempt the problem. 1. Entire solution was a mess with multiple formula and units errors. 2. Attempted problem but obtained no correct answers due to using one incorrect formula. 3. Applied formulas and units correctly but missed multiple answers (reactions, max shear/moment, endurance strength, diameter) due to a math or units error. 4. Applied formulas and units correctly but missed one answer (reactions, max shear/moment, endurance strength, diameter) due to a units or math error. 5. Correctly completed entire problem with proper formulas and units.

Purdue College of Technology at Columbus/SE Indiana
Results and Closing the Loop
Part B

Course Title: Machine Elements
Course Number: MET 214
Faculty Member: Professor Joe Fuehne
Year: ___2007
Term: _☐__Fall _☒_Spring

Assessment Results

Data summary and brief analysis for each course outcome assessed this semester: *(Include outcome, method, timing, criteria, and results.)*

2007	4	4	3	1	2	3	3	3	5							3.10	3.00.
																Average	Median
2005	3	5	3	2	3	2	4	5	2	2	2	2	1	0	1	2.47	2.00

The rubric results above show the students' performance for the assessment for CLO #7 for 2007 and 2005. The class was not offered in 2006. The average of 3.10 for 2007 is slightly better than the 2.47 from 2005 but is far below the desired average of 4.0.

Based on Assessment Results,

1. **What do you wish to continue?**

Neatness, accuracy and a logical flow to problem solutions are critical in the workplace as well as in school. Problems that require a lengthy solution will continue to be assigned.

2. **What changes will you make to course, e.g. course emphases, assessment instrument, timing of assessment?**
   (Briefly describe instructional change(s) and your rationale.)

It appears that emphasizing the GFSA format for all solutions in other 100- and 200-level classes has had a somewhat positive effect. The instructor will continue to do this and hold students accountable for their work.

Faculty Signature: **Joseph P. Fuehne**

Date: **May 25, 2007**

TWO-PART ASSESSMENT FORM FOR MET 230, CLO 3

Purdue College of Technology at Columbus/SE Indiana
Class Assessment Form
Part A- What and How of Assessment

Topics from the Purdue University at Columbus/SE Indiana Mission Statement	**Program or Area Learning Outcomes**	**Core Learning Objectives**	**Assessment of Core Learning Objectives**
The mission of Purdue University at Columbus/SE Indiana is: 1. To prepare its graduates to succeed as leaders, professionals, informed consumers, responsible citizens, and lifelong learners. 2. To admit to its programs an academically proficient population of students pursuing post-secondary education. 3. To reach out to an expanded audience of learners through residential and distance education utilizing a variety of learning media and technologies. 4. To play a leadership role in Indiana's economic and social development. 5. To promote human and intellectual diversity by providing equal access and opportunity to representatives of a rich variety of populations and cultures. *6.* To contribute to the welfare and advancement of human societies throughout the world.	*Upon completing their course of study in Mechanical Engineering Technology at Purdue College of Technology at Columbus/SE Indiana, students should be able to demonstrate:* 1. Apply knowledge, problem solving techniques, and hands-on skills in the areas of product development, manufacturing processes, materials specification, fluid power, energy systems, and continuous improvement. 2. Recognize the need to continue professional development by engaging in lifelong learning. 3. Demonstrate proficiency in written and oral communications. 4. Solve problems in a team environment. 5. Demonstrate awareness of the accepted standards of professional integrity and ethical conduct	**Course Title: Fluid Power** **Course Number: MET 230** Faculty Member: Professor Joe Fuehne Year: 2007 Term: ☐ Fall ☒ Spring 1. *Design fluid power systems* with off the shelf components. 2. *Analytically analyze* fluid power systems for proper operation. 3. Demonstrate understanding of operational theory of *pressure* vs. *flow* relationships in hydraulic systems. 4. Demonstrate understanding of operational theory of *pressure* vs. *flow* relationships in pneumatic systems. 5. Demonstrate understanding of application o *the conservation of energy equation* to fluid power systems. 6. Demonstrate the operation and function of working fluid power systems. 7. Demonstrate application of compressible and incompressible fluids in dynamic and static fluid power systems. 8. Demonstrate conventional solenoid control valve vs. servo control valve technology application to motion control circuits. 9. Use application software for analyzing, documenting, and presenting the results of technical work	**Core Learning Objectives being assessed this semester:** 3. Demonstrate understanding of operationa theory of *pressure* vs. *flow* relationships in hydraulic systems. This assessment of CLO 3 relates to **Outcome #1** dealing with the technical understanding of pressure vs. flow relationships. **Methods of Assessment:** 1. Evaluate essay problem 8 on final exam for technical understanding. **Criteria:** CLO 3 Rubric for technical knowledge: 0. Couldn't describe either method of computing friction coefficient. 1. Completely omitted one approach and poorly described the alternative approach. 2. Poorly described both approaches to computing friction coefficient. 3. Completely described one method but poorly described the second approach. 4. Somewhat described both methods but omitted a few important details. 5. Completely described both ways to compute friction coefficient.

Purdue College of Technology at Columbus/SE Indiana
Part B – Results and Closing the Loop

Course Title: Fluid Power
Course Number: MET 230
Faculty Member: Professor Joe Fuehne
Year___2007____________
Term: ☐ Fall ☒ Spring

Assessment Results

Data summary and brief analysis for each course outcome assessed this semester: *(Include outcome, method, timing, criteria, and results.)*

Fall 2004	2	1	2	0	3	2	0	1	4							1.67
Fall 2005	1	5	5	4	5	2	3	5	5	1	1	1	4	4	2	3.20
Spring 2007	5	3	5	2	2	4	2									3.29

A lab experiment formed the basis for this assessment. The first class (2004) watched the instructor conduct the lab. The rubric results were poor (1.7). Subsequent classes (2005, 2007) actually performed the lab in teams of 3 or 4. This change was suggested in previous documentation as a potential improvement. The focus was to compute friction coefficient two ways. The first was to measure pressure at 2 points along a straight section of pipe, relate it to head loss using Darcy's equation and compute an experimental friction coefficient. Similarly, a second approach used a venturi tube to measure flow rate, computed a Reynold's number and read the friction coefficient from Moody's diagram. The objective of the lab was to compare the values and offer explanations for differences. On the exam, students were asked in an essay question to completely describe both methods for computing the friction coefficient. The rubric results above represent the students' performance on this problem. The desired average is a 4 (max = 5). This form represents the third measurement performed on the CLO and class and is a significant improvement using the recommendations from 2004.

Based on Assessment Results,

2. What do you wish to <u>continue</u>?

The lab experiment is good and reinforces the lectures of flow vs. pressure relationships. The lab is introduced to students with a handout and that will continue. Over three offerings, the rubric average increased from 1.7 to 3.29. Although this is still below the desired average of 4, it is a significant improvement and this practice will continue

2. What <u>changes</u> will you make to course, e.g. course emphases, assessment instrument, timing of assessment?
(Briefly describe instructional change(s) and your rationale.)

Having students conduct the lab by making their own measurements, reading the manometer, and adjusting the valves to properly re-direct the flow significantly increased understanding of the pressure vs. flow relationship. The next step to improving the rubric score may be to reduce group size of the teams or include a similar question on a quiz in addition to the question on the final exam. In 2007, the lab and subsequent report were done at the end of the semester. In future semesters, the lab will be assigned earlier to allow feedback from the instructor.

Faculty Signature: Joseph P. Fuehne

Date: May 24, 2007