Continuous Improvement and Program Assessment Manual

CIPA Manual
Department of Biological Systems Engineering
Undergraduate Programs

Revised
Summer 2023
https://bse.unl.edu/downloads/files/Modified%20CIPA%20Manual%202023%20Summer.pdf

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I. BACKGROUND

a. Purpose and Organization

The intent of the Continuous Improvement and Program Assessment (CIPA) manual is to guide the continuity, consistency, and continual quality improvement practices of the Bachelor of Science in Agricultural Engineering (AGEN) and Biological Systems Engineering (BSEN) and Agricultural Systems Technology (AGST) undergraduate programs of the Department of Biological Systems Engineering (BSE) at the University of Nebraska-Lincoln (UNL). The manual illustrates how the continuous improvement processes are embedded in the management of the programs. Individuals outside and independent of the program should be able to understand the Department's process for assessment, evaluation, data storage and maintenance through use of the manual. A single CIPA Manual is kept by the department because the AGEN, BSEN, and AGST programs share faculty and departmental governance and employ similar, if not identical, assessment processes.

Multiple audiences for the manual include ABET, the North Central Association of Colleges and Universities, and USDA/NIFA, all of whom have accreditation or advisory roles.

The manual is organized along the lines of the ABET accreditation process for purposes of simplicity and ease of use. It is kept in an electronic file available to BSE administrators, faculty and staff. Such availability facilitates its role as a dynamic document with which continuous improvements are made not only to the AGEN, BSEN, and AGST programs, but also to the continuous improvement and program assessment (CIPA) process. Because administrative and faculty members guiding these programs change with time, institutional memory is enhanced through orderly use and regular updating of the CIPA process for the programs.

b. Schedule

Continuity and consistency are ensured through the regular use of this manual for continuous improvement and program assessment (CIPA) cycles of the AGEN, BSEN, and AGST programs. Changes to the CIPA process, and hence to this document, are made at the Department's undergraduate and ABET subcommittee workshops, through the leadership of the Department Head and the Chair of the Department Curriculum Committee, by the faculty members participating in workshops.

Table 0. Schedule Table (replace page as revised versions become available)

Assessment Duties and Responsibilities											
		What is the expected/ target level of attainment?	Who is responsible for _____(of) the tool?					What is the frequency for ____?		When was last activity?	When is next activity?
Assessment Tools	Programs		preparing	administering	analyzing/ interpreting results	acting on the results	documenting the activity	collection	reporting		
---Active---											
Fundamentals of Engineering (FE) Exam	AGEN, BSEN	Confidence interval greater than zero	--	NCEES	David Mabie	ABET Committee	David Mabie	Annual	Annual	Spring 2023	Summer 2024
Grades	AGEN, BSEN	90% receive C or greater	Gene Gillam	UNL Registrar	David Mabie	ABET Committee	David Mabie	Annual	Two-year	Spring 2023	Summer 2023
Department Advisory Council (PEO discussion)	AGEN, BSEN	Not Applicable	Mark Stone (Department Head)	Mark Stone (Department Head)	ABET Committee	ABET Committee and Unit Head	David Mabie	Three-year	--	Spring 2023	Spring 2025
Senior Exit Interview and Surveys	AGEN, BSEN, AGST	2.5 on 4-point scale	Gene Gillam	Mark Stone, Tami Brown-Brandl (Department Head, 480 Instructor)	Gene Gillam	CIPA Committee and Unit Head	David Mabie	Annual	Two-Year	Spring 2023	Spring 2024
Course/Curricula Student Outcomes Matrices (SOMs)	AGEN, BSEN	Outcome Specific	Course Instructor	Course Instructor	ABET Committee	CIPA Committee and Course Instructor	David Mabie (ABET Committee chair)	Annual	Three-Year	Spring 2023	Spring 2026
Course-level Activity Assessments	AGEN, BSEN	Outcome Specific	Course Instructors	Course Instructors	Course Instructors	ABET Committee	David Mabie (ABET chair)	Annual	Annual	Fall 2022	Fall 2023
ACE Assessment	AGST, AGEN, BSEN	ACE Outcome Specific	Course Instructors	Course Instructors	Course Instructors	ABET Committee	David Mabie (ABET chair)	Annual?	Five-year (Relative to each outcome)	Spring 2022	Spring 2024
Course Reflections	AGEN, BSEN,		Course Instructor	Course Instructor	Course Instructor	Course Instructor	Course Instructor	Semi-annual	--	May 2023	December 2023

Assessment Duties and Responsibilities											
		What is the expected/ target level of attainment?	Who is responsible for _____(of) the tool?					What is the frequency for ____?		When was last activity?	When is next activity?
Assessment Tools	Programs		preparing	administering	analyzing/ interpreting results	acting on the results	documenting the activity	collection	reporting		
	AGST										
---Inactive---											
Alumni Survey	AGEN, BSEN			Alumni Association	Evan Curtis	Evan Curtis	(CIPA chair)			July 2013	
Client Evaluation of Senior Design Projects	AGEN, BSEN	3.0 on 4-point scale	Evan Curtis	(AGEN/ BSEN 480 instructors	Evan Curtis	AGEN/ BSEN 480 instructors	Angela Pannier	Annual	Two-Year	May 2017	May 2018

II. ASSESSMENT INSTRUMENTS

Achievement targets for each of the Student Outcomes were established in 2002 and have been updated and streamlined every three years through annual workshops. Both direct measures and indirect measures provide criteria for evaluating student performance. Current targets are listed for each instrument in the following sections.

Actions taken to correct performance, or to "close the loop" in ABET terminology, are reassessed in the following three-year cycle. The existing process forces the faculty members to be cautious in establishing "feel-good" targets, which appear noble, but for which nothing could be realistically corrected if the data indicate lack of achievement. The assessment schedule, individuals/groups responsible and target attainments are stated in Table 0.

a. Fundamentals of Engineering (FE) Exam

Results from the FE Exam are essential in the assessment process for both the AGEN and BSEN degree programs. NCEES Subject Matter Reports provide aggregated summary data on EAC/ABET program examinees. The aggregated results state the student's discipline-specific exam module and undergraduate program. The Dean's Office from the College of Engineering semi-annually distributes a copy of the NCEES Subject Matter Report for currently-enrolled students identifying themselves as majoring in Agricultural Engineering, Biological (non-Biomedical) Engineering, or Biomedical Engineering degree program. The relevant Subject Matter Reports are made available to the College of Engineering shortly after either January or July.

The FE Exam is used to assess and evaluate ABET Student Outcomes 1, 2, 4, and 6. FE exam results are used to compare UNL AGEN and BSEN students with their peers across the country using methodology recommended by NCEES (NCEES, 2016). AGEN students typically sit for the Other Disciplines module of the FE Exam. BSEN students typically sit for either the Other Disciplines module or the Environmental module of the FE Exam. BSEN students can self-select to be identified as being in the Biological Engineering or in the Biomedical Engineering degree discipline.

FE exam results are used to compare UNL BSEN students with their peers across the country using methodology recommended by NCEES (NCEES, 2016). BSEN students typically sit for either the Other Disciplines module or the Environmental module of the FE Exam. BSEN students can self-select to be identified as being in Biological Engineering or in the Biomedical Engineering degree discipline.

Comparison (comparators) of BSEN students is made to similar students of similar degree programs at Carnegie I institutions through the "Scaled Score" method. The scaled score (index) compares the student performance (i.e., average % correct) at UNL to the performance of the average student at peer Carnegie I institutions in the similar degree discipline for each topic area. The difference between UNL scores and comparator scores are scaled using the standard deviation of the comparator scores. For this index, a value of zero indicates that UNL scores were equal to

comparator scores, a value greater than zero indicates that UNL students exceeded their peers, while a value less than zero indicates UNL students performed poorer than their peers.

Following the NCEES procedures, a one standard deviation confidence interval is generated about the mean UNL score based on the number of UNL students taking the exam. Scores are tracked for each six-month examination interval. The target for all exams taken by our students is a scaled score value greater than or equal to zero, indicating that UNL student meet or exceed the performance of our peers. This target is considered not to be met when the confidence interval generated about the UNL score is completely below the zero value for 3 successive examination administrations. The reported values in the self-study are the highest value in the confidence interval. Therefore the review is looking to identify any negative data point indicating the performance on that particular topic area was significantly below comparator scores on the same topic.

Note:
The mapping of FE exam topics to student outcomes for the exams most likely to be taken by BSE students is shown in the following 3 figures.

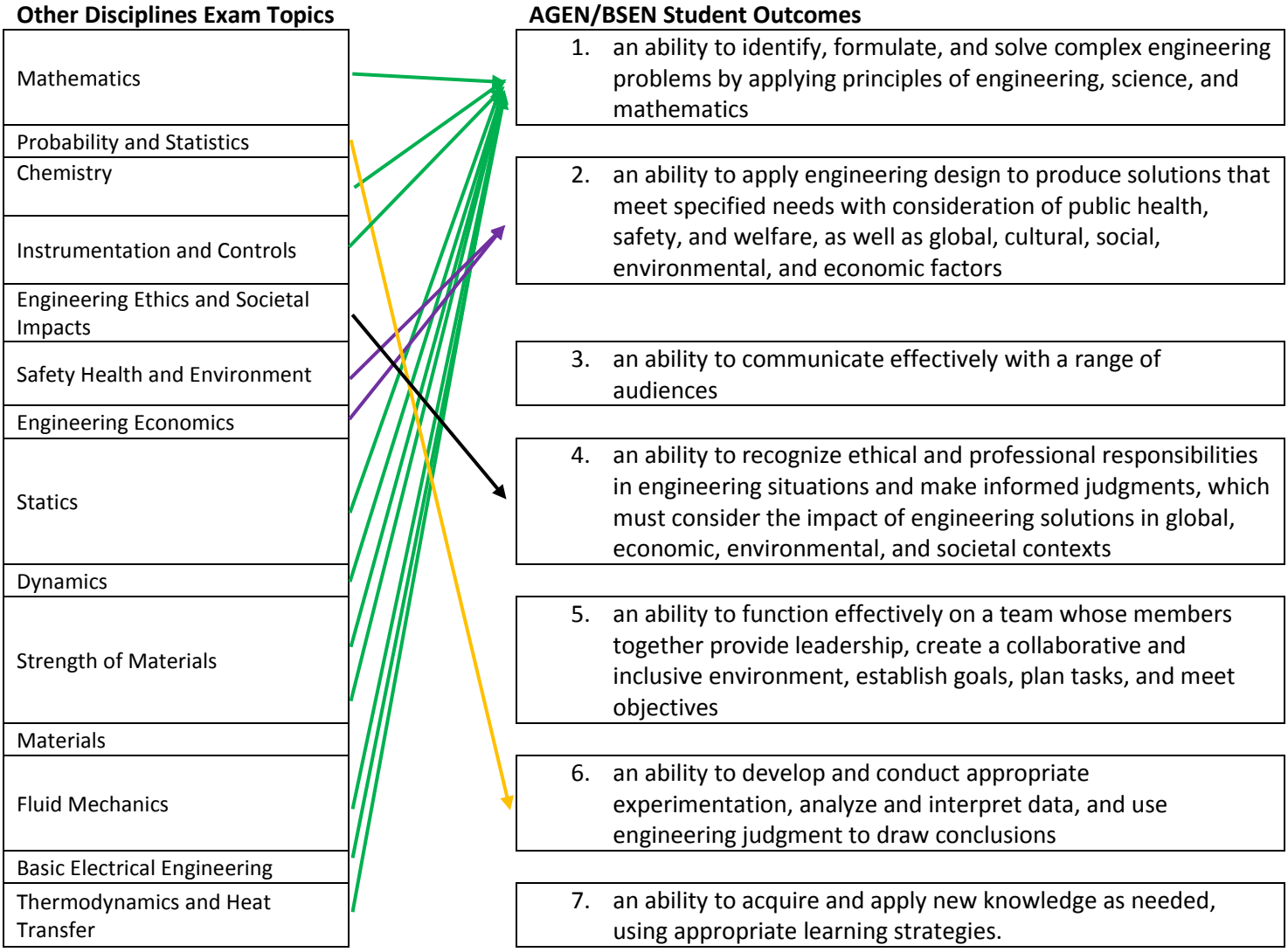

Figure 1 Mapping of Other Disciplines FE Exam Topics to ABET Student Outcomes for both the AGEN and BSEN majors

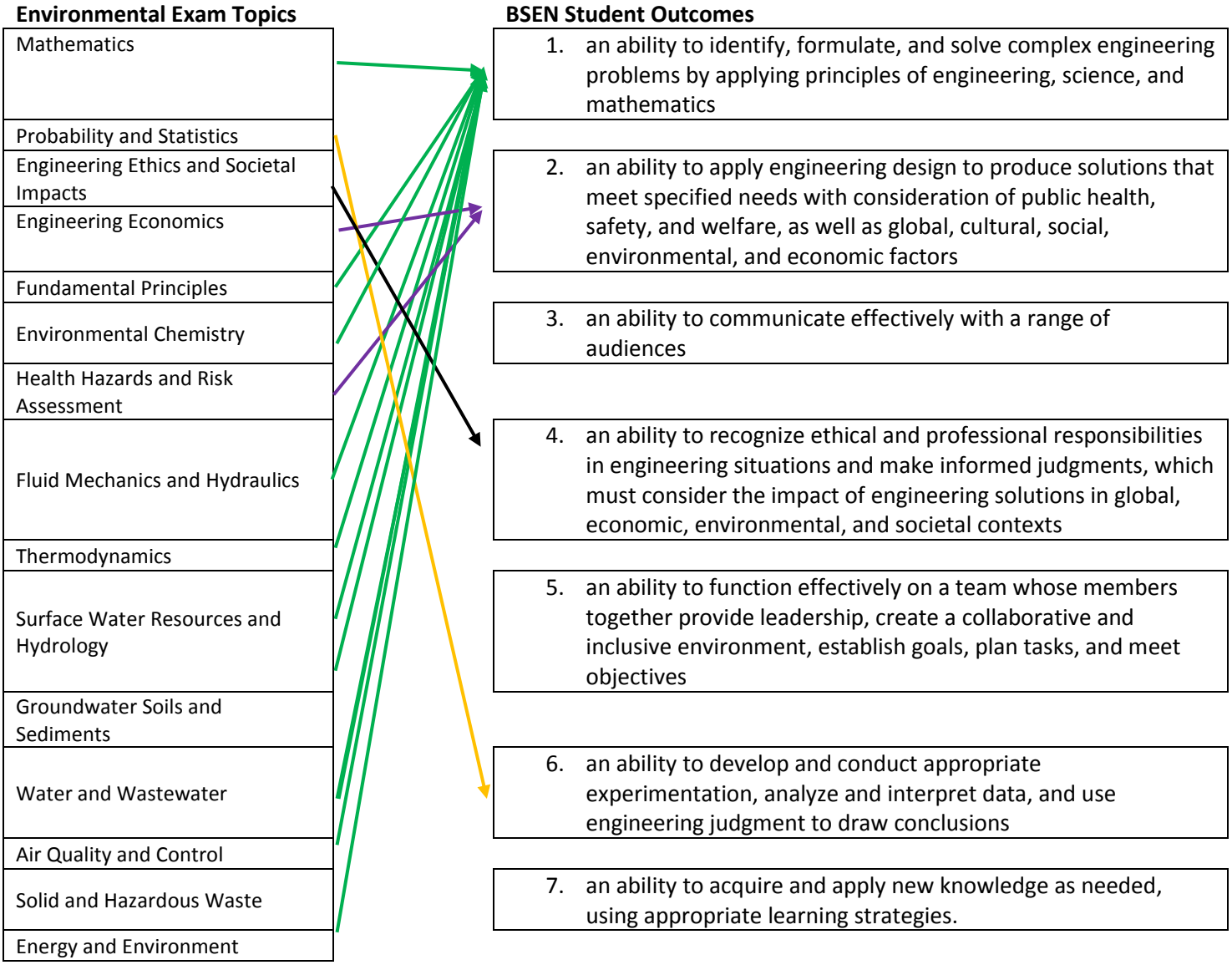

Figure 2 Mapping of Environmental FE Exam Topics to ABET Student Outcomes for BSEN majors

b. Grades

Grades for required engineering, science, mathematics and statistics courses taken outside of BSE are used to assess student outcomes 1, 3, and 6. The content of these courses is almost entirely associated with one of these student outcomes and the course grades received are assumed to indicate attainment of these outcomes. Course grades are evaluated using 3 year averages based on data from the UNL Office of Registration and Records. Grades and trends in grades are evaluated annually. Course grades are tabulated by the frequency of A's, B's, ... F's and are grouped in relation to Student Outcomes. The courses used to evaluate each student outcome and the criteria used in evaluation are chosen based on a significant percentage of a respective major taking a specific course (>25%)

Honors sections of courses are included as well as the regularly taught classes. The courses currently covered by this process are listed in Table 1 according to their target outcomes. As courses are added to or deleted from the AGEN and BSEN program curricula they are added or deleted from the annual request to the Registrar or are removed in the analysis. To avoid grade bias, no AGEN or BSEN courses are part of the grades assessment.

The numbers of students receiving each grade are added and divided by the appropriate total as follows to be compared with the respective student outcome and target. Currently, there are two parts to each target, namely, those who achieved a B or better and those who achieved C or better. For the "B grade or better" phase, the number of students who obtained a grade from A+ to B are added using a sum command until all courses in outcome/benchmark are counted. That is, the number resulting should represent the total number of all students who achieved a B or better in all the courses corresponding to the desired outcome/benchmark. This number is divided by the total number of students who took those courses, which is obtained by adding the appropriate numbers in the total column. This gives a percentage of students with a B grade or higher. The same process is used for the C or better benchmark, i.e., the relevant students' course grades are added from A+ to C, and then divided by the total number of students taking the courses. These results are then compared to the target. Example: When grades are used for assessment of Outcome B, the total number of students who obtained a B or better in *either* MECH 321 *or* MATH 380 is divided by the total number of students who took MECH 321 *or* MATH 380.

Table 1. Courses Grouped by Student Outcome for Procurement of Grades.

Student Outcome	AGEN Program	BSEN Program
1	Math/Sciences/Engineering CHEM 109, 109L, 110, 110L CIVE 310 CSCE 155N LIFE 120 MATH 106, 107, 208, 221 MECH 130, 200, 223, 310, 373, PHYS 211, 212	Math/Sciences/Engineering BIOC 321, 321L, 401, 431 CHEM 109, 109L, 110, 110L, 113, 114, 251, 253, 261, 263 CIVE 310 CSCE 155N LIFE 120, 120L, 121, 121L MATH 106, 107, 208, 221 MECH 130, 200, 223, 310, 373, PHYS 211, 212
3	Communications: ENGR 100	Communications ENGR 100
6	Statistics Math 380 Mech 321	Statistics Math 380 Mech 321

c. Department Advisory Council

The Department of Biological Systems Engineering has had an External Advisory Board for many years. Early versions of the Board consisted of well-known, highly-placed agricultural and biological engineers from across the country, most of whom were not Nebraska alumni. The Board's configuration and function has changed over the years. Today it is considered a Council whose function includes providing feedback and suggestions to improve our undergraduate programs. Members are chosen to reflect a cross-section of emphasis areas within each of the undergraduate programs, and to provide a range of experience from approximately five to 35 years from graduation. Membership on the current Council is listed in Table 2.

Table 2. Department Advisory Council Membership

ADVISORY COUNCIL MEMBERSHIP BIOLOGICAL SYSTEMS ENGINEERING 2017		
Name	**Alumni Degree / Graduation Year**	**Field/Employer**
Brauer, Bobby	BS BSEN (10)	Industry/Bayer Crop Science
Brumm, Tom		Academia/Iowa State University
Brunkhorst, Kelly	BS MSYM (95)	Industry/NE Corn Board
Burr, Michael	BS/MS MSYM (93, 97)	Industry/Purina Animal Nutrition LLC
Christensen, Jeff		Industry/ Case New Holland
Christy, Ann		Academia/The Ohio State University
Magnusson, Brian	BS AGEN (01)	Industry/Lindsay
Ohlinger, Deb	BS BSEN (94)	Industry/Olsson
Sauer, Andy	BS/MS AGEN (95,98)	Industry/Burns & McDonnell
Toner, Anna	BS BSEN (17)	Industry/Medtronic

The Council meets biannually, with time spent with the faculty members, students, and the Department Head. The status and emerging needs of undergraduate education are included during this session. Research and extension updates are provided to the Council as well. A written agenda is given in advance to the Council and a written response to selected issues and issues arising during the meeting is provided by the Council.

Action items on undergraduate curricula that evolve from the meeting of the Advisory Council are placed on the agenda of the future workshops and, depending on the nature of the item and recommendations from the workshop, are acted upon by the Curriculum Committee or Department Head. Thus, the process for receiving and acting upon feedback and recommendations of the Advisory Council are pre-established, facilitating continuous improvement of AGEN, BSEN and AGST.

d. Senior Exit Interview and Survey

Exit Interviews have been conducted with the graduating seniors each semester for several decades. The exit interview is more than an "interview" because it includes written as well as oral feedback. The exit interviews are conducted at the end of each semester as students are finishing AGEN/BSEN 480 or AGST 462. The students are given a questionnaire in which they are asked to self-assess their capabilities, the capabilities and functionality of the Department and the AGEN, BSEN and AGST programs, and their experiences while at the university. Additionally, a session is held where one or more faculty members or the Department Head meets with the group of students and ask them

more probative and discussion questions. This format has allowed the faculty members to 'listen' more carefully and gain insights into what is between the lines of the written feedback.

The responses are captured on a 1-4 Likert type scale using the following descriptions:

1 – Below Average
2 - Average
3 – Above Average
4 – Excellent

The exit interview results provide data for the assessment and evaluation of Student Outcomes 1-7. The data is collected and compiled from Qualtrics by appropriate staff and the shared with the department head and accreditation committees. The results, where appropriate, are shared with the faculty at the annual workshops.

e. Course and Curricula Student Outcomes Matrices (SOMs)

A portion of assessment of student achievement for outcomes for the AGEN and BSEN programs is based on course content expressed as "Course SOMs (Student Outcome Matrices)." A SOM captures the extent to which each goal in a course is attained within in the context of Student Outcomes 1-7. The metric used to make this relationship is rooted in Bloom's Taxonomy (Bloom, et al., 1956). Bloom's descriptors for the level of the cognitive domain were first used for program assessment purposes in 2003. Their use was adjusted for uniformity of definition by instructors, between courses, and across the curriculum in 2006. Starting with academic year 2012-2013 the faculty adapted to the Revised Bloom's taxonomy, wherein each student outcome is described in terms of "remembering, understanding, applying, analyzing, evaluating, or creating." Latest revisions of course and curriculum targets occurred in spring 2023.

Each AGEN and BSEN course has its own SOM which relates the course to the Student Outcomes 1-7 using the Bloom's Taxonomic Scale as a measure of accomplishment. Upon assembly of the Course SOMs, the contribution of each course to the overall AGEN or BSEN Program is then compiled into "Curriculum Student Outcomes Matrices (Curriculum SOMs)." Curriculum SOMs have two parts. The first focuses on the contribution of core courses of the curriculum. These courses include Departmental courses required of all students. The second part is made up of the elective courses available to students within the Department. Although the set of courses that a student takes depends to some extent on the chosen emphasis area, there will always be a set of core courses, core emphasis electives, and minimum elective AGEN and BSEN courses that serve as a common basis for each student's outcomes.

f. Course-level Assignments

Based on the results of the SOMs exercise, assignments from courses with content related to student outcomes were identified to be used as direct measures of achievement of each outcome. This

process began in the Fall 2016 semester and an initial data collection cycle was completed in Spring 2017. This process will be repeated every year. At present, a signature assignment is being evaluated for each outcome, however, additional assignments may be added in the future.

Evaluations are performed either by the course instructor or by a group of faculty (such as for senior design presentations). For most student outcomes, a rubric to assist the faculty in making these evaluations has been developed by the CIPA committee.

Table 3. Assignments and targets used to evaluate student attainment of the Student Learning Outcomes in the BSEN program.

Student Outcome	Course(s)	Assignment	Target
1	AGEN/BSEN 344	Exam(s)	80% of students will achieve acceptable (3) or better
2	AGEN/BSEN 480	Capstone Final Design Report	80% of students will achieve acceptable (3) or better
3	AGEN/BSEN 480	Capstone Final Design Presentation	80% of students will achieve acceptable (3) or better
4	AGEN/BSEN 303, 317, 355	Signature Assignments	80% of students will achieve acceptable (3) or better
5	AGEN/BSEN 480	CATME Peer Evaluations	80% of students will achieve acceptable (3) or better
6	AGEN/BSEN 460	Laboratory Exercise	80% of students will achieve acceptable (3) or better
7	AGEN/BSEN 344	Final Project	80% of students will achieve acceptable (3) or better

g. Senior Checks and Degree Audits

Senior checks and degree audits provide direct feedback on the utility and performance of prerequisites and satisfactory course and program completion for the AGEN, BSEN, and AGST degree programs.

h. Alumni Survey

(*Discontinued, Process stored in event the survey is resumed.*)
The Department maintains a database listing the names of prospective and current students, and alumni. Staff member, Diann Young, updates this database at the end of every semester. The alumni portion of the database includes year and semester of graduation, alumni positions, and contact information. Staff member, Evan Curtis, updates this database each time an alumnus contacts the Department (typically using the alumni contact form on the Department website, or through contact directly with faculty members and/or staff).

Every year, the CIPA committee designated faculty and the Student Services Coordinator initiate the alumni survey to those who graduated two, four, and six years ago, to obtain data regarding how well their undergraduate AGEN or BSEN program prepared them to attain the Program Educational Objectives. The CIPA committee designated faculty and the Student Services Coordinator work to send the alumni an email message (to their last known email address) asking them to go to a website where they can respond anonymously to the survey. The survey consists of a series of statements directly related to their attainment of the Program Educational Objectives. Alumni are asked to indicate whether they strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree with each statement. They also have the opportunity to add free-form comments on each of the educational objectives. Copies of the message and the survey are included in Appendix IV of this manual.

Through the use of Qualtrics survey results are recorded and exported to an Excel spreadsheet titled "Alumni Survey Results" followed by the year the survey was taken. The results are compiled after a one-to two-month waiting period, to allow all the responses to be received. The Survey results are accumulated over a three-year evaluation cycle to obtain sufficient response numbers for meaningful analyses. The accumulated results are analyzed to determine what percentage of students strongly agree, or agree with each of the statements related to their attainment of the Program Educational Objectives.

III. PROGRAM ASSESSMENT AND IMPROVEMENT

a. ABET Committee Meetings

Drs. David Mabie (chair of ABET committee), Deepak Keshwani, David Jones, Saleh Taghvaeian, Mr. Gene Gillam currently comprise the ABET committee responsible for assessment matters in the Department. They meet as needed (weekly to quarterly) to identify and work on issues of concern to continuous improvement of the curricula. They also set the agenda for the annual workshop meetings. They keep records, follow up on workshop outcomes, organize instructional training events, and forward curricular recommendations to the curriculum committee.

b. Annual Workshops

The BSE Department hosts semi-annual workshops in August and/or December for a half-day meeting. The purpose of these workshops is to provide annual identification of needed program improvements and an assessment of changes made in previous years. All teaching faculty members are expected to attend these workshops. Solicitation of agenda items is made during the spring or fall semester and the agenda is prepared in advance. Minutes are kept and reviewed at each workshop to give structure and continuity to the continuous improvement process.

Recommendations and action items are formulated during the meetings and forwarded as needed to the Department Curriculum Committee, the Department Head and advisors, as dictated by the nature of the item. Where program changes involving curricula are involved, the Department Curriculum Committee actions are followed by Department approval by the faculty and then by College and/or University level action as needed.

c. Student Outcomes

For the AGEN and BSEN Programs, several data sources are used as part of the continuous improvement activities. As shown in Table 4, instruments are used for each of the Student Outcomes (1-7). Each Student Outcome is assessed and evaluated based upon two or more data sources. These data sources provide a means of measurement and comparison to performance targets available for Outcomes 1-7. The performance targets, set by the faculty members, provide each a unique metric with which to evaluate student outcome attainment.

Table 4. Data Sources for Assessment and Evaluation of AGEN and BSEN Programs.

Student Outcome	1	2	3	4	5	6	7
Data Sources:							
1. Course Assignments	✓	✓	✓	✓	✓	✓	✓
2. Exit Survey	✓	✓	✓	✓	✓	✓	✓
3. FE Exam	✓	✓		✓		✓	
4. Course Grades	✓		✓			✓	

Course Assignments Based on the results of the SOMs exercise, assignments from courses with content related to student outcomes were identified to be used as direct measures of achievement of each outcome. This process began in the Fall 2016 semester and an initial data collection cycle was completed in Spring 2017. This process will be repeated every year. At present, there is only one assignment being evaluated for each outcome, however, additional assignments may be added in the future.

Senior Exit Interview and Survey Results from this instrument provide data for assessment of each of the Student Outcomes (1-7). The interview portion of this instrument provides only indirect data; thus, those results are not used for formal assessment purposes. A specific scenario question is used to ask the students their self-identified capabilities to engaging with each of the student outcomes under said scenario. The oral interviews and the remaining questions are supportive of program quality in that they relate to adequacy of teaching, advising, and infrastructure. The current faculty-determined target level for each Outcome-related question in the Survey is an average of 2.5 (out of 4) for each question related to Student Outcomes. The results are reviewed annually by the ABET subcommittee. The data are compiled by Student Outcome. These results and, where appropriate, specific annual results are shared with the faculty at annual workshops.

FE Exam Comparison of students is made to students of similar degree programs at Carnegie Doctoral Universities: Highest Research Activity institutions through the "Scaled Score" method. The scaled score (index) compares the student performance (i.e., average % correct) at UNL to the performance of the average student at peer Carnegie Doctoral Universities: Highest Research Activity institutions in the similar degree discipline for each topic area. The difference between UNL scores and comparator scores are scaled using the standard deviation of the comparator scores. For this index, a value of zero indicates that UNL scores were equal to comparator scores, a value greater than zero indicates that UNL students exceeded their peers, while a value less than zero indicates UNL students performed poorer than their peers.

The FE Exam data are used in the assessment of students outcomes 1, 2, 4, and 6. However, because AGEN and BSEN students are not required to take the FE Exam, those selecting to sit for the exam are not likely to be a representative sample to cover all AGEN and BSEN students may give a skewed view of student attainment of outcomes. Thus, FE Exam results are used only to

supplement other assessment measures to provide additional insight into where improvements may be needed. Though AGEN and BSEN assessment processes do not rely heavily on FE Exam results, the results are viewed as supplemental external, direct measure of achievement of Student Outcomes.

Grades Aggregated grades are used as a direct measure of program performance in Student Outcomes 1, 3, and 6. These grades are reported and discussed as needed at annual workshops. Summary statistics from the three-year performance in graphical format are compared to the requisite outcome/target. Performance trends are detected by comparison of the sequential (annual) three-year results. When targets are not met, the problematic courses are identified from the raw data in the original spreadsheets. Actions as outlined for that Outcome are taken based on discussion of the issue at the annual workshop.

Student Outcome Matrices (SOMs) Development of SOMs for each core, emphasis, and supporting course was initiated in 2003, refined in 2006, and computerized in 2010. Originally implementation used traditional descriptors for the Bloom's classifications levels (knowledge, comprehension, etc.) and incorporated the Student Outcomes A.1-K. Use of Bloom's taxonomy enabled the Department to rank the extent to which the Student Outcomes were attained, using a universally accepted classification scale. However, because Bloom's descriptors are open to interpretation, they were "tailored" with engineering wording in 2006 and further refined in 2008 to minimize classification confusion, error, or bias. Starting with academic year 2012-2013 the faculty adapted to the Revised Bloom's taxonomy, wherein each student outcome is described in terms of "remembering, understanding, applying, analyzing, evaluating, or creating." Starting in 2017 the syllabi were revised to adapt to student outcomes 1-7 from a-k.

Evidence Collection Evidence of Student Outcome accomplishment, usually homework, exams, projects and presentations are currently collected every year as detailed in table 3.

Gap Analysis Specific pieces of evidence for the SOMs are identified based on the maximum level of achievement using Bloom's levels for each of the Student Outcomes. In cases where the evidence falls outside the parameters set by Bloom's descriptors rubric, professional judgment is used to assess the level of achievement. In rare cases, course instructors are consulted for assistance. The following is a list of considerations made when evaluating achievement of student outcomes in courses:

1. Degree to which an individual course contributes to Student Outcomes 1-7;
2. How the course contributes to Student Outcomes 1-7 within the curricula
3. The strength of the relationship of the PEO's to the Student Outcomes

Gap Analysis for Individual Courses

The maximum Bloom's level achieved by each course for each Outcome, as determined by syllabi and instructors, and the target/intended maximum Bloom's levels from the SOM are transferred to the SOM matrix. The achieved Bloom's levels are compared to the maximum Bloom's level targets to determine if the targets are being met, exceeded, or lacking. When a

gap between the achieved and maximum SOM Bloom's level is found, suggestions are made on whether to improve the course, change the SOM, or collect additional evidence. When possible, detailed suggestions on how to improve assignments, projects, etc. are given.

Gap Analysis for the Curricula

The curricula analysis sheet is composed of one large matrix relating Student Outcomes and Bloom's levels. A course number is entered the matrix for each Student Outcome it fulfilled in the corresponding Bloom's level column to show how each course contributes to the overall curricula. The Department set target Bloom's levels for each Student Outcome that the curricula as a whole should achieve. Those targets are highlighted on each curricula matrix. To determine whether the target Bloom's levels are achieved, a weighted average, median, and maximum Bloom's level for each Outcome is calculated and placed into its own column. While each statistic has merit, no single statistic is a complete representation of the success of the curricula in achieving the target Bloom's levels, therefore an average of the three is taken and used as the "Achieved Bloom's level" for comparison purposes.

Senior Checks and Degree Audits Senior checks and degree audits are used constantly to provide assurance of course completion within the Student Outcomes structure of our programs. In addition, the checks and audits provide feedback on the utility and performance of prerequisites, and evidence of satisfactory course and program completion for AGEN and BSEN. The Senior Check and Degree Audit processes are described in detail in Part e of Section IV (Matriculation Management).

d. Program Educational Objectives (PEOs)

The AGEN and BSEN PEOs are published annually in the UNL Undergraduate Bulletin, and on the Department website. Our process for developing, maintaining, and making known the AGEN and BSEN PEOs involves several constituencies, data sources, and milestones:

- Every third year, the Department Advisory Council is asked to reflect on the appropriateness of the AGEN and BSEN PEOs.
- Data from the course and curricular SOMs is checked to ensure that Student Outcomes are supportive of the PEOs.

Department Advisory Council Program Educational Objectives are reviewed for clarity and attainability by a typical graduate a few years after graduation. At the meeting a simple majority of the council member in attendance can request revisions to the PEOs or its sub-parts. The comments and suggestions from the DAC report are discussed by ABET committee and refined to a proposal, if necessary. A proposal of changes is submitted by the ABET committee chair to the faculty to develop any revisions, typically at appropriate faculty meetings. After the faculty, have made any revisions and voted to approve them, the revised PEOs are brought to the DAC in their next meeting for approval. Once approved, the new PEOs are submitted to the Department Curriculum Committee for communication with Office of the University Registrar bulletin/ catalog editors and COE web development staff. The changes are published in the undergraduate bulletin and COE web pages. Verification is conducted by the ABET committee.

Relationship of PEOs to Student Outcomes The relationship of PEOs to Student Outcomes achievement is an essential element of our program evaluation and improvement process. PEOs should directly support Student Outcomes. AGEN and BSEN Student Outcomes were determined by the faculty in this context and directly conform to outcomes suggested by ABET. Relation of PEOs to Student Outcomes is part of the three-year review and occurs as needed.

In summary, the PEOs, Student Outcomes, and the courses that make up the AGEN and BSEN curricula are related through the CIPA Hierarchy (Appendix V, Figure 13). All core AGEN and BSEN courses plus one supporting course (STAT/MATH 380 or MECH 321), and the engineering emphasis area core courses, are used to accomplish the Student Outcomes. Courses are evaluated based on the maximum Bloom's level achieved for each Student Outcome and are then combined with the specified courses in the curricula to evaluate the achievement of curricular Bloom's targets for each Student Outcome. PEO's are then mapped to Student Outcomes using a strong, medium, and low correlation scale, and this scale is then converted to Bloom's levels to correlate the PEO's to the curricular Bloom's targets for each Outcome. This approach relates what students learn in class to what they should know upon graduation, and to what they should be able to accomplish 3-5 years post-graduation.

The Department Curriculum Committee and Department Head are responsible for gathering feedback from the above constituencies and data from other sources on the PEOs, and for monitoring

and improving the PEOs. They organize feedback for discussion at the AUCW and DAC meetings. The faculty discusses this feedback in the context of the role and mission of the Department, Student Outcomes (1-7), trends and needs identified through organizations such as the American Society of Agricultural and Biological Engineers (ASABE), American Society for Engineering Education (ASEE), Institute for Biological Engineers (IBE), and the National Academy of Engineering (NAE). Potential improvements in the PEOs are identified at the AUCW. The curriculum committee incorporates change into the PEOs on a three-year interval as appropriate.

e. Curriculum Approval

The AGEN and BSEN programs operate under the ultimate authority of the University of Nebraska-Lincoln faculty with approval mechanisms at the Department, College, and University levels. Curriculum committees at each level act independently, in succession, starting at the Department and proceeding to the College and University levels. At the Department level, curricular improvements can be initiated at any time by individual or groups of faculty members, by the subcommittees appointed by the Department Head, or at the AUCW. Curricular initiatives are acted upon by the Department Curriculum Committee and by the Department Faculty prior to being forwarded to the College Curriculum Committee.

IV. MATRICULATION MANAGEMENT

a. Admission to the Program

Students entering the AGEN and BSEN programs are admitted either as freshmen, through transfer from other colleges or other university programs, or from other institutions of higher education. UNL and COE policies dictate entrance procedures for all instances. Students are initially classified as "Pre-engineering" for their first 43 to 62 credit hours and are then admitted to "regular engineering status" in the Agricultural or Biological Systems Engineering programs through an application process that begins with a form completed by a department pre-engineering advisor. This triggers a formal review of the student's academic file by a standing sub-committee of the Curriculum Committee (plus the Department Head). The student's academic performance and progress toward the degree are specifically evaluated at this time. If the student is making satisfactory progress toward graduation, and has met all COE requirements, he or she is admitted to "regular engineering status." If a student is not accepted, the student is counseled, specific deficiencies are addressed, and the student may reapply at the end of the next semester. A letter of acceptance or non-acceptance with reasons is sent to the student with a copy to the adviser.

b. Advising

The department is transitioning its advising model for AGEN and BSEN students. When appropriate, this section will make references to the old and new model. All students in the Fall 2023 incoming cohort will be on the new model. Other students are being advised on the old model.

Each AGEN student is advised by Dr. Roger Hoy, faculty academic adviser until the point of professional admission. Each BSEN student is advised by one of two professional academic advisers until the point of professional admission. The formal advising and monitoring process begins with New Student Enrollment (NSE), which is handled by the College of Engineering during the summer for incoming freshman and transfer students. At the NSE session, the student's transcript, ACT score, and Math Placement Exam score are evaluated; and if a student has academic deficiencies, a plan is developed to remove these deficiencies in a timely manner. Dr. Hoy (for AGEN) and a professional academic advisor (BSEN) is assigned to a student at NSE and serves as the academic advisor until professional admission (which typically occurs at the end of the student's second year in the program). In the old model, after professional admission, the student is assigned to a faculty adviser in their respective emphasis areas. The faculty advisers are supported by professional advisers on advising logistics and UNL advising processes. In the new model, after professional admission, they will remain with Dr. Hoy (AGEN) or their professional academic advisor (BSEN), but will be assigned a faculty career and professional mentor in their respective emphasis area. This new model reflects the changing landscape around advising technologies and allows more career-focused mentoring by faculty with the advising logistics being handled by experienced academic advisers.

c. Credit Procedures and Policies for Freshmen and Transfer Students

Students who transfer to the University of Nebraska-Lincoln from other accredited colleges or universities and wish to be admitted to the College of Engineering (COE) must meet COE freshman entrance requirements and have a minimum cumulative GPA of 2.5 and be calculus-ready. Students not meeting either of these requirements must enroll in the Explore Center or another University college until they meet COE admission requirements. Students transferring from UNO, UNL, or UNK to the College of Engineering must be in good academic standing with their institution.

The COE accepts courses for transfer for which a C or better grade was received. Although the University of Nebraska-Lincoln accepts D grades from the University of Nebraska at Kearney and at Omaha, not all majors in the COE accept such low grades. Students must conform to the requirements of their intended major and, in any case, are strongly encouraged to repeat courses with a grade of C- or less.

All transfer students must adopt the curricular requirements of the undergraduate catalog current at the time of transfer to the COE—not that in use when they entered the University of Nebraska-Lincoln. Upon admission to Nebraska, students wishing to pursue degree programs in the COE will be classified and subject to the policies defined in the subsequent section.
Students who were previously admitted to COE and are returning to the College of Engineering must demonstrate a cumulative GPA of 2.5 to be readmitted to COE.

When a student transfers to UNL from another institution, UNL Admissions collects all transcripts from the transfer applicant and files them in UNL's Perceptive system, which allows access to all authorized personnel. UNL Admissions maintains a database of mappings from non-UNL courses to UNL courses, which facilitates automatic processing of transcripts. Courses not in the database are analyzed by the Faculty Transfer Evaluator of the relevant academic unit who then approves a Transfer Course Equivalency form, with copies sent to the Registrar, the Office of the Dean, and the student's advisor.

Transfer credits for required courses are allowed only if the appropriate department confirms that the transfer course is equivalent to a course at UNL. For courses in the Biological Systems Engineering Department, the Director of Undergraduate Programs serves as the official transfer credit evaluator and analyzes the content of the transfer course with the aid of the instructor directly involved in teaching the relevant UNL course. They review the course syllabus, textbook, and other materials used in the course proposed for transfer credit. If there is doubt, the BSE Exceptions Committee discusses the course to inform the decision of the transfer credit evaluator. Transfer credit for a BSE course is allowed only if there is substantial duplication of the equivalent UNL course. Detailed information for faculty and students on transfer credit is given at https://creditevaluation.unl.edu/.
In general, transfer courses from other universities do not count as part of the UNL GPA (exceptions are courses taken at other University of Nebraska campuses). Credits can be transferred, but grades are not. At least 30 of the last 36 credit hours needed for a degree must be registered for and completed at UNL or UNO while identified with the College of Engineering. This means that,

practically speaking, the last year of a student's work must be spent in residence. Credit earned during education abroad may be used toward degree requirements if students participate in prior approved programs and register through UNL.

d. Exceptions Subcommittee

Questions from advisers and students regarding acceptable substitutions and waivers of required and elective courses in the program are handled by a standing committee often referred to as the "exceptional committee." A record of committee decisions is kept by the chair of the Department Curriculum Committee (who is a member of the committee) and is available to all faculty member advisers via the Department secure server. This record enables substitutions and waivers to be made on a consistent basis and avoids repetitive requests to the exceptions committee. The committee meets informally if unanimous agreement does not occur on a request. Substitutions and waivers are documented through the senior check and degree process described subsequently. The actions of this subcommittee are reviewed at the AUCW and recommendations for adjustments to the curricula are given, if deemed necessary, to the curriculum committee for action.

e. Senior Check and Degree Audit Procedures

The chief procedure for ensuring graduating seniors meet all degree requirements is the "Senior Check" and the University's Degree Audit process, which provides timely verification and enforcement in meeting the graduation requirements. Students and advisors have immediate access to the Degree Audit system and can run the audit at any time. A student can adopt a more recent edition of a catalog through a formal request process. However, the student cannot choose a catalog published prior to matriculation. This requirement will be checked automatically using the computerized MyDegreeAudit tool. Students are monitored for graduation through the analysis of graduation requirements by performing the degree audit and initiating the "Senior Check" for the Bachelor of Science in Biological Systems Engineering.

The Senior Check form is used in conjunction with the MyDegreeAudit tool to keep track of a student's progress toward the BSEN degree. Undergraduate advisors typically start a Senior Check form the first time they meet with a student and update it on each subsequent visit. This allows both the student and the advisor to quickly and clearly see how a student is progressing in the BSEN engineering curriculum and what remains for graduation.

Prior to graduation, the Office of Undergraduate Registration works the BSEN professional advisors and ESS to verify completion of graduation requirements for each student applying for graduation. The senior check process is as follows:

1. A list of students applying for graduation is provided to ESS.
2. The ESS advisor liaison for BSEN reviews the degree audits to ensure all requirements are being met.

3. For unmet requirements, the ESS advisor liaison communicates with the BSE Director of Undergraduate Programs to determine the best method for the student to meet these requirements. When appropriate, the degree audit is updated manually to indicate how the requirements are being met.
4. Any unmet requirements that cannot be satisfied through an updated degree audit are reported to the faculty advisor and the student who develop a plan to meet the unmet requirements. This system of checks and rechecks is a formal, documented procedure to assure that all students meet all Department, College, and University requirements.

V. GLOSSARY OF TERMS

Biological Systems Engineering Department

University of Nebraska-Lincoln

Achievement Centered Education (ACE)

The general education program for undergraduate studies in all eight colleges within the University of Nebraska-Lincoln. The ACE program is innovative and outcomes-focused, and is based on a shared set of four institutional objectives and ten student learning outcomes. Students must complete the equivalent of 3 semester credit hours for each of the ten ACE Student Learning Outcomes (SLOs).

Assessment

An objective evaluation and measurement of performance against predetermined standards, which in the ABET Self-Study are called *Targets*.

Bloom's Taxonomy

A method for categorizing the level of abstraction of questions that commonly occur in educational settings.

Clients

Those individuals that serve as clients for teams in the senior capstone design sequence (AGEN/BSEN 470/480). A client represents a concern (company, agency, etc.) with a need for engineering design. They interact with the design team and aid with problem definition and context; establish design constraints, objectives, and requirements, and evaluation of the resulting design.

Clientele (Constituents)

Those we serve are considered clientele. Our clientele, in part, include the citizens of Nebraska, those who hire our graduates, our students, and their parents.

Cognitive Domain

The sphere of influence or activity relating to knowledge or intellectual activity, to thinking or to the act or process of knowing in the broadest sense; specifically, the activities associated with the intellectual process by which knowledge is gained from perception or ideas.

Continuous Improvement

Operational philosophy that is based on the notion that increasing quality is an ongoing responsibility of everyone in the organization.

Continuous Improvement and Program Assessment (CIPA) Manual

A manual containing an overview of the processes through which continuity, consistency, and continual quality improvement is attained in the undergraduate programs of the Biological Systems Engineering (BSE) Department at the University of Nebraska-Lincoln (UNL). This manual illustrates how the continuous improvement process is embedded in management of the program to enable individuals outside and independent of the program to ascertain what constitutes the process and how it works.

Course Goals

These are course specific statements that appear on a course syllabus, and are written in the context of the course and what the student is expected to have attained upon completion of the course. Course goals appear in two locations, on the syllabus and again in the *Student Outcomes Matrix* for that course.

Course Student Outcome Matrix (Course SOM)

This matrix is constructed on a single sheet for each course in the curriculum. It consists of the contribution of the *Course Goals,* extracted from the syllabus, cross-referenced to each of the program *Student Outcomes* (A.1-K). The instructor fills in the matrix by assigning an appropriate level of accomplishment of each goal (based on *Bloom's Taxonomy*) to each outcome. In the Self-Study Document the matrix for each course is printed on the reverse side of the course syllabus.

Criteria - General

The eight general classifications used by ABET to assure quality and to foster systematic pursuit of improvement in the quality of engineering education that satisfies the needs of constituencies in a dynamic and competitive environment.

Criteria - Program

Specific statements about the nature of the AGEN and BSEN curricula and the faculty members involved in delivering those programs.

Curriculum Student Outcome Matrix (Curriculum SOM)

This matrix is assembled by aggregating the extent to which each course achieves its C*ourse Goals,* and contributes to the *Student Outcomes A.1-K*, into a corresponding matrix for the entire curriculum. Thus, the level to which the curriculum achieves (based on *Bloom's Taxonomy*) Student Outcomes via each course is mapped for assessment purposes.

Cycle

Two cycles are defined for purposes of this report. A three-year cycle (2020-2023) is the last half of the overall six-year (2017-2023) assessment cycle. The shorter cycle is generally used to assess dynamic trends and to focus on issues that need medium-term response. The six-year cycle is used to correspond to the full accreditation cycle since the previous ABET visit. Thus, program improvements are scheduled for implementation on the maximum on a three-year interval. However, assessments and improvements are not restricted to the three-year cycle and may occur on much shorter intervals.

Data Source

Specific assessment tool, instrument, or method by which direct or indirect data are acquired for assessment purposes.

Degree Audit Reporting System (DARS)

DARS is a web-based system at UNL used to ensure all degree requirements are satisfied for each student. The system is available to academic advisers and is used in advising sessions. It is also available to each student so they can evaluate their progress. DARS has gained acceptance and has been broadly used since 2003.

Design

The process of devising a system, component, or process to meet desired needs. It is often an iterative process involving basic science, mathematics, and engineering principles to optimally convert resources to meet constraints and to meet stated needs. We interpret the previous two sentences to include, in the most elementary context, solution of open-ended problems.

Instrument

A tool, rubric, or method by which data are acquired with which to compare targets that were established to assess performance.

Pre-Engineering Students

Students are accepted into the College of Engineering on a provisional basis for establishing their academic credentials and firming up their career objectives. These students may take freshman- and sophomore- level courses in the College of Engineering and are classified as Pre-Engineering Students. Students are considered for admission to the professional degree program (regular status) after completing 43 credit hours that are applicable to the program degree.

Professional Component

A characteristic requisite and adequate ability or quality needed for practice and design in the agricultural engineering and biological systems engineering professions.

Program Educational Objectives (PEOs)

Statements describing expected attainments of graduates within a few years of their graduation as a result of their educational preparation.

Student Learning Outcomes (SLOs)

The ten outcomes under the ACE program. Each outcome contributes to the overall ACE general education requirement to help students better integrate what they learn throughout their education and in their lives. http://ace.unl.edu/archive/ace1_IOSLO.pdf

Student Outcomes

Statements describing what students are expected to know and do at time of graduation. These relate to skills, knowledge, and behaviors that students acquire in the program. These are the A.1-K Outcomes often referred to in ABET activities. They differ from *Program Educational Objectives* (PEOs) but are defined in such a way as to support achievement of PEOs.

Senior Exit Survey

This survey is composed of questions from the outcomes A.1-K and questions for the students to rate their adviser, facilities, instructors, and program. There are questions for the students to rate numerically how well they agree with the statement given and essay questions to receive feedback. At the end of each question the student is asked to evaluate each course they have taken on a scale from 0-4, and to provide any comments regarding those selections.

Targets

Quantitative and qualitative standards against which performance may be compared for purposes of assessing the extent to which *Student Outcomes* or *Program Educational Objectives* are being achieved.

Appendix I Student Outcome Rubrics

Rubric for assessment of the attainment of student outcome 1

	Problem Solving Process/Category	Explicit Tasks Performed	Level of Attainment				Error(s) Committed	Category Score
			Deficient	Developing	Acceptable	Excellent		
			1 pt	2 pts	3 pts	4 pts		
Conceptual	Identify Problem and System Constraints	▪ Identified unknown(s) ▪ Restated problem ▪ Identified system constraints ▪ Communicated assumption	Did not explicitly identify and define the problem/system	Completed some of the problem/system definition task with multiple errors	Completed most of the problem/system definition tasks with minimal errors	Clearly identified and defined the problem/system	□ Incorrect unknown □ Incorrect assumption □ Ignored or incorrect problem constraints	
Conceptual	Represent the Problem	▪ Drew a visual representation ▪ Related variables/values	No representation drawn, no relationships indicated	Drew a representation or related variables, but not both	Drew a representation and related variables, but with errors	Drew a representation and indicated variable relationships	□ Incorrect representation □ Incorrect relate variables	
Conceptual	Organize Knowledge	▪ Identified known values ▪ Identified equation(s) ▪ Identified conversion factor	Did not explicitly organize information about the problem	Completed some information organization tasks with multiple errors	Completed some information organization tasks with minimal errors	Fully organized information needed to solve the problem	□ Incorrect known values □ Misused governing equation □ Incorrect conversion factor	
Analytical	Allocate Resources (Execution)	▪ Manipulated equation(s) ▪ Derived units ▪ Used conversion factor ▪ Documented math	No work shown	Partially documented execution tasks with multiple errors	Partially documented execution tasks with minimal errors	Fully documented execution tasks (Work showed evidence of relevant tasks)	□ Incorrectly manipulated equation □ Incorrect calculation □ Incorrect unit derivation □ Inconsistent transcription □ Inconsistent units □ Incorrect unit assignment □ Missing units throughout	

							□ Used irrelevant information □ Other _____	
	Evaluate the Solution	▪ Checked accuracy ▪ Indicated final answer ▪ Justify final answer	Did not evaluate solution	Evaluated the solution with multiple errors	Evaluated the solution with minimal errors	Adequately evaluated the solution	□ Incorrectly manipulated equation □ Incorrect calculation □ Incorrect unit derivation □ Inadequate reasoning	
	Final Solution Accuracy		Missing Answer	Incomplete Answer	Mostly complete answer	Complete Answer	□ Missing units □ Incorrect units □ Incorrect value □ Did not answer the question	

Rubric for assessment of the attainment of student outcome 2 (definition block)

Assessment Block: Definition	Deficient (1)	Developing (2)	Acceptable (3)	Excellent (4)
Problem Statement	No problem statement attempted.	Problem statement is provided, but is vague and does not clearly establish the need for an engineering design solution. It could use improvements in clarity, and the statement alludes to a specific final design solution.	Problem statement is provided and establishes the need for an engineering design solution, but could use improvements in clarity or the statement alludes to a specific final design solution	A statement that summarizes the context of the problem and establishes the need for an engineering solution is included. Problem statement doesn't allude to a specific final design solution
Stakeholder analysis	Stakeholder analysis is not attempted.	Lists some stakeholders that are impacted by the design, but does not address stakeholders that influence the design (or vice versa)	Not all relevant stakeholders are identified, but descriptions are provided for the ones identified.	Lists and describes all individuals or groups that influence or are impacted by the design

Project goals and design objectives	No goal or objectives attempted	Project goal(s) are listed, but no design objectives (or vice versa). More clarity is needed to establish scope of the project and anticipated deliverables.	Goal statements and design objectives are listed, but more clarity is needed to establish scope of the project and anticipated deliverables.	Goal statement(s) that sets the general direction and scope for the project and includes the intended outcomes and anticipated deliverables is provided; specific design objectives of what needs to be designed to achieve the project goal are included
Criteria and constraints	No relevant design criteria or constraints described	Describes relevant design criteria, but missing constraints (or vice versa), not all criteria and constraints are clearly identified or described.	Identifies and describes most relevant design criteria and constraints but has some issues with clarity	Lists and describes all relevant criteria - desired functions, attributes, or behaviors that can be specified using metrics. Describes all relevant constraints- limitations and restrictions imposed on the design, and conditions that must be satisfied by a design

Rubric for assessment of the attainment of student outcome 2 (implementation block)

Assessment Block: Implementation	Deficient (1)	Developing (2)	Acceptable (3)	Excellent (4)
Brainstorming and identification of design alternatives	Multiple viable design alternatives are not identified.	Limited viable alternatives are proposed and no justification is provided.	Multiple viable design alternatives are proposed, but relevant justification is lacking for some alternatives.	Multiple viable design alternatives are proposed to meet objectives of the design project Relevant justification for each alternative is provided to explain viability
Evaluation of alternatives	No decision making tool is provided and/or no analysis	Decision making tool lacks details and criteria	Decision making tool is provided but criteria	A detailed decision making tool such as a Pugh decision

	of alternatives is provided.	weighting is not used. Alternatives are evaluated and ranked/sorted using the decision making tool.	weighting is not justified. Alternatives are evaluated and ranked/sorted using the decision making tool.	matrix is developed that includes constraints and weighted criteria. Justification for criteria weighting is documented Alternatives are evaluated and ranked/sorted using the decision making tool.
Use of engineering analysis and tools	No evidence of application of relevant engineering and science principles, and no evidence of use of appropriate computational/design tools.	Relevant engineering and science principles are identified but significant mistakes in application are evident. Computational and design tools are used in a limited way.	Relevant engineering and science principles are identified, but some application mistakes are evident. Appropriate computational and design tools are used in to support implementation of the proposed design alternative.	Relevant engineering and science principles are identified and applied in the analysis and implementation of the chosen design alternative. Appropriate computational and design tools are used to support implementation of the proposed design alternative.
Description of final design	Final design description incomplete and lacks design specification and justification of design choices.	Final design description mostly complete but is unclear and disorganized. Specifications and justifications of design choices incomplete or missing.	Final design description complete with specifications. Justifications of design choices incomplete.	Comprehensive presentation of final design is presented that includes detailed design specifications, and justification of how design choice addresses the need.

Rubric for assessment of the attainment of student outcome 2 (impact assessment block)

Assessment	Deficient (1)	Developing (2)	Acceptable (3)	Excellent (4)

Block: Impact assessment				
Consideration of public health, safety, and welfare factors	No relevant public health, safety, and welfare factors are identified.	Limited number of factors identified. Discussion of risk to stakeholders is not included.	Comprehensive identification of relevant public health, safety, and welfare factors. Risk to stakeholders is not evaluated for all factors.	Comprehensive identification of relevant public health, safety, and welfare factors. Each factor is evaluated in the context of risk to the stakeholders based on likelihood of occurrence, and potential impact.
Consideration of global factors	No global factors identified and no justification provided.	At least one global factor is identified Impact of global factor(s) is not described. (or) Limited justification is provided for not considering global factor.	At least one global factor is identified Impact of global factor(s) on the design process or anticipated use of the design is not clearly described (or) Justification for not considering global factors is provided but lacks sufficient evidence.	At least one global factor is identified and impact on the design process or anticipated use of the design is described. (or) Justification with evidence is provided if global factors are not relevant to the project.

Consideration of cultural factors	No cultural factors identified and no justification provided.	At least one cultural factor is identified Impact of cultural factor(s) is not described. (or) Limited justification is provided for not considering cultural factor(s)	At least one cultural factor is identified Impact on the design process or anticipated use of the design is not clearly described (or) Justification for not considering cultural factors is provided but lacks sufficient evidence.	At least one cultural factor is identified and impact on the design process or anticipated use of the design is described. (or) Justification with evidence is provided if cultural factors are not relevant to the project.
Consideration of social factors	No social factors identified and no justification provided.	At least one social factor is identified Impact of social factor(s) is not described. (or) Limited justification is provided for not considering social factor(s).	At least one social factor is identified Impact on the design process or anticipated use of the design is not clearly described (or) Justification for not considering social factors is provided but lacks sufficient evidence.	At least one social factor is identified and impact on the design process or anticipated use of the design is described. (or) Justification with evidence is provided if social factors are not relevant to the project.
Consideration of environmental factors	No environmental factors identified and no justification provided.	At least one environmental factor is identified Impact of environmental factor(s) not described. (or) Limited justification is provided for not considering economic factor(s),	At least one environmental factor is identified Impact on the design process or anticipated use of the design is not clearly described (or) Justification for not considering environmental factors is provided but lacks sufficient evidence.	At least one environmental factor is identified and impact on the design process or anticipated use of the design is described. (or) Justification with evidence is provided if environmental factors are not relevant to the project.

Consideration of economic factors	No economic factors identified and no justification provided.	At least one economic factor is identified Impact of economic factor(s) is not described. (or) Limited justification is provided for not considering economic factor(s).	At least one economic factor is identified Impact on the design process or anticipated use of the design is not clearly described (or) Justification for not considering economic factors is provided but lacks sufficient evidence.	At least one economic factor is identified and impact on the design process or anticipated use of the design is described. (or) Justification with evidence is provided if economic factors are not relevant to the project.

Rubric for assessment of the attainment of student outcome 3 (written)

	Deficient (1)	Developing (2)	Acceptable (3)	Excellent (4)
Required information - Background information - Problem Statement - Stakeholder Analysis - Design goals/objectives - Criteria and constraints - Risk analysis	Significant missing information and explanation did not provide the audience an understanding of the scope of the project	Some required information was missing and explanation provided only partial understanding of the scope of the project	All required information was included, but some elements were not clearly explained, but overall scope of the design project was apparent	All required information was included and explained with sufficient detail for the audience to understand the scope of the design project
Use of graphics and visuals	No attempt to incorporated relevant graphics/visuals	Graphics and visuals were incorporated but some were not relevant to the presentation and distracted from the presentation. and/or were missing some elements such as captions, titles, labels etc.	Relevant and visually appealing graphics and visuals were appropriately incorporated. Some elements such as captions, titles, labels etc. were missing	Relevant and visually appealing graphics and visuals were incorporated in the presentation. Appropriate captions, titles, labels were used with the graphics and visuals
Layout and design of slides	Majority of the following features were missing and/or significant improvement needed - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Legible font sizes	1 or 2 of the following features were missing and/or need some improvement - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Legible font sizes	All the following features were present, but could use some improvement - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Legible font sizes - Appropriate citations	Slides had the following features: - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Legible font sizes - Appropriate citations for images, data, etc

	- Appropriate citations for images, data, etc	- Appropriate citations for images, data, etc	for images, data, etc	
Delivery and professionalism	Significant improvement in majority of the following areas: - Speaking clearly and coherently - Use of formal language - Highly specific jargon was minimal or clearly explained - Smooth transition between speakers - Presentation and presenters completed each other Presentation was within the allotted 10 min time-limit	Some improvement needed in 2 of the following areas: - Speaking clearly and coherently - Use of formal language - Highly specific jargon was minimal or clearly explained - Smooth transition between speakers - Presentation and presenters completed each other Presentation was within the allotted 10 min time-limit	Significant improvement needed in 1 of the following areas: - Speaking clearly and coherently - Use of formal language - Highly specific jargon was minimal or clearly explained - Smooth transition between speakers - Presentation and presenters completed each other Presentation was within the allotted 10 min time-limit	Presenters demonstrated all the following without need for significant improvement - Speaking clearly and coherently - Use of formal language - Highly specific jargon was minimal or clearly explained - Smooth transition between speakers - Presentation and presenters completed each other - Presentation was within the allotted 10 min time-limit

Rubric for assessment of the attainment of student outcome 3 (oral)

	Deficient (1)	Developing (2)	Acceptable (3)	Excellent (4)

Required Information	Significant information was missing and explanation did not provide the reader an understanding of the scope of the project, and/or elements were difficult for all readers to understand.	Some required information was missing and explanation provided only partial understanding of the scope of the project, and and/or elements were difficult for some readers to understand.	All required information was included and the overall scope of the project was apparent, but some elements were not clearly explained, and/or elements were difficult for some readers to understand.	All required information was included and explained with sufficient detail for readers of varying technical expertise to understand the project scope and detail.
Organization	The report lacked organization into clear sections that delineated the various aspects of the report.	The report was organized with clear headings, but the introduction did not fully explain the contents and purpose of the report and the conclusion did not summarize key findings.	The report was organized with clear headings, but either the introduction did not fully explain the contents and purpose of the report or the conclusion did not summarize key findings.	The report was well organized in a logical sequence and contained clear headings, an introduction explaining the contents and purpose of the report, and a conclusion summarizing key findings.
Figures	The report did not incorporate figures or 3 or more of the following aspects are missing: - Provided key data - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Used legible font sizes - Figures had captions or titles. - Graphs had appropriate axes labels with units. - Graphs with multiple lines had an appropriate legend.	The report incorporated figures, but 1 or 2 of the following aspects are missing: - Provided key data - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Used legible font sizes - Figures had captions or titles. - Graphs had appropriate axes labels with units. - Graphs with multiple lines had an appropriate legend.	The report incorporated figures and contained all of the following aspects, but they could use some improvement: - Provided key data - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Used legible font sizes - Figures had captions or titles. - Graphs had appropriate axes labels with units. - Graphs with multiple lines had an appropriate legend.	The report incorporated figures that contained the following aspects: - Provided key data - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Used legible font sizes - Figures had captions or titles. - Graphs had appropriate axes labels with units. - Graphs with multiple lines had an appropriate legend.

Tables	The report did not incorporate tables or 3 or more of the following aspects are missing: - Provided key data - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Used legible font sizes - Tables had captions or titles. - Table columns had appropriate headings	The report incorporated tables, but 1 or 2 of the following aspects are missing: - Provided key data - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Used legible font sizes - Tables had captions or titles. Table columns had appropriate headings	The report incorporated tables and contained all of the following aspects, but they could use some improvement: - Provided key data - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Used legible font sizes - Tables had captions or titles. Table columns had appropriate headings	The report incorporated table that contained the following aspects: - Provided key data - Visually appealing template that utilized contrast - Balanced use of text, graphics and white-space. - Used legible font sizes - Tables had captions or titles. Table columns had appropriate headings
Grammar	The report contained more than 10 grammar errors	The report contained no more than 10 grammar errors	The report contained no more than 5 grammar errors	The report contained no more than 2 grammar errors

Citation and References	More than two sources of information in the document from external sources is not properly cited.	One or two sources of information in the document from external sources is not properly cited.	All information in the document from external sources is properly cited, but some references are not formatted according to the format proscribed in the assignment.	All information in the document from external sources is properly cited and references are formatted according to the format proscribed in the assignment.

Rubric for assessment of the attainment of student outcome 4

	1 Deficient	**2 Developing**	**3 Acceptable**	**4 Excellent**
Recognition of ethical and professional responsibilities	Issue is not an ethical/professional issue an engineer might face.	Ethical and professional responsibility is recognized. Student does not explain why the issue has ethical implications or how/why an engineer would face this issue.	Ethical and professional responsibility is recognized. Student explains why the issue has ethical implications or explains how/why an engineer would face this issue.	Ethical and professional responsibility is recognized. Student explains why the issue has ethical implications and explains how/why an engineer would face this issue.
Economic impacts	Economic impacts are not addressed	Only positive **or** negative ethical issue is discussed	Both positive **and** negative ethical issue is discussed	Describe appropriate actions to promote positive ethical impacts and mitigate negative ethical impacts
Environmental impacts	Environmental impacts are not addressed	Only positive **or** negative ethical issue is discussed	Both positive **and** negative ethical issue is discussed	Describe appropriate actions to promote positive ethical impacts and mitigate negative ethical impacts
Societal impacts	Societal impacts are not addressed	Only positive **or** negative ethical issue is discussed	Both positive **and** negative ethical issue is discussed	Describe appropriate actions to promote positive ethical impacts and mitigate negative ethical impacts
Global impacts	Global impacts are not	Only discusses either	Discusses a positive **or**	Discusses both positive

(across Economic, Environmental and Societal discussions, judge if discussion of any impact extends beyond local to national or multi-country levels)	addressed at the national or multi-national levels	positive **or** negative ethical impact (at the national level for one of the impacts	negative ethical impact at the multi-national level for one of the impacts **-OR-** Discusses both positive **and** negative ethical impact at the national level for two impacts	**and** negative ethical impact at multi-country level for one of the impacts

Rubric for assessment of the attainment of student outcome 5

	1 Deficient	2 Developing	3 Acceptable	4 Excellent
Group Leadership (Maps to CATME dimension: Keeping the Team on Track)	Is unaware of whether the team is meeting its goals. Does not pay attention to teammates' progress. Avoids discussing team problems, even when they are obvious.	Combination of some behaviors from 1 and 3	Notices changes that influence the team's success. Knows what everyone on the team should be doing and notices problems. Alerts teammates or suggests solutions when the team's success is threatened.	Includes behaviors in 3 and one or more of the following: Watches conditions affecting the team and monitors the team's progress. Makes sure that teammates are making appropriate progress. Gives teammates specific, timely, and constructive feedback
Collaborative and Inclusive Environment (Maps to CATME dimension: Interacting with Teammates)	Interrupts, ignores, bosses, or makes fun of teammates. Takes actions that affect teammates without their input. Does not share information. Complains, makes excuses, or does not interact with teammates. Is defensive. Will not accept help or advice from teammates.	Combination of some behaviors from 1 and 3	Listens to teammates and respects their contributions. Communicates clearly. Shares information with teammates. Participates fully in team activities. Respects and responds to feedback from teammates.	Includes behaviors in 3 and one or more of the following: Asks for and shows an interest in teammates' ideas and contributions. Makes sure teammates stay informed and understand each other. Provides encouragement or enthusiasm to the team. Asks teammates for feedback and uses their suggestions to improve.
Establish goals, plan tasks, and meet objectives (based on Meeting Minutes and progress reports, and Gantt Chart)	Meeting minutes and biweekly progress reports are either absent or do not contain summary of progress towards meeting objectives or goals for future work. Gantt Chart is either not included or provides very limited plans for the project	Meeting minutes and biweekly progress reports contain partial information on progress towards meeting objectives and goals for future work are occasionally provided.. Gantt Chart is provided that aligns with project and includes tasks, but no clear milestones.	Meeting minutes and biweekly progress reports contain updates on progress towards meeting objectives. Gantt Chart is provided that aligns with project and includes detailed tasks, and milestones.	All elements of 3 plus the following: Meeting minutes and biweekly progress reports contain action items with assigned responsibilities for various team members. Gantt Chart contains both actual and planned schedule for tasks

Experiments & Data Category	Level of Completion			
	1 - Deficient	2 - Developing	3 - Acceptable	4 - Excellent
Develop Experiments	Did not develop experiments	Developed an experiment but missed important independent or dependent variables.	Developed an experiment with important independent and dependent variables, but lacking sufficient replicates.	Developed an experiment with important independent and dependent variables, and sufficient replicates.
Conduct Experiments	Did not collect data	Data was collected with major errors	Data was fully collected with minimal errors	Data was fully collected with no errors
Analyze Data	Did not analyze data	Data was analyzed incorrectly	Data analysis was correct but scope was limited	Data was analyzed correctly and completely.
Interpret Data	Did not clearly interpret the data	Some interpretation done, but incorrectly or incompletely	Primary interpretation done correctly, secondary interpretation missing or incomplete	Data was thoroughly interpreted
Draw Conclusions	No clear conclusion drawn	Conclusions are drawn but incomplete or incorrect	Conclusions drawn are correct, but some conclusions are missing	Conclusions are fully drawn addressing all important points

Rubric for assessment of the attainment of student outcome 6

Rubric for assessment of the attainment of student outcome 7

	Performance			
Criteria:	1 - Deficient	2 - Developing	3 - Acceptable	4 - Excellent
Acquire new information	It cannot be determined which sources are used	Can determine which sources were used but are either limited or not well known	Examines multiple widely known sources	Examines all the widely known sources, e.g. internet and library
	does not examine reliability of sources and uses unreliable	Uses a combination of reliable and unreliable sources without	Uses reliable sources and cites them correctly	uses only reliable sources and describes reliability of sources

	ones	distinguishing between them		
	there is no way to discern how current the used information is	Current information is used and currency referenced	information used is current or appropriate mix of old and current	current information is compared and contrasted to old information
Apply new knowledge	New knowledge used incorrectly.	New knowledge used correctly, but analysis is basic, applicability not discussed.	New knowledge used correctly, applicability described appropriately	New knowledge used correctly; applicability, advantages, and disadvantages discussed
	Copies arguments from sources but does not critically examine them.	Presents arguments from sources and concludes which ones are appropriate for this application	Presents arguments from sources and discusses which ones are appropriate for this application	Produces well-crafted arguments based upon new information; justifies assumptions from reliable sources or their own experience.
	Gets lost in unimportant details	Doesn't fully identify critical issues and components of the new knowledge	Identifies critical issues and component of the new knowledge in a limited manner	Identifies critical issues and component of the new knowledge.