CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

In 2010, MEM Department Curriculum committee made a well-considered decision to adopt the EC2000 ABET a – k Outcomes without modification. Prior to 2010 and for the SD Mines mining engineering General Review of 2009, the Program Outcomes were worded somewhat differently from the ABET a – k Outcomes. This caused a bit of confusion. Thus, the Student Outcomes currently being assessed are:

a. an ability to apply knowledge of mathematics, science and engineering

b. an ability to design and conduct experiments, as well as to analyze and interpret data

c. an ability to design a system, component, or processes to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

d. an ability to function on multi-disciplinary teams

e. an ability to identify, formulate, and solve engineering problems

f. an understanding of professional and ethical responsibility

g. an ability to communicate effectively

h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

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

j. a knowledge of contemporary issues

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

The outcomes are currently published on the department website at: http://www.sdsmt.edu/Academics/Departments/Mining-Engineering-and-Management/Accreditation---Assessment/

B. Relationship of Student Outcomes to Program Educational Objectives

The relationship between student outcomes and program educational objectives is shown in Table 3-1.

As stated in under ***CRITERION 2, part B***, the **Educational Objectives** of the Mining Engineering program which support the mission of SD Mines (http://www.sdsmt.edu/Academics/Office-of-the-Provost/Assessment/ABET-accredited-Programs/) are:

#1. Graduates from the Mining Engineering Program will have the analytical and technical abilities necessary to work effectively in the field of mining engineering and will be informed of recent technical advances in the field.

#2. Graduates from the Mining Engineering Program will be cognizant of societal issues and their role as future professional engineers working for the general benefit of society.

The first educational objective, "*the analytical and technical abilities necessary to work effectively in the field of mining engineering and will be informed of recent technical advances in the field,"* is clearly represented by the student outcomes related to problem solving, engineering design and teaming. Student Outcomes aligned with PEO #1 are *a*, *b*, *c*, *d*, *e*, *g*, and *k.*

Likewise, the second educational objective, "*will be cognizant of societal issues and their role as future professional engineers working for the general benefit of society,"* relates to the interactions between the professional mining person and society. Student Outcomes aligned with PEO #2 are *f, h*, *i*, and *j*.

Thus, the skills that graduates of this program acquire in meeting the student outcomes, along with experience acquired in the industry, should enable the graduates to achieve program objectives within a few years after graduation.

Table 3-1. Mapping of Program Educational Objectives (PEOs) to Student Outcomes.

Student Outcomes (*a* – *k*)	**Program Educational Objectives (PEOs)**	
	PEO #1	***PEO #2***
a. an ability to apply knowledge of mathematics, science and engineering	X	
b. an ability to design and conduct experiments, as well as to analyze and interpret	X	
c. an ability to design a system, component, or processes to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	X	
d. an ability to function on multi-disciplinary teams	X	
e. an ability to identify, formulate, and solve engineering problems	X	
f. an understanding of professional and ethical responsibility		X
g. an ability to communicate effectively	X	
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context		X
i. a recognition of the need for, and ability to engage in life-long learning		X
j. a knowledge of contemporary issues		X
k. the ability to use techniques, skills, and modern engineering tools necessary for engineering practice	X	

CRITERION 4. CONTINUOUS IMPROVEMENT

In the continuous improvement process we must ask ourselves periodically, "How well are we doing, and in what ways can we improve?" One measure of how well we are doing is by looking at the number of potential employers coming on campus during the spring and fall Career Fairs looking for mining engineering graduates.

In 2004 – 05, 57 companies came to the Fall Career Fair, of which 11 were looking for mining engineers from SD Mines; 36 companies came to the Spring Career Fair, of which 5 were seeking mining engineers. In 2008 – 09, 145 companies came to the fall fair, 45 of which were seeking mining engineers; and 72 came to the spring fair, 13 of which were seeking mining engineers. In 2015 – 16, 144 companies came to the fall fair, 24 of which were seeking mining engineers; and 85 companies came to the spring fair, 7 of which were seeking mining engineers (a marked downturn in the mining economy, especially within the coal sector, was apparent in AY 2015 – 16). Table 1-8 documents the total number of companies participating in the SD Mines Career Fair, fall semester and spring semester, plus the number of companies recruiting mining engineering graduates from AY 2010 -11 through AY 2015 – 16.

Given this significant increase in companies seeking mining engineering graduates from 2004 to present, it is apparent that they see something they like in the product.

How can we improve? There is always room for improvement, no matter where one is positioned within some sort of ranking system. We therefore sought input from outside to determine our shortcomings and areas wherein we need improvement. This outside counsel has come primarily from alumni, supervisors of alumni, and employers of alumni who responded to our surveys; and from our Industrial Advisory Board, which meets twice per year and is the most active of campus advisory groups.

A. Student Outcomes

Data from various sources are collected in order to assess student outcomes, as well as to assess, evaluate and continuously improve this program. The mining engineering program has adopted the continuous improvement process presented below in Figure 4-1 (modified from the Figure 4-1 of the 2009 Self Study in 2014 to its present form).

Student outcomes are assessed and evaluated for each graduate of the mining engineering program using a direct assessment mechanism, and for the group as a whole using several indirect supporting mechanisms. Direct assessment of student outcomes is provided by (tool #1) grades from selected student work in which the work has been determined by the mining engineering faculty members to correspond to specific student outcomes. Indirect assessment of student outcomes and of the mining engineering program is carried out using group measures such as: (tool #2) Student Exit Surveys, the Student Satisfaction Survey (SSI) and the (tool #3) 3- to 5-year surveys of employers, alumni and our Industrial Advisory Board members.

As shown in Figure 5-4 (***CRITERION 5. CURRICULUM***), each course in the mining engineering curriculum contributes to a sub-set of the student outcomes (SOs). This contribution is achieved through the course objectives, which, in turn, are attained through the course (learning) outcomes particular to each course. The course (learning) outcomes are specific to the content of the course and describe the course-related abilities the students should acquire by satisfactorily completing the course.

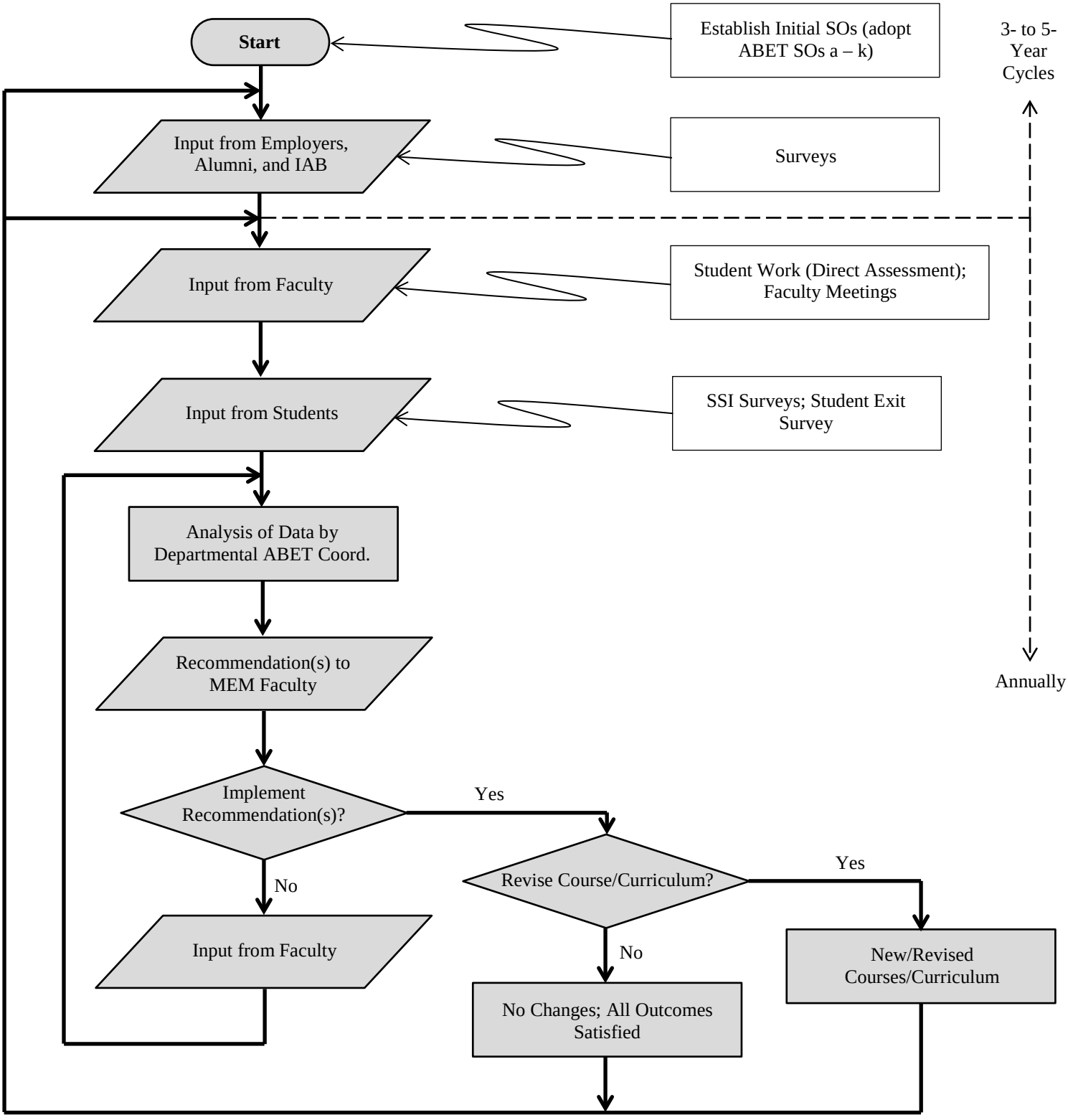

Figure 4-1. Mining engineering process for assessing and evaluating student outcomes.

The course-based Level of Achievement for each outcome is tabulated year-by-year within a spreadsheet created for this purpose. The spreadsheets used for the 2015-16 assessment process are available in the assessment binders for review, along with sample assignments and other important assessment tools.

Prior to, and including the 2012 – 2013 academic year, the data was accumulated sporadically, and much of the data that was accumulated was lost due to turnovers in faculty plus a major departmental move from the third floor of the Mineral Industries Building to the second floor, which resulted in accumulated records being inadvertently thrown out. In the 2013 – 14 academic year a more rigorous program of quality assurance/quality control of the assessment materials was implemented; and n 2015 a single faculty member was given the responsibility of accumulating, reviewing and tabulating the data that was available, then of devising and implementing a better process to assure that each faculty member, and the department as a whole, follows the devised Continuous Improvement process.

B. Continuous Improvement

1. Process for reviewing the attainment of Student Outcomes

As part of the continuous improvement process, feedback from the aforementioned assessment tools (Tool #1: grades from selected student work; Tool #2: student exit surveys and the Student Satisfaction Survey (SSI); and Tool #3: 3 – 5-year surveys of employers, alumni and our IAB members) are used to determine whether the student outcomes ***a*** through ***k*** are being met.

For the 2009 General Review, a detailed assessment strategy was devised by the mining engineering program to assess the students' attainment of the 11 outcomes (***a*** through ***k***). Included below are the assessment tools that were devised for the 2009 review, then revised prior to the 2016 review.

Each section of the assessment tool is divided into four parts:

1) Implementation Strategies which details several strategies employed to ensure that graduates of the program meet the outcome;
2) Assessment Plan which lists and discussed the methods chosen to assess how well the graduates meet the outcome year-to-year;
3) Assessment Results which are tables (Tables 4-1 through 4-11) created for use in the assessment process. The tables list the Assessment Methods, the Performance Criteria, the Course(s) used for course-based assessment, the Acceptance Criteria, and the Result of the yearly (and periodic) assessment.
4) The Level of Achievement of each outcome over the assessment period (2012-13 through 2015-16).

It must be noted that much of the material for the assessment of each outcome collected between the initial General Review of 2009 – 10 and 2012 was misplaced and, therefore, only 4 academic years are summarized in the following tables. Due to a number of reasons, including a major move from 3rd floor of the Mineral Industries Building to new office space on the 2nd floor and turnover in academic personnel, a major portion of the coursework-based assessment data collected during AY 2010 – 11 and AY 2011 – 12 was either thrown out or simply misplaced. Therefore, it was not considered optimal to include on the following tables

(Table 4-1 through 4-11) the course-based assessment data and results for those academic years.

A note on the hi-light colors below in Tables 4-1 through 4-11:

Green hi-light was used to note areas of concern with a certain Performance Criteria in the Course-Based Assessments. This is not necessarily a non-achievement item; rather it denotes an assignment or other effort with a lower than expected achievement level.

Blue and yellow hi-lights were used within the Results box of both the Student Exit Surveys and the Alumni Surveys to indicate results that should be given a "heads up!" It is, again, not necessarily a serious concern, as yet, but may become an issue in the future. Blue denotes an "agreement" score between 1.5 and < 1.6 (with resulting agreement percentages between 87.5 and 85.0). Yellow denotes an "agreement" score greater than or equal to 1.6 (with resulting agreement percentage ≤ 85.0), indicating a lower level of agreement with the question.

Yellow also denotes an alumni agreement response greater than or equal to 2.2 (≥ 2.2), which results in a percentage agreement of less than or equal to 70.0 (≤ 70%).

A note of the determination of "Level of Achievement" for each Outcome *a* - *k*:

The assessment of the *level of achievement* of each Outcome (***a*** – ***k***) is normally completed at the end of the Spring term by the faculty member given the responsibility of collecting, reviewing and tabulating the data for the academic year (the Departmental ABET Coordinator). This is normally done within two weeks of the end of the Spring semester.

The first step in the process of the review for each Outcome is the Transcript Audit. The transcript for each graduating senior is audited utilizing a very formal process to determine if the potential graduate has achieved and passed satisfactorily all of the courses which meet the ABET Program Criteria for mining engineering, the SD BOR Gen Ed Goals, and any MEM Department-imposed additional criteria. If any of the aforementioned criteria or goals is missing from the student's transcript, then the advisor will not sign off with an "Ok to graduate" note at the bottom of the degree audit form which is submitted to Enrollment Management. This is further discussed in sections ***CRITERION 1. STUDENTS, Part B (Evaluating Student Performance)*** and ***CRITERION 5. CURRICULUM, Part A, (Program Curriculum),*** sub-section #5: Meeting the Requirements of the General and Program Criteria.

The next step in the process is for the responsible faculty member to collect all the Course-based Assessment data for each outcome. At ABET general review time, he/she also collects samples of the assignments used in this process. Certain homework assignments, which are normally assigned in one form or another each time the course used for the course-based assessment is taught, are used as proxies to determine the level of achievement via the course-based assessment tool.

The faculty member responsible for teaching the course (or who is responsible for managing the course if it is taught by a TA, as in rock mechanics lab) is responsible for determining the level of achievement according to the Acceptance Criteria scale devised for said course. Often, the responsible faculty member will add notes or comments to the form used to determine the Result of the course-based assessment. The notes tend to supplement the assessment of the level of achievement as determined by the Coordinator or by the course instructor.

If any current survey data is available—either Student Exit Survey data, Alumni Survey data or Employer Survey data—then the faculty assessment Coordinator will add that to the table of assessment data for each outcome. The surveys of graduates or employers are conducted on a 3- to 5-year cycle, and the Student Exit Surveys are normally administered to graduating seniors at the end of each semester,

The ABET Coordinator then reviews the data provided and high-lights any anomalous results. These anomalies are then reviewed to determine if it is a recurring event (possible problem or non-achievement of the outcome), or if it is truly just an anomaly. He/she then drafts a short summary of the overall achievement of the Outcome, year-by-year, which is added to the outcome assessment worksheet for each outcome. Outcome Assessment Worksheets for Academic Years 2012 -13 through 2015 – 16 are included in each of the Outcome ***a – k*** notebooks which are available for review.

The process used for measuring Outcomes ***a*** through ***k*** is:

Graduates of the SD Mines mining engineering program will have

a) an ability to apply knowledge of mathematics, science and engineering

Implementation Strategies for Outcome *a*

Three strategies were implemented to ensure the use of mathematics, physics, chemistry, and computer applications in furtherance of Outcome ***a***. The Mining Engineering curriculum includes required courses in mathematics, physics, chemistry and basic general engineering (computer applications).

1. Mining Engineering students are required to take 27 credits of mathematics, physics and chemistry as part of their basic Math and Sciences curriculum. The mathematics requirement includes 10 credits of calculus, 3 credits of differential equations and 1 credit of statistics (taught as MEM 307). The physics and chemistry requirements are 6 credits of calculus-based physics and 4 credits of university-level chemistry, respectively. The physics and chemistry include hands-on laboratories. Computer applications including computer-aided design, computer-aided problem solving, basic computer software, and professional computer software are introduced in several engineering courses (eg: MEM 110L, MEM 301, MEM 307, MEM 464).
2. Numerous engineering and Mining Engineering courses utilize the material from the required courses in mathematics, chemistry, physics and computer applications, including, but not limited to:

    - EM 216 (Statics & Dynamics)
    - MEM 201 (Surveying for Mineral Engineers)
    - MEM 202 (Materials Handling and Transportation)
    - MEM 307 (Mineral Exploration and Geostatistics)
    - MEM 304 (Theoretical and Applied Rock Mechanics)
    - EM 331 (Fluid Mechanics)
    - GEOL 322 (Structural Geology)
    - MEM 401 (Theoretical and Applied Mine Ventilation)
    - EE 303 (Basic Circuits)

- MEM 464 (Mine Design and Feasibility Study)

3. The basic lower-division courses in mathematics, physics and chemistry are taught by the appropriate departments (with the exception of 1 credit of statistics taught in MEM 307). Their content is relatively standardized and subject to articulation agreements with many other colleges and universities for transfer credits. One of the mathematics courses (Calc III) has been modified specifically for Mining Engineering and is taught by the Math Department as Math 205 (Mining & Management Mathematics I).

Assessment Plan for Outcome *a*

Three assessment methods were chosen to assess the ability of Mining Engineering students with respect to Outcome ***a***:

1. Advising and Transcript Audit. Multiple levels of advising ensure that the mathematics classes, physics classes, chemistry classes and basic computer applications class are completed prior to graduation.
   - Near the end of each semester, each student is encouraged to meet with his/her advisor to review his/her status and to plan his curriculum for the coming semester. During this process, deficiencies in mathematics, chemistry, physics and computer applications are noted and a plan is formulated for the student to get back on track.
   - During the student's last semester in residency before graduation, a degree check is completed for the student by his/her advisor. This degree audit is performed, by SD Mines rules, to assure that the student has completed all requirements for graduation. This check, once completed, is sent to Enrollment Management with a recommendation for, or against, graduation.
2. Course-Based Assessment. Certain work by the students performed in four Mining Engineering courses were evaluated for Outcome ***a***. The courses are: MEM 301 (Computer Applications in Mining), MEM 304 (Theoretical and Applied Rock Mechanics), MEM 307 (Mineral Exploration and Geostatistics), and MEM 401 (Theoretical and Applied Ventilation Engineering).
3. Student Exit Survey. Each graduating senior completes an Exit Survey during the last week of classes during his/her final semester in full-time residency.

Table 4-1. Assessment Results of Outcome a (Graduates of the SD Mines mining engineering program will have the ability to apply knowledge of mathematics, science and engineering).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students pass required courses in mathematics, chemistry and physics.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Students are able to use spreadsheet fit a high-order polynomial to engineering data.	301	70% or better[1]	95% avg. 21/22 (95.5%) achieved	96% avg. 22/23 (95.7%) achieved	74% avg. 16/23 (70%) achieved	
	Students are able to use software to generate Mohr-Coulomb and Hoek-Brown Failure Criteria and determine the parameters of linear and non-linear strength envelopes for rock from rock strength data.	304	70% or better[1]	84.7% avg. 34/38 (89.5%) achieved	79.9% avg. 29/39 (74.4%) achieved	88.6% avg. 19/22 (86.3%) achieved	87.9% avg. 17/19 (89.5%) achieved

Table 4-1. Outcome a, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Course-Based Assessments	Students can solve geostatistical distance/variance relationship for unknown grade at a point.	307	70% or better[1]	100% achieved. "B" avg.	74% of the students achieved a 70% or better (part of the final exam)	83% of the students achieved a 70% or better (part of a homework)	4.0/4.0; (15/18) 100% achieved. 3 students didn't complete the course
	Students understand, and can apply, the Hardy-Cross Method of approximation/ students can solve ventilation networks with regulated airflow distribution system.	401	70% or better[1]	3.1/4.0; 21/27 (78%) achieved.	3.1/4.0; 16/20 (80%) achieved. 1 student couldn't complete the course.	3.8/4.0; 20/20 (100%) achieved.	3.8/4.0; 20/20 (100%) achieved.
Student Exit Survey	I have gained an adequate knowledge of mathematics and physics and their application to engineering problems.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.5600/5[2] (86.0%)	1.4118/5[2] (89.71%)	1.3125/5[2] (92.19%)	

Table 4-1. Outcome a, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Student Exit Survey (cont)	I have learned to use computers to solve engineering problems.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.5600/5[2] (86.00%)	1.6471/5[2] (83.82%)	1.5625/5[2] (85.94%)	

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree
2 = 75% agree
3 = 50% agree
4 = 25% agree
5 = 0% agree

Level Of Achievement of Outcome *a*

The first step in the determination of the "Level of Achievement" of this outcome, and of all the other outcomes, is the Advising and Transcript Audit. Advising is an ongoing process, semester-to-semester. The final Transcript Audit occurs in the final semester before the student graduates, and also, ideally, in the semester before the student graduates in order to pinpoint any "heads up!" deficiencies that the student should address to assure he/she does graduate.

These deficiencies most commonly occur because the student did not meet the SD BOR GenEd requirements, ie, taking too few Humanities or Social Sciences credits; not taking the proper Engineering Mechanics courses; missing credits in higher-level mathematics; improper substitutions; and/or missing ABET Program Criteria courses.

All seniors who are on the final graduation list have passed through this review and audit.

The next step in the determination of the "Level of Achievement" is the Course-Based Assessment process. For this outcome, four problems-type mining engineering courses were chosen to assess via specific homework assignments given yearly in the courses. The "Acceptance Level" was set at 70%, or better (ie, "C" grade, or better on a 90, 80, 70, 60 grading scale).

Looking at the achievement rate of the proxy assignments in the four courses (MEM 301, 304, 307 and 401), it is observed that the students achieved at least a 70% in all four of them for all of the academic years listed. It can be surmised from the course-based assessment results that the students, as a whole, attained Outcome ***a.***

The final observation for Outcome ***a*** are the results of the Student Exit Surveys. When queried if they agreed that they had "gained an adequate knowledge of mathematics and physics and their application to engineering problems," the graduating seniors agreed with the statement at an 86 to 92% level; however, when queried if they agreed with the next statement that they had "learned to use computers to solve engineering problems," they agreed with the statement at a much lower level (84 – 86%).

It can, therefore, be surmised from the student exit surveys that the graduating seniors are not altogether comfortable yet with their capabilities of using math, physics, and computers to solve engineering problems.

In summary:

Based upon the results of the assessment as summarized in Table 4-1, mining engineering students have achieved the ability to utilize advanced mathematics, general scientific principles, and computer applications for solving practical engineering problems by the time they graduate. However, the graduating seniors did not feel strongly that they were able to use computers to solve engineering problems, as indicated by Exit Survey scores greater than 1.5000.

Additionally, some of the comments from students indicated that they believed that the Maptek *Vulcan* mine design system was stressed too much in MEM 301 (Computer Applications), and other available software was not stressed enough. **Consideration should be given to introducing other mine design software, such as Carlson's *Carlson Mining*.**

Otherwise, no additional actions are recommended at this time with regards to Outcome ***a***.

Graduates of the SD Mines mining engineering program will have

b) an ability to design and conduct experiments, as well as to analyze and interpret data

Implementation Strategies for Outcome *b*

Two strategies were implemented to ensure that students demonstrated the ability to design and conduct experiments and/or field investigations, and interpret and analyze data, as required by Outcome ***b***.

1. Completion of 1 Laboratory Credit in Chemistry, 1 Laboratory Credit in Mineralogy and Petrology for Mining and 1 Laboratory Credit in Geology. Students are required to complete science courses in Chemistry (CHEM 112), which has a separate required laboratory course (CHEM 112L); and also in Physics (PHYS 211 and 213), Mineralogy and Petrology for Mining (MEM 314) and Geology (GEOL 322) which include laboratories (MEM 314L and GEOL 322L).
2. Completion of Laboratory Credits in Mining Engineering. Students are required to complete a minimum of 5 credits (in 4 courses) of mining engineering laboratories in which they conduct experiments or analyze and interpret data.
    - MEM 201L (Surveying for Mineral Engineers; 2 lab cr.)
    - MEM 301L (Computer Applications in Mining; 1 lab cr.)
    - MEM 304L (Theoretical and Applied Rock Mechanics; 1 lab cr.)
    - MEM 401L (Theoretical and Applied Ventilation; 1 lab cr.)

Assessment Plan for Outcome *b*

Three assessment methods were chosen to assess the ability of mining engineering students with respect to Outcome ***b***:

1. Advising and Transcript Audit. Advising and transcript audit ensures that students have demonstrated the ability to conduct experiments and/or field investigations, and interpret and analyze data.
    - Student Advising. The students are encouraged to meet each semester with their advisor to ensure that students take and pass the courses in the Mining Engineering sequence which develop the ability to design and conduct experiments and/or field investigations, and analyze and interpret data in their field of specialty.
    - Transcript Audit. The Mining Engineering program audits the transcript of every student every semester to ensure that students have completed appropriate prerequisite courses, including laboratory courses, before being allowed to take other engineering courses that depend upon these courses. Students attempting to enroll in an engineering course without the necessary prerequisites are disallowed registration into it by WebAdvisor.
    - Graduation Audit. A graduation evaluation and audit is performed by the student's advisor during the last semester prior to his/her graduation.
2. Course-based Assessment. We evaluated student performance in two courses: MEM 304L (Rock Mechanics) and MEM 401L (Ventilation)

3. Student Exit Survey. Each graduating senior completes an Exit Survey during the last week of classes during his final semester in full-time residency.

Table 4-2. Assessment Results of Outcome b (Graduates of the SD Mines mining engineering program will have the ability to design and conduct experiments, as well as to analyze and interpret data).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students pass required courses in mathematics, chemistry and physics.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Student is able to follow instructions and conduct an experiment.	304L	70% or better[1]	85.7% avg. 33/38 (86.8%) achieved	91.1% avg. 39/39 (100%) achieved	82.3% avg. 31/34 (91.2%) achieved	81.3% avg. 27/31 (87.1%) achieved
	Student is able to acquire, analyze, and interpret data.	304L	70% or better[1]	83.5% avg. 33/37 (89.2%) achieved	93.1% avg. 39/39 (100%) achieved	74.3% avg. 23/34 (67.6%) achieved	68.3% avg. 18/31 (58.1%) achieved
	Student is able to acquire, analyze and interpret data.	401L	70% or better[1]	27/27 (100%) achieved.	19/20 (95%) achieved.	20/20 (100%) achieved.	20/20 (100%) achieved.
Student Exit Survey	I have learned to design and conduct experiments.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.6000/5[2] (85.0%)	1.6875/5[2] (82.81%)	1.4375/5[2] (89.07%)	

Table 4-2. Outcome b, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Student Exit Survey	I have learned to analyze and interpret experimental data.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.5600/5[2] (86.0%)	1.5294/5[2] (86.77%)	1.4000/5[2] (90.0%)	

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree
2 = 75% agree
3 = 50% agree
4 = 25% agree
5 = 0% agree

Level Of Achievement of Outcome *b*

The course-based metrics indicate that our graduates have achieved Outcome ***b***; the ability to design and conduct experiments and/or field investigations, and analyze and interpret data in their field of specialty. The single area of concern was with MEM 304L (Rock Mechanics Lab) for AY 2012 – 13 and AY 2013 – 14. In both years, the 70% achievement level goal was not attained. However, the AYs 2014 – 15 and 2015 – 16 show significant improvement in the achievement levels of the students being able to "acquire, analyze, and interpret data."

The Student Exit Surveys indicate, however, that the students overall do not believe with a high level of confidence they have learned to *design and conduct experiments* and *analyze and interpret data*. The students responded, at the time of graduation, with a percentage agreement in the low- to mid-80s that they have achieved this outcome.

More effort should be directed by the mining engineering faculty to assure that the students do attain this goal. Additional metrics (assignments) are warranted.

Graduates of the SD Mines mining engineering program will have

c) an ability to design a system, component, or processes to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

Implementation Strategies for Outcome *c*

Three strategies were implemented to ensure the students demonstrate the ability to analyze and design systems, components, or processes relevant to the mining field in furtherance of Outcome ***c***.

1. The Mining Engineering curriculum ensures that the students receive a broad-based education in mining engineering. Numerous Mining Engineering courses and outside-the-department courses provide the foundation for the later courses with significant design content. These foundation courses include MEM 120 (Introduction to Mining and Sustainable Development), MEM 202 (Materials Handling and Transportation), MEM 204 (Surface Mining Methods and Unit Operations), MEM 303 (Underground Mining Methods and Equipment), MET 220 (Mineral Processing), and the Geology/GeolE courses. These courses must be taken by the student prior to taking the final, capstone design course.
2. In addition to the foundation Mining Engineering and outside-the-department courses, significant design content is included in numerous upper-level Mining Engineering courses, including MEM 301 (Computer Applications in Mining), MEM 304 (Theoretical and Applied Rock Mechanics), MEM 305 (Introduction to Explosives Engineering), MEM 401 (Theoretical and Applied Ventilation Engineering), and MEM 464 (Mine Design and Feasibility Study).
3. Senior Capstone Design: All Mining Engineering students are required to complete satisfactorily a capstone senior design project and present the results of that project to the Mining Engineering faculty, any guests, and his/her peers. Depending on the instructor and/or the number of students registered in the course, the students may each be required to submit a design project, or they may be assigned teams. To insure that the students are

aware of real-world project constraints, they are required to discuss extensively, but not exclusively, the following: Resources/reserves, strip ratio, grade estimates, cut-off grade determination, sequencing and scheduling, equipment selection, economics, sustainability and mineland reclamation, process selection and basic design, haulroad design and layout, waste disposal, and water management; the underground mining project will additionally include elements such as: ground control, stope design, and ventilation design. The capstone design project is evaluated based upon the written project design and the oral presentation.

Assessment Plan for Outcome *c*

Five assessment methods were chosen to assess the ability of Mining Engineering students with respect to Outcome ***c***:

1. Advising and Transcript Audit. A transcript audit is performed by the student's advisor during the last semester prior to his graduation to ensure that the student has taken the required courses that demonstrate his ability to analyze and design systems, components, or processes relevant to the mining engineering field. The advisor also checks to make sure that the student has taken the requisite engineering science and engineering design credits.
2. Course-Based Assessments. Student performance in four courses with a significant design component were assessed for this outcome (MEM 304—Theoretical and Applied Rock Mechanics, MEM 305—Introduction to Explosives Engineering, MEM 401—Theoretical and Applied Ventilation Engineering, and MEM 464—Mine Design and Feasibility Study).
3. Student Exit Survey. Each graduating senior completes an Exit Survey during the last week of classes during his final semester in full-time residency.
4. Evaluation of the Senior Design Project. Each student's final senior design project is evaluated by the course instructor with input from the other faculty. The project is evaluated for design content and feasibility.
5. Alumni Survey. The response of recent alumni to our survey are analyzed.

Table 4-3. Assessment Results of Outcome c (Graduates of the SD Mines mining engineering program will have the ability to design a system, component, or processes to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students pass required courses to satisfy this criterion.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Student is able to design a ground support system for an underground opening.	304	70% or better[1]	88.6% avg. 35/37 (94.6%) achieved	91.8% avg. 37/39 (94.9%) achieved	100% avg. 20/20 (100%) achieved	100% avg. 26/26 (100%) achieved
	Student is able to design a typical quarry blast.	305	70% or better[1]	13.91/20 avg; 10/23 (43.5%) achieved	14.47/20 avg; 50% achieved	16.61/20 avg; 100% achieved	26.65/30 avg; 22/23 achieved
	Student is able to design and analyze a simple ventilation network.	401	70% or better[1]	3.7/4.0; 27/27 (100%) achieved.	3.6/4.0; 18/20 (90%) achieved. 1 student couldn't complete the course	3.6/4.0; 20/20 (100%) achieved.	3.96/4.00; 20/20 (100%) achieved.

Table 4-3, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	**2014-15**	**2013-14**	**2012-13**
Course-Based Assessments	Students are able to design a mining system.	464	70% or better[1]	100% (13/13) achieved	100% achieved 70% or better	3.76/4.0 avg; 100% achieved 70% or better.	3.84/4.0 avg;16/17 achieved 70% or better.
Student Exit Survey	I have learned to analyze and design systems, components or processes in my field.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.6400/5[2] (84.00%)	1.4706/5[2] (88.23%)	1.4375/5[2] (89.06%)	
Evaluation of Senior Design Project	The senior design project is rated based upon design content for the purpose of this outcome.		"C or better final grade.	F2015: 100% achieved.	F2014: 100% achieved.	F2013: 3.7/4.0 avg. 100% achieved	F2012: 3.75/4.0 avg. 100% achieved
Survey of 2008 – 10 Alumni taken in 2015 (24 respondents)	Answer to the Survey Question: "How well do you feel you rate on these attributes.....(1) *Ability to conduct design in your field*"			24 responses: 2.3333/5[3] (66.67%)			

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree; 2 = 75% agree; 3 = 50% agree; 4 = 25% agree; 5 = 0% agree

[3] Meaning of the ratings: 1.0 = Excellent; 5.0 = Poor: (1.0 = 100% agree; 5.0 = 100% disagree; 3.0 = 50/50)

Level Of Achievement of Outcome *c*

What is most noticeable in Table 4-3 is that, according to the Student Exit Survey, 85 to 89% of the graduating seniors believe they *have learned to analyze and design systems, components or processes in their field*, whereas 67% of the responding alumni feel comfortable with their ability to *conduct design in your field*, a significant disparity between the average response of graduating seniors from the Student Exit Surveys (Results = 1.6400/5; 1.4706/5 and 1.4375/5) and that of the alumni from the Alumni Survey (Result = 2.3333/5, which results in a 67% agreement).

Based upon the results of the coursework assessments as summarized in Table 4-3, mining engineering students have mostly achieved the ability to analyze and design systems, components, or processes relevant to the mining engineering field. **However, based upon the survey results and the MEM 305 blast design exercise, more work is needed.** No additional actions are recommended at this time with regards to Outcome ***c***.

Graduates of the SD Mines mining engineering program will have

d) an ability to function on multi-disciplinary teams

Implementation Strategies for Outcome *d*

Three strategies were implemented to ensure that students demonstrated the ability to work effectively in multi-disciplinary teams, as required by Outcome ***d***.

1. Completion of Laboratory and Recitation Courses. Certain courses within the Mining Engineering curriculum require that the students work together in groups, both in experimentation and in writing the reports and presenting the results. These courses include:

   - MEM 201 (Surveying for Mineral Engineers)
   - MEM 301 (Computer Applications in Mining)
   - MEM 401 (Theoretical and Applied Ventilation Engineering)

   Students are also required to work together in outside-the-department courses such as GeoE 221 (Geology for Engineers) and GeolE 322 (Structural Geology).

2. Completion of MEM 464 (Mine Design and Feasibility Study) Senior Capstone Design Project. All Mining Engineering students are required to take MEM 464 (Mine Design and Feasibility Study), which forms the culminating design experience of their mining engineering education. The design project requires that the students assemble themselves into teams of three to five students with individual students taking the lead in the design of different aspects of the project (NOTE: Depending on the number of students in the class and the instructor, it may not be reasonable to assemble the students into groups and, therefore, students may be required to submit an individual project).

3. Encouragement of Study and Homework Groups. Students are encouraged to work in groups for homework and for study. To promote this activity, the Mining Engineering Department, and specifically the South Dakota School of Mines and Technology, has created several facilities in which students may interact:

- The MI Building D&C Lounge. The D&C Lounge is furnished with tables and chairs, comfortable chairs and chaise lounges to encourage students to interact, relax, or work in groups. This room has become a second home to many students doing homework, writing laboratory reports and preparing for exams.
- Mining Engineering Maptek Advanced Design Laboratory (MI 223/225). The Maptek Design Laboratory is a mid-sized room with modern computing facilities to encourage group interaction during the capstone design process. When this room is not being used for classes, it is possible to find many students working therein.

Assessment Plan for Outcome *d*

Four assessment methods were chosen to assess the ability of engineering students with respect to Outcome ***d***:

1. Advising and Transcript Audit. Advising and transcript audit ensures that students have demonstrated the ability to work effectively in multi-disciplinary teams.
   - Student advising. The students are encouraged to meet each semester with their advisor to ensure that students understand the prerequisite structure of the curriculum, which requires them to take lower-level courses in which they work in multi-disciplinary teams (e.g. MEM 201) before being allowed to enroll in upper-level courses.
   - Transcript audit. The Mining Engineering Program audits transcript of every student every semester to ensure that students have completed appropriate prerequisite courses before being allowed to take other engineering courses that depend upon these courses. Students attempting to enroll in engineering courses without the necessary prerequisites are not allowed to register for them without proper clearance.
   - Graduation audit. A graduation evaluation and audit is performed by the student's advisor during the last semester prior to his graduation to ensure that the student has taken the required courses that include having worked effectively in multi-disciplinary teams.
2. Course-Based Assessment. We evaluated student performance with respect to teamwork in two courses: MEM 201 (Surveying for Mineral Engineers) and MEM 464 (Mine Design and Feasibility Study).
3. Student Exit Survey. Each graduating senior completes an Exit Survey during the last week of classes during his final semester in full-time residency. Two questions on the survey were assessed in regards to the students' perceived ability to work effectively in multi-disciplinary teams.
4. Alumni Surveys. The responses of recent alumni to our survey are analyzed.

Table 4-4. Assessment Results of Outcome d (Graduates of the SD Mines mining engineering program will have the ability to function on multi-disciplinary teams).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students pass required courses with at least minimum acceptable grade.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Students work as a survey team to develop a satisfactory final survey project.	201	70% or better[1]	100% achieve 70% or better (13.25/15 avg. based on spring semester).	85% achieve 70% or better (one semester students scored poorly overall on this assignment).	100% achieve 70% or better (13/15 avg).	90.62/100 avg; 100% of teams attained a 70% or better
	Students are able to perform project management as a design team. Or, students work together as a multi-disciplinary team to develop a satisfactory mine design final project.	464	70% or better[1]	3.5/4.0 avg. 91% (12/13) achieved.	100% achieved 70% or better	3.76/4.0 avg; 100% achieved 70% or better.	3.84/4.0 avg;16/17 achieved the teaming.

Table 4-4. Outcome d, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	**2014-15**	**2013-14**	**2012-13**
Student Exit Survey	I have learned to work with others on group projects.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.3600/5[2] (91.00%)	1.4706/5[2] (88.23%)	1.1250/5[2] (96.88%)	
	I am comfortable dealing with others whose training and expertise are different from my own.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.2400/5[2] (94.00%)	1.2941/5[2] (92.65%)	1.1875/5[2] (95.31%)	
Survey of 2008 – 10 Alumni taken in 2015 (24 respondents)	Answer to the Survey Question: "How well do you feel you rate on these attributes.....(5) *Skills needed for effective teamwork*"			24 responses: 2.1250/5.0[3] (71.88%)			

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree; 2 = 75% agree; 3 = 50% agree; 4 = 25% agree; 5 = 0% agree

[3] Meaning of the ratings: 1.0 = Excellent; 5.0 = Poor: (1.0 = 100% agree; 5.0 = 100% disagree; 2.5 = 50/50)

Level Of Achievement of Outcome *d*

Two courses—MEM 201 and MEM 464—were used to assess whether or not the students were able to work effectively on teams. According to the course-based assessments between 85 and 100% of the students in the groups attained this outcome, which was consistently above the 70% minimum level of achievement for the teaming.

The two questions on the exit survey dealing with teaming were consistently answered affirmatively (88 – 97% agreed). Additionally, the 24 alumni who responded to the question of whether or not they have developed the skills necessary for effective teamwork responded positively at the 72% level.

Therefore, as evidenced by the results of the coursework assessments, the Student Exit Surveys and the Alumni Surveys, graduates of the mining engineering program have achieved the ability to work effectively on teams.

A point of note was evident in the comments section of many of the Student Exit Surveys: the students enjoyed the teaming experience and learned much from the interaction. However, all students who were teamed with an "underachiever" (i.e., someone who did not pull his/her weight) demanded a method of student-student evaluation. They were extremely disappointed in the grading process when these "underachievers" were allowed to pass the course based upon other grades in other assignments in the course. or based upon the work of the other team members. **An effective method of student-student evaluation, which also needs to be incorporated into the grade for the course, needs to be developed. This work is in progress by the newly-hired Associate Professor who was given responsibility for the capstone design course.**

Graduates of the SD Mines mining engineering program will have

e) an ability to identify, formulate, and solve engineering problems

Implementation Strategies for Outcome *e*

Three strategies were implemented to ensure that students demonstrated the ability to identify, formulate and solve engineering problems, as required by Outcome ***e***.

1. Assignment of Engineering Problems. Students are required to identify, formulate and solve engineering problems throughout their curriculum. Practical engineering homework problems are assigned in almost all levels of courses, both required and elective. The required mining engineering courses in which significant engineering problems are assigned include, but are not limited to, the following:

    - MEM 201 (Surveying for Mineral Engineers)
    - MEM 202 (Materials Handling and Transportation)
    - MEM 301 (Computer Applications in Mining)
    - MEM 304 (Theoretical and Applied Rock Mechanics)
    - MEM 305 (Introduction to Explosives Engineering)
    - MEM 401 (Theoretical and Applied Mine Ventilation)

2. Assignment of Open-ended Laboratory Projects. Open-ended laboratory projects that involve the solution of engineering problems occur in these required mining engineering courses:

   - MEM 201 (Surveying for Mineral Engineers/Lab)
   - MEM 202 (Materials Handling and Transportation/Lab)
   - MEM 301 (Computer Applications in Mining/Lab)
   - MEM 304 (Theoretical and Applied Rock Mechanics/Lab)
   - MEM 401 (Theoretical and Applied Mine Ventilation/Lab)

3. Senior Design Project. All Mining Engineering students are required to complete a senior-level capstone design project course (MEM 464—Mine Design and Feasibility Study), which results in the successful design of an entire mining project. The faculty closely supervises all activities of the final design project.

Assessment Plan for Outcome *e*

Three assessment methods were chosen to assess the ability of engineering students with respect to Outcome ***e***:

1. Graduation Transcript Audit. A graduation evaluation and audit is performed by the student's advisor during the last semester prior to his graduation to ensure that the student has taken the required courses that include the ability to identify, formulate and solve engineering problems.
2. Course-Based Assessment. We evaluated student performance in MEM 201 (Surveying for Mineral Engineers), MEM 202 (Materials Handling and Transportation), MEM 301 (Computer Applications in Mining), MEM 304 (Theoretical and Applied Rock Mechanics), and MEM 305 (Introduction to Explosives Engineering) for this outcome.
3. Student Exit Survey. Each graduating senior completes an Exit Survey during the last week of classes during his final semester in full-time residency.

Table 4-5. Assessment Results of Outcome e (Graduates of the SD Mines mining engineering program will have the ability to identify, formulate, and solve engineering problems).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students pass required engineering courses, including senior capstone design.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Students are able to make the required final map from survey data.	201	70% or better[1]	100% achieve 70% or better (51.5/60 avg.).	100% achieve 70% or better (58.9/60 avg)	92% achieved 70% or better (51.8/60 avg)	90.62/100 avg; 100% of teams attained a 70% or better
	Students can select proper mining equipment based upon given information.	202	70% or better[1]	3.7/4.0; 20/23 (87%) achieved	2.85/4.00; 15/21 achieved	2.97/4.00; 20/26 achieved	3.42/4.00; 22/27 achieved
	Students are able to use professional mining software to generate a 3-D digital model from field or map data.	301	70% or better[1]	91% achieve 70% or better (13/15 avg).	95.6% achieve 70% or better	95.6% achieve 70% or better	
	Students are able to perform the stability analysis of surface or underground engineering structure to be constructed in rock.	304	70% or better[1]	92.5% avg. 37/38 (97.4%) achieved	89.7% avg. 35/39 (89.7%) achieved	100% avg. 20/20 (100%) achieved	100% avg. 26/26 (100%) achieved

Table 4-5. Outcome e, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	**2014-15**	**2013-14**	**2012-13**
	Students can do a powder factor blast design.	305	70% or better[1]	16.5/20 avg; 100% achieved 70% or better.	46.6/50 avg; 96.8% attained a 70% or better.	16.42/20 avg; 89.5% attained a 70% or better.	18.73/20 avg; 100% achieved a 70% or better.
Student Exit Survey	I have learned to identify, formulate and solve engineering problems.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.4800/5[2] (88.00%)	1.2941/5[2] (92.65%)	1.2500/5[2] (93.75%)	

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree; 2 = 75% agree; 3 = 50% agree; 4 = 25% agree; 5 = 0% agree

Level Of Achievement of Outcome *e*

Based upon the metrics chosen to assess achievement of Outcome ***e***, it is evident that the students have gained the ability to identify, formulate, and solve engineering problems by the time they graduate. Therefore, no additional actions are recommended at this time with regards to Outcome ***e***.

Graduates of the SD Mines mining engineering program will have

f) an understanding of professional and ethical responsibility

Implementation Strategies for Outcome *f*

Two strategies were implemented to ensure that Mining Engineering graduates have an awareness of the professional and ethical responsibilities.

1. Faculty will discuss awareness of the professional and ethical responsibilities in engineering in selected required courses, for example:
    - MEM 203 (Introduction to Mine Health and Safety). The ethics of proper safety training and reporting is discussed. Along with this, the potential penalties for misreporting or falsifying reports is discussed.
    - MEM 405 (Mine Permitting and Reclamation). Students are introduced to ethical and professional standards for mine permitting and mineland reclamation.
    - MEM 464 (Mine Design and Feasibility Study). Students incorporate professional ethical standards into the capstone mine design.
2. Students are required to discuss a case study on ethics and submit a written paper as part of MEM 120 (Introduction to Mining, Sustainable Development and Introductory Management) or MEM 466 (Mine Management).

Assessment Plan for Outcome *f*

Two assessment methods were chosen to assess the level to which our graduates are aware of professional and ethical responsibilities, as reflected in Outcome ***f***:

1. Course-based Assessment. We evaluated student performance in MEM 120 (Introduction to Mining, Sustainable Development and Introductory Management) in which students write a short paper on professional and ethical responsibilities of engineers or on a political/ethical situation affecting mining (or MEM 466—Mine Management).
2. Student Exit Survey. Students were surveyed at the end of their senior year.

Table 4-6. Assessment Results of Outcome f (Graduates of the SD Mines mining engineering program will have an awareness of professional and ethical responsibilities).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students pass required courses with at least minimum acceptable grade.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Case study on ethics	120 or 466	70% or better[1]	Avg 12.9/15 27/27 Achieved 70% or better (466)		Avg 14/15 41/42 achieved 70% or better (120)	
Student Exit Survey	I understand my professional and ethical responsibilities as an engineer.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.2000/5[2] (95.00%)	1.2353/5[2] (94.12%)	1.0000/5[2] (100%)	

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree; 2 = 75% agree; 3 = 50% agree; 4 = 25% agree; 5 = 0% agree

Level Of Achievement of Outcome *f*

Based upon the metrics chosen to assess achievement of Outcome ***f***, it is evident that the students have an awareness of professional and ethical responsibilities. Therefore, no additional actions are recommended at this time with regards to Outcome ***f***.

Graduates of the SD Mines mining engineering program will have

g) an ability to communicate effectively

Implementation Strategies for Outcome *g*

Three strategies were implemented to ensure that students demonstrated the ability to present technical information clearly in both oral and written formats, as required by Outcome ***g***.

1. Completion of Written Reports. Students write and submit formal reports in a number of required Mining Engineering courses, such as:
   - MEM 405 (Mine Permitting and Reclamation)—Numerous short topical reports as well as a formal final report on a topic of the student's choosing (with in very specific topic guidelines) are required in this course.
   - MEM 466 (Mine Management)—Numerous (3 to 5) short topic reports on management-related subjects are required in this course.
2. Completion of Oral Reports. In addition to the final written reports, students are frequently required to give oral presentations of the final projects for Strategy #1 above. MS PowerPoint is utilized for these presentations.
3. Senior Design Presentation. Senior students in MEM 464 are required write a detailed feasibility study on a mining project for the capstone senior design course. At the end of the semester they are required to formally present the results of their capstone design project to the Mining Engineering faculty, the Mining Engineering student body, and any other invited guests. They must defend their design project during a question and answer session at the conclusion of the oral presentation. Evaluation sheets are distributed to the audience and the oral presentations are evaluated by the faculty and the groups' peers.

Assessment Plan for Outcome *g*

Five assessment methods were chosen to assess the ability of engineering students with respect to Outcome ***g***:

1. Graduate Transcript Audit. A graduation evaluation and audit is performed by the student's advisor during the last semester prior to his graduation to ensure that the student has taken the required courses that include the ability to present technical information clearly in both oral and written forms.
2. Course-based Assessment. We evaluated student performance in three courses, MEM 405 (Mine Permitting and Reclamation), MEM 464 (Mine Design), and MEM 466 (Mine Management).
3. Student Exit Survey. Each graduating senior completes an Exit Survey during the last week of classes during his final semester in full-time residency. The questions on the exit

survey were analyzed to determine the students' perception of their ability to present technical information clearly in both oral and written formats at the time of graduation.

4. Alumni Surveys. The responses of recent alumni to our survey are analyzed.
5. Evaluation of the Senior Design Project. Each student's final senior design project is evaluated by the course instructor with input from the other faculty. The project is evaluated for design content and feasibility. An oral presentation of the project is required to be made to the student's peers and the Mining Engineering faculty.

Table 4-7. Assessment results of Outcome g (Graduates of the SD Mines mining engineering program will have the ability to communicate effectively).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students pass required courses with at least minimum acceptable grade.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Students write a final research paper according to specific guidelines.	405	70% or better[1]	Avg 8.6/10 31/31 achieved 70% or better	Avg 40/50 18/19 achieved 70% or better	34.67/40 avg; 90% achieved 70% or better	34.83/40 avg 26/29 achieved 70% or better.
	Students are able to deliver a written final design feasibility report in printed and/or electronic format.	464	70% or better[1]	100% achieved 70% or better.	100% achieved 70% or better.	3.7/4.0 avg; 17/17 achieved 70% or better.	3.84/4.0 avg;16/17 achieved 70% or better.
	Student teams are able to deliver a final design presentation in front of an audience.	464	70% or better[1]	100% achieved 70% or better.	100% achieved 70% or better.	4.0/4.0 avg; 17/17 achieved 70% or better.	3.84/4.0 avg; 17/17 achieved 70% or better.

Table 4-7. Outcome g, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Course-Based Assessments	Presentation or exercise on Vision, Mission and/or Objectives of company of choice.	466	70% or better[1]	Avg 13.5/15 27/27 achieved 70% or better	Avg 12.5/15 19/21 Achieved 70% or better		
Student Exit Survey	I am comfortable speaking in front of a group of my peers.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.2800/5[2] (93.00%)	1.5294/5[2] (86.76%)	1.6250/5[2] (84.37%)	
	I have learned to make effective presentations to peers.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.3600/5[2] (91.00%)	1.5882/5[2] (85.30%)	1.5000/5[2] (87.50%)	
	I have learned to communicate effectively in writing.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.5833/5[2] (85.42%)	1.7647/5[2] (80.88%)	1.6250/5[2] (84.38%)	

Table 4-7. Outcome g, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	**2014-15**	**2013-14**	**2012-13**
Evaluation of Senior Design Project	Presentation of senior design project is rated on content, organization, clarity and speaker's ability to answer questions.		Review of faculty/student evaluation sheets and notes	Fall 2015: 3.5/4.0 avg. 100% (13/13) attained	Fall 2014: 3.0/4.0 avg. 100% attained	F2013: 3.7/4.0 avg. 100% attained	F2012: 3.75/4.0 avg. 100% attained
Survey of 2008 – 10 Alumni taken in 2015 (24 respondents)	Answer to the Survey Question: "How well do you feel you rate on these attributes.....(4) *Ability to present ideas and information in **written** and **oral** form*"			24 responses: 2.0833/5.0[3] (72.92%)			

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree; 2 = 75% agree; 3 = 50% agree; 4 = 25% agree; 5 = 0% agree

[3] Meaning of the ratings: 1.0 = Excellent; 5.0 = Poor: (1.0 = 100% agree; 5.0 = 100% disagree; 3.0 = 50/50)

Level Of Achievement of Outcome *g*

It is interesting to note that most of the students do attain this outcome as evidenced by the coursework assessments; however, the perception via the Student Exit Survey of their achievement of this outcome differs quite significantly from the Alumnus' perception. Only about 73% of the alumni respondents felt they had achieved the a*bility to present ideas and information in **written** and **oral** form*, whereas approximately 80 - 93% of the graduating Mining Engineering seniors believed they had achieved it. **The recommendation for this outcome is to continue the current process and obtain additional insight from the alumni and employers.**

Graduates of the SD Mines mining engineering program will have

h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

Implementation Strategies for Outcome *h*

The impact of engineering solutions on global and societal issues is first introduced to our students in MEM 120 (Introduction to Mining and Sustainable Development). This concept is also discussed in several other required Mining Engineering courses: MEM 302 (Mineral Economics and Finance), MEM 466 (Mine Management), MEM 405 (Mine Permitting and Reclamation), and MEM 464 (Mine Design and Feasibility Study).

Our General Education program [see ***CRITERION 5. CURRICULUM, part A, (General Education***)] requires at least 21 credits of courses outside of mathematics, sciences, and engineering (Additional courses not included as General Education in Table 5-1 but which are "General Education" in nature include Econ 201/202 and MEM 446 [formerly HRM 417]). Within this General Education requirement, the South Dakota Board of Regents has established seven General Education Goals which must be satisfied within the first sixty-four (64) credits. Specific Goals pertinent to this outcome include:

- **Goal #3:** Students will understand the organization, potential, and diversity of the human community through the study of social sciences.
- **Goal #4:** Students will understand the diversity and complexity of the human experience through the study of arts and humanities.

Additionally, 15 credits of courses categorized as "Other" in Table 5-1 are taken by students majoring in Mining Engineering; as well as 20 credits of what we consider management-related courses.

Assessment Plan for Outcome *h*

Four assessment methods are used to assess the awareness among our graduates of the impact of engineering solutions in a global and societal context in conformance with Outcome ***h***.

1. Graduation Transcript Audit. A transcript audit is performed by the student's advisor during the last semester prior to his graduation to ensure that the student has taken the required courses that promote awareness of the impact of engineering solutions in a global and societal context. Enrollment Management conducts an audit of each graduating senior to verity the completing of the General Education requirements.

2. Course-based Assessment. We evaluated student performance in MEM 120 (Introduction to Mining and Sustainable Development), the course in which students are first exposed to this topic, and two more advanced courses: MEM 302 (Mineral Economics and Finance) and MEM 466 (Mine Management).
3. Student Exit Survey. Each graduating senior completes an Exit Survey during the last week of classes during his final semester in full-time residency.
4. Alumni Surveys. The responses of recent alumni to our survey are analyzed.

Table 4-8. Assessment Results of Outcome h (Graduates of the SD Mines mining engineering program will have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students pass required courses with at least minimum acceptable grade.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Students will do a case study on societal issues (Sustainable Development) as related to mining operations in a foreign country.	120	70% or better[1]	Avg 27.3/35 20/22 Achieved 70% or better	Avg 22.5/25 23/33 Achieved 70% or better	Avg 21.3/25 40/42 achieved a 70% or better	
	Assessment of mineral economics final project.	302	70% or better[1]	83% of the term projects achieved 70% or better	77% attained a grade of 70% or better	28.04/40 avg; 19/39 achieved a 70% or better.	49.9/70 avg; 19/31 achieved a 70% or better

Table 4-8. Outcome *h*, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Course-Based Assessments	Students will complete a study of at least one overseas company in the mining industry and write a review of their mission & vision statement.	466	70% or better[1]	Avg 13.3/15 27/27 achieved 70% or better	Avg 12.9/15 22/21 achieved 70% or better	Not Assigned	
Student Exit Survey	I have gained an awareness of the impact of engineering activities in a global and societal context.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.4000/5[2] (90.00%)	1.5294/5[2] (86.77%)	1.5625/5[2] (85.94%)	
Survey of 2008 – 10 Alumni taken in 2015 (24 respondents)	Answer to the Survey Question: "How well do you feel you rate on these attributes.....(8) *Awareness of the interaction, both positive and negative, between societal issues and the mining industry*"		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	24 responses: 2.5417/5[3] (61.46%)			

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree; 2 = 75% agree; 3 = 50% agree; 4 = 25% agree; 5 = 0% agree

[3] Meaning of the ratings: 1.0 = Excellent; 5.0 = Poor: (1.0 = 100% agree; 5.0 = 100% disagree; 3.0 = 50/50)

Level Of Achievement of Outcome *h*

With regards to the course-based assessments, all students achieved an *awareness of the impact of engineering solutions in a global and societal context*. Most (86 to 90%) of the graduating seniors also felt they achieved this outcome per results of the exit Surveys. However, only about 61% of the alumni who responded to the Alumni Survey believed they had achieved this outcome. **More work towards introducing the students to the impact of engineering solutions to society is warranted.**

Graduates of the SD Mines mining engineering program will have

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

Implementation Strategies for Outcome *i*

Three strategies were implemented to ensure that the graduating students acquire the ability to engage in life-long learning in their field. They include:

1. Students complete the Mining Engineering curriculum, which provides them with a broad background in engineering upon which to build in order to engage in life-long learning in their field. The curriculum includes:
    - Required lower division core courses in mathematics, physics, chemistry and other basic sciences totaling 35 credits.
    - Required and elective upper division mining engineering (and allied engineering fields) and management-related courses comprising a minimum of 65 units of upper division lecture and laboratory courses.
2. Students learn to conduct research and to work independently through open-ended laboratory projects in several courses, including:
    - MEM 304 (Theoretical and Applied Rock Mechanics), which is a required course for determining the basic physical and mechanical properties of rocks using experimentation and instrumentation.
    - MEM 464 (Mine Design and Feasibility Study), the capstone senior design project is an open-ended mine design project of either an underground mine or a surface mine.
3. Students are strongly encouraged to become active in student professional societies (the D&C Club of the SME and the ISEE student club) and to attend the professional society meetings.

Assessment Plan for Outcome *i*

Five assessment methods were chosen to assess the ability of engineering students with respect to Outcome ***i***. They include:

1. Graduate Transcript Audit. A transcript audit is performed by the student's advisor during the last semester prior to his graduation to ensure that the student has taken the required courses that demonstrate an ability to engage in life-long learning.

2. Course-based Assessment. We evaluated student performance in two required courses that require students to research important issues in their field (MEM 405—Mine Permitting and Reclamation and MEM 466—Mine Management).
3. Participation in Society Meetings. Students are given the opportunity many times during their tenure at SD Mines to attend, and participate in, local, regional and national professional society meetings.
4. Student Exit Survey. Each graduating senior completes an Exit Survey during the last week of classes during his final semester in full-time residency to assess the students' belief that they have the ability to engage in life-long learning in their field.
5. Alumni Surveys. The responses of recent alumni to our survey are analyzed.

Table 4-9. Assessment Results of Outcome i (Graduates of the SD Mines mining engineering program will have a recognition of the need for, and ability to engage in life-long learning).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students pass required courses with at least minimum acceptable grade.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Evaluation of final term paper on major mining environmental issue.	405	70% or better[1]	Avg. 34.4/40 31/31 achieved 70% or better	Avg. 40/50 18/19 achieved 70% or better	34.34/40 avg; 83.33% achieved 70% or better.	34.83/40 avg. 26/29 achieved 70% or better.
	Evaluation of quizzes relating to guest speaker topics on career paths.	466	70% or better[1]	Avg. 6.7/8 23/27 Achieved 70% or better	Avg. 8.6/10 15/21 achieved 70% or better	Not Assigned	

Table 4-9. Outcome i, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	**2014-15**	**2013-14**	**2012-13**
Evaluation of Participation in Student Professional Organizations	Students participate in student chapter of SME and/or ISEE.			Attended ISEE national (14), SME national (25), BITW* (11) in 15-16.	Attended ISEE national (17), SME national (33), BITW* (19) in 14-15.	Attended ISEE national (15), SME national (36), BITW* (22) in 13-14.	Attended ISEE national (19), SME national (31), BITW* (25) in 12-13.
Student Exit Survey	I am aware that I will need to continue learning new information and methods in my professional career.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.1200/5[2] (97.00%)	1.2353/5[2] (94.12%)	1.0625/5[2] (98.44%)	
Survey of 2008 – 10 Alumni taken in 2015 (24 respondents)	Answer to the Survey Question: "How well do you feel you rate on these attributes.....(7) *Keeping up with new advances and other technical information in your field*"			24 responses: 2.2083/5[3] (69.79%)			

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree; 2 = 75% agree; 3 = 50% agree; 4 = 25% agree; 5 = 0% agree

[3] Meaning of the ratings: 1.0 = Excellent; 5.0 = Poor: (1.0 = 100% agree; 5.0 = 100% disagree; 3.0 = 50/50)

* BITW = Best in the West Drill and Blast Conference

Level Of Achievement of Outcome *i*

According to survey results, approximately 70% of alumni believe they have achieved Outcome ***i*** since they graduated. However, over 90% of the graduating seniors in Mining Engineering believe they have achieved this outcome by the time of graduation.

According to the metrics used for measuring this outcome, it appears that the Mining Engineering graduates have achieved this outcome, so no further action is required at this time.

There appears to be a disjoint with Outcomes *h* and *i* that occurs after graduation.

Graduates of the SD Mines mining engineering program will have

j) a knowledge of contemporary issues

Implementation Strategies for Outcome *j*

Three strategies were implemented to ensure that graduates of the Mining Engineering program will have an adequate awareness of contemporary issues and their relationship to mining engineering.

1. Students obtain an education in contemporary issues through the General Education Core curriculum.

   Our General Education program (Table 5-1) requires 21 credits (Gen Ed) plus 14 (Other) of course work outside of mathematics, sciences, and engineering (NOTE: The 1 credit of PE is not included). Within this General Education requirement, the South Dakota Board of Regents has established seven General Education Goals which must be satisfied within the first sixty-four (64) credits. Specific Goals pertinent to this outcome include:

   - **Goal #3:** Students will understand the organization, potential, and diversity of the human community through the study of social sciences.
   - **Goal #4:** Students will understand the diversity and complexity of the human experience through the study of arts and humanities.

2. Faculty will discuss contemporary issues and their relationship to mining engineering in selected courses, such as MEM 120 (Introduction to Mining, Management and Sustainable Development), MEM 302 (Mineral Economics and Finance), MEM 405 (Mine Permitting and Reclamation), and MEM 466 (Mine Management).
3. Students are strongly encouraged to become active in student professional societies (the D&C Club of the SME and the ISEE student club) and to attend the professional society meetings.

Assessment Plan for Outcome *j*

Three assessment methods were chosen to assess the level to which our graduates are aware of contemporary issues and their relationship to engineering, as reflected in Outcome ***j***:

1. Graduate Transcript Audit. A transcript audit is performed by the student's advisor during the last semester prior to his graduation to ensure that the student has taken the required courses that demonstrate an awareness of contemporary issues and their relationship to the

mining industry. Also, Enrollment Management conducts an audit of each graduating senior to verity the completing of the General Education requirements.

2. Course-based Assessment. We evaluated student performance in MEM 120 (Introduction to Mining and Sustainable Development) and MEM 405 (Mine Permitting and Reclamation).
3. Student Exit Survey. Each graduating senior completes an Exit Survey during the last week of classes during his final semester in full-time residency. One question on the Senior Exit Survey addressed the students' perception of how aware they believe they are of contemporary issues and their relationship to mining engineering.

Table 4-10. Assessment Results of Outcome j (Graduates of the SD Mines mining engineering program will have a knowledge of contemporary issues).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students have the broad background in the humanities and social sciences necessary to understand contemporary issues and their relation to mining engineering.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Evaluation of report on sustainability.	120	70% or better[1]	Avg. 27.3/35 20/22 Achieved 70% or better	Avg. 22.5/25 23/33 Achieved 70% or better	Avg. 21.3/25 40/42 Achieved 70% or better	
	Evaluation of report on mining reclamation or pertinent environmental issue.	405	70% or better[1]	Avg. 41.4/50 31/31 achieved 70% or better	Avg. 36.6/50 13/19 achieved 70% or better	34.67/40 avg; 90% achieved 70% or better	34.83/40 avg. 26/29 achieved 70% or better.

Table 4-10. Outcome j, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Student Exit Survey	I have gained an awareness of how some contemporary issues are related to engineering.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.5200/5[2] (87.00%)	1.6471/5[2] (83.82%)	1.4375/5[2] (89.06%)	

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree
2 = 75% agree
3 = 50% agree
4 = 25% agree
5 = 0% agree

Level Of Achievement of Outcome *j*

Based upon the metrics chosen to assess achievement of Outcome ***j***, it is evident that, on the whole, the students have gained an awareness of contemporary issues and their relationship to mining engineering. Therefore, no additional actions are recommended at this time with regards to Outcome ***j***.

Graduates of the SD Mines mining engineering program will have

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

Implementation Strategies for Outcome *k*

Two strategies were implemented to ensure that the graduating students acquire the ability to use modern engineering tools, software, and instrumentation through hands-on experience relevant to their field of specialty.

1. Students are required to use modern engineering software and tools in required and elective courses, including:

    - MEM 201 (Surveying for Mineral Engineers)
    - MEM 202 (Materials Handling and Transportation)
    - MEM 204 (Surface Mining Methods and Unit Operations)
    - MEM 301 (Computer Applications in Mining)
    - MEM 303 (Underground Mining Methods and Equipment)
    - MEM 305 (Introduction to Explosives Engineering)
    - MEM 307 (Mineral Exploration and Geostatistics)
    - MEM 302 (Mineral Economics and Finance)
    - MEM 464 (Mine Design and Feasibility Study)

2. Students are required to obtain hands-on experience with instrumentation in required and elective laboratory courses, including the following:

    - MEM 304 (Theoretical and Applied Rock Mechanics)
    - MEM 401 (Theoretical and Applied Ventilation Engineering)

Assessment Plan for Outcome *k*

Four assessment methods were chosen to assess the ability of engineering students with respect to Outcome ***k***:

1. Graduation Transcript Audit. A transcript audit is performed by the student's advisor during the last semester prior to his graduation to ensure that the student has taken the required courses that include the ability to use modern engineering tools, software, and instrumentation.

2. Course-based Assessment. We evaluated student performance in four required courses that require students to use modern engineering tools, software (MEM 201—Surveying for Mineral Engineers and MEM 301—Computer Applications in Mining) and instrumentation (MEM 304—Theoretical and Applied Rock Mechanics and MEM 401—Theoretical and Applied Ventilation Engineering).

3. Student Exit Survey. Each graduating senior completes an Exit Survey during the last week of classes during his final semester in full-time residency.
4. Alumni Surveys. The responses of recent alumni to our survey are analyzed.

Table 4-11. Assessment Results of Outcome k (Graduates of the SD Mines mining engineering program will have the ability to use techniques, skills, and modern engineering tools necessary for engineering practice).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	2014-15	2013-14	2012-13
Advising and Transcript Audit	Students pass required courses with at least minimum acceptable grade.		All courses passed satisfactorily.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.	Verified by student's advisor.
Course-Based Assessments	Students are able to use modern surveying instruments.	201	70% or better[1]	100% achieve 70% or better	92.3% achieve 70% or better	100% achieve 70% or better	3.125/4.0 avg; 31/32 achieved 70% or better.
	Students are able to use modern mining engineering professional software.	301	70% or better[1]	90.4% achieve 70% or better	100% achieve 70% or better	95.6% achieve 70% or better	
	Students are able to acquire test data using rock mechanics instruments and present the data & results in a final report.	304L	70% or better[1]	86.9% avg. 37/37 (100%) achieved.	93.6% avg. 39/39 (100%) achieved	77.8% avg. 26/34 (76.4%) achieved	72.7% avg. 23/31 (74.2%) achieved

Table 4-11. Outcome k, (cont).

Assessment Method	Performance Criteria	Course	Acceptance Criteria	Result			
				2015-16	**2014-15**	**2013-14**	**2012-13**
Course-Based Assessments (cont)	Students are able to use a laboratory ventilation trainer and associated instrumentation.	401	70% or better[1]	27/27 (100%) achieved.	19/20 (95%) achieved. 1 student couldn't complete the course	20/20 (100%) achieved.	20/20 (100%) achieved.
Student Exit Survey	I have learned to use computers to solve engineering problems.		Score of 1.0 – 2.0 out of 5.0, meaning at least 75% agree.	1.5600/5[2] (86.00%)	1.6471/5[2] (83.82%)	1.5625/5[2] (85.94%)	
Survey of 2008 – 10 Alumni taken in 2015 (24 respondents)	Answer to the Survey Question: "How well do you feel you rate on these attributes.....(6) *Ability to use pertinent computer (besides design software) and communications technology*"			24 responses: 2.125/5[3] (71.88%)			

[1] At least 70% of the students receive at least the minimum acceptable grade of "C" on the representative assignment.

[2] Meaning of the ratings: 1 = 100% agree; 2 = 75% agree; 3 = 50% agree; 4 = 25% agree; 5 = 0% agree

[3] Meaning of the ratings: 1.0 = Excellent; 5.0 = Poor: (1.0 = 100% agree; 5.0 = 100% disagree; 3.0 = 50/50)

Level Of Achievement of Outcome *k*

Based upon the metrics chosen to measure this outcome, it is clear that at the time of graduation, the students have achieved the ability to use modern engineering tools, software, and instrumentation through hands-on experience relevant to the field of mining engineering. Therefore, no additional action is required at this time.

SUMMARY LEVEL OF ACHIEVEMENT OF OUTCOMES *a – k*

In summary, our course-based, advising and transcript audit metrics indicate that the students are achieving all outcomes, with some minor issues within some of the course-based assessment tools. However, the students via the Student Exit Survey and the alumni via the Alumni Survey show some level of disagreement with the course-based assessments. **This needs to be followed up on. Does this mean that the students are not quite so confident they attained all objectives; does it also mean that the alumni feel they should have learned more and worked harder?**

The lessons learned from the course-based assessment tools and from the survey tools have been utilized to give insight where elements of the mining engineering program need strengthening. Indications are that "writing and speaking effectively," "contemporary issues," and "lifelong learning" are all areas that need to be further addressed. The last 2 points, "lifelong learning" and "contemporary issues" were raised by the alumni in surveys as they do not feel they are continuing these learning processes into their professional careers. More effort should be directed by the Department towards enhancing the School's professional conferencing/seminar footprint.

2. Improvements to the program since 2009 ABET General Review.

As detailed under the BACKGROUND INFORMATION section at the beginning of this Self Study, the PEV for the 2009 General Review found shortcomings (concerns) within the program in the general areas of 1) teaming; 2) design experience; 3) faculty number and competencies; and 4) institutional support.

Our assessments for the 2009 General Review, and additional assessments leading up to the 2016 General Review have resulted in recommendations, which have been implemented, to moderate or eliminate these concerns.

Besides the shortcomings (concerns) listed above in BACKGROUND INFORMATION, our own assessment of the data collected for the 2016 General Review found that the students needed additional work in the general areas of writing and presenting technical and/or project information.

Changes and improvements implemented in the period since the 2009 General Review are (NOTE: some were initiated prior to the 2009 General Review):

Curriculum Changes. In 2012, the mining engineering curriculum was changed to comply with the mandate from the SD BOR that all majors decrease the credit hour requirement for graduation to 120. The mining engineering program sought, and received, a variance to allow it to require 130 credit hours for graduation, thus lessening the impact of the

reduction on the overall curriculum. Figure 5-1 shows the mining engineering curriculum pre-2012; Figure 5-2 shows the changes to the curriculum which resulted from the mandate to decrease from 136 to 130 the credit hours for graduation.

In 2014, the MEM Department submitted a curriculum change to require three, instead of one, mining engineering or other engineering technical electives. The changes to the mining engineering curriculum which were implemented to free up six additional credits for the technical electives were:

1. Drop the four credit Language requirement. This resulted in the mining engineering program's Humanities and Social Sciences requirement coming into compliance with the minimum SD BOR requirement of six credits of Humanities and six credits of Social Sciences.
2. Eliminate the two credits of Free Elective and combine this two credits with the four credits freed up by dropping the Language requirement.

Additional Elective Courses have been developed and added to the mining engineering course list. At the time of the 2009 General Review, only 2 mining engineering courses were offered as electives: MEM 450/550—Rock Slope Engineering and MEM 433/533—Computer Applications in Geoscience Modeling. Only one of these courses, MEM 450/550, was regularly offered for mining engineering majors. The other one (MEM 433/533) was developed as a service course for Geological Engineering majors. The MEM courses developed as electives for mining engineering seniors and highly qualified juniors are (NOTE: In the dual 4XX/5XX numbering system, the 4XX-level courses are taken by undergraduates for undergraduate credit):

- MEM 410/510—Advanced Mineral Economics for Managers
- MEM 415/515—Advanced Mining Geotechnical Engineering
- MEM 420/520—Advanced Tunneling and Underground Excavation
- MEM 525/525—Advanced Rock Mechanics
- MEM 430/530—Resource Industry Mergers and Acquisitions
- MEM 435/535—Resource Industry Finance and Accounting
- MEM 440/540—Advanced Mine Ventilation and Environmental Engineering
- MEM 445/545—Advanced Geostatistics and Grade Estimation
- MEM 455/555—Rock Slope Engineering II
- MEM 480/580—Advanced Explosives and Blasting

The addition to the mining engineering program's curriculum of a second and third technical elective requirement, all three of which must be taken in the senior year, resulted in a miss-balance in the curriculum, year-to-year. So in order to mitigate that situation, courses were shuffled around, paying strict attention to pre-requisites (Figure 5-5), to obtain the balance shown in Figure 1-1.

Additional Faculty and Re-alignment of Advisors. Since the 2009 General ABET Review, 100 % of the faculty assigned to the program at that time have either moved on or retired. Dr. C. Kliche, who just retired in June 2016, was the last one who was involved with the 2009 General Review. As can be seen by referring to BACKGROUND INFORMATION, part G, under "***Actions Taken to Address Shortcomings from 2009 General Review***," which lists the current faculty and each one's hire date, none were

employed by SD Mines at the time of the 2009 General Review. This replacement of the "old guard" by the "new guard" allows for fresh thought and the introduction of a broad range of new ideas, techniques and courses into the program. Additionally, the expertise of each of the MEM instructional personnel provides a very wide scope of competency, thoroughly covering all aspects of the ABET Mining Engineering Program Criteria, as can be seen by perusing Figure 6-3.

As is discussed under ***CRITERION 6. FACULTY, part C***, prior to 2013 most of the undergraduate advising was done by Dr. Kliche. At the beginning of the 2014 – 2015 academic year, the undergraduate and graduate students within the MEM Department were re-assigned to new advisors. The students will stay with the assigned advisor until he/she graduates or leaves the department. This shift took a significant load off Dr. Kliche and allowed many of the newer MEM faculty to get involved in the advising process. Furthermore, by allowing the new faculty to become involved in the advising process, it thusly encouraged them to become more familiar with the program's curriculum; the pre-requisite structure and rules; career and internship advising; and the general rules of the institution for transfer credits, overloads, appeals and suspension, the WebAdvisor system, degree checks at graduation time, and the like.

MEM 464—Mine Design and Feasibility Study has been significantly re-structured to include almost exclusively real-world mine design projects supplied by the mining industry. Additionally, where possible, the industry sponsor will also provide company mentors and "consultants" as resources to the student participants. These projects are listed under ***CRITERION 5. CURRICULUM, PART a (6), (The Capstone Design Experience)***, and are available for the review in the resource room.

Teaming is an integral part of the capstone mine design experience.

Students from other majors are encouraged to participate in the MEM 464, with limited success. This area (participation by students from other majors) needs additional attention.

3. Re-assessment of results of improvements.

The improvements during the period leading up to the 2009 General Review involved mainly modifications and "fixes" to the initial MEM program, as designed by Dr. John Wilson in 2003. One major "fix" involved the realization that to keep the program title "Mining Engineering and Management" would result in seeking accreditation in Mining and Similarly Named Engineering Programs plus in Engineering Management and Similarly Named Engineering Programs. The program name was thus changed to "Mining Engineering" within the Mining Engineering and Management Department.

Additional relevant modifications and "fixes" to the original mining engineering curriculum during the period leading up to the 2009 General Review include:

- Language (usually met by a 4-credit course in Spanish or German) was added as a requirement for MEM students which fit in as a Humanities course within the 16 required credit hours of Hum/Social Sciences.

This Language requirement was dropped as part of the re-vamped mining engineering curriculum which was completed in 2014. This requirement, from the onset, was unpopular with the mining engineering student body.

- The addition of three management-related courses to the curriculum which were originally designed to be taught by the Black Hills State University's Business School (BADM 407—International Business; HRM 417—Human Resources Management; Econ 304—Managerial Economics).

  Since our students had much difficulty getting into the Black Hills State University (BHSU) classes for any one of a number of reasons, the MEM Department decided to develop these courses itself as MEM courses. Dr. Ivy Allard, formerly of the BHSU School of Business, was hired and given this task. The courses show up in the new MEM curriculum as: MEM 476—International Business for Mining Engineers; MEM 446—Human Resource Management for Mining Engineers; MEM 376—Managerial Finance for Mining Engineers.

- Thermodynamics was originally slated to be taught as a module within the mine ventilation course. This proved not to be optimum as it was soon found that it would not be given sufficient emphasis in the ventilation class due to the amount of mine ventilation material that needed to be covered. ATM 404 (later changed to AES 404)—Atmospheric Thermodynamics (for Mining), was added to the mining engineering curriculum in 2009. The atmospheric sciences group, who teach this course as part of their meteorology curriculum, modified the course for mining engineering by offering a 2 credit option. This course, normally taken the semester before the mine ventilation class, provides the needed background theory for mine ventilation.
- Mineralogy and petrology have been quite a challenge. Originally, Mineralogy was taught by the geology group as a separate 2 credit course and petrology was taught as a 3 credit course. In 2009, the Geology program was convinced to offer a modified version of Minerology as a 1 credit course for mining students (Geol 214L—Mineralogy for Mining Engineers.

  In 2010, due to faculty/expertise shortage and with the blessing of the mining engineering faculty, the Geology program combined the Geol 214L (1 cr) and the Geol 341/341L (3 cr) into a new 4 credit Mineralogy and Petrology course, Geol 314/314L (4 cr). In 2015, the MEM department took over the Geol 314/314L class, re-named and re-numbered it, and modified it for mining students. The result is MEM 314 (Mineralogy and Petrology for Mining), taught by Dr. Kelli McCormick, who has a strong background in geology.

  This course and its instructor have been assessed once via the IDEA student opinion survey instrument since its switch to the mining program's suite. Results of these surveys indicate initial dissatisfaction with the course and the instructor, due mainly to the newness of both. The second assessment results (Spring 2016) are not in as of this writing.

4. Significant future program improvement plans.

As discussed under ***CRITERION 1. STUDENTS, part D (Advising and Career Guidance),*** the MEM Department has implemented the Student Satisfaction Inventory survey (SSI) to attempt to identify areas of improvement for our strategic planning process. The initial survey was conducted in the Spring of 2015, and pertinent results are tabulated in Tables 1-6 and 1-7.

As stated previously, the SSI survey compares the student's level of importance of a particular item with their level of satisfaction. A "gap number" measures the difference between the importance and satisfaction. A negative gap number indicates that the student is actually more satisfied with the item than it is important to them. Referring back to Tables 1-6 and 1-7 which show some of the more important (to MEM) questions and the measured "gap" between the students perception of the statement's importance and his/her satisfaction, the following action strategy that provides for a continuous improvement plan was developed. It should be noted that individual faculty also develop continuous improvement plans for their respective courses; however, those items were not specifically included in this document but are a critical component of the ABET Self-Study. Note: the numbered bullets below refer to the hi-lighted Question Numbers in Table 1-6.

Academic Advising

1. *My academic advisor helps me set goals to work toward.*

The MEM Department has tried a couple of different strategies with respect to academic advising. The current strategy is to assign a student to a single academic advisor after the student's freshman or first year at SD Mines (Dr. Roberts is the advisor for all incoming freshman and transfer students). This will allow the faculty to work with a student for the course of their academic careers and thereby, establish an approach for the student to graduate in the shortest amount of time possible while still achieving a solid education.

2. *My academic advisor is knowledgeable about requirements in my major.*

Academic advising can be challenging, especially in the case where several curriculum programs are in place. This is the case for the MEM Department where students are on one of two curriculum programs. Minor changes to the curriculum, obviously completed to improve the curriculum, can actually exacerbate the challenge with advising and keeping all of the programs straight. To that end, it is proposed that the department hold a series of advising "seminars" throughout the course of the academic year. The purpose of these seminars would be to share advising experiences, report both challenges and successes, and address questions with the curriculum to improve the academic advising process.

Concern for the Individual

3. *This institution shows concern for students as individuals.*

The faculty within MEM strive to connect with the students and provide a sense of belonging within the department. Many of the faculty employ an "open-door" policy whereby students can meet with the faculty for course assistance, advising, or other discussion at nearly any time of the day. The department holds various professional and social functions throughout the course of the academic year that bring MEM students and

faculty together for food, discussion, and continuing education. Through early warning systems implemented campus-wide (such as Starfish), department faculty can identify students who may be struggling mentally or emotionally and can recommend various campus services to these students (i.e., counseling, campus ministries, supplemental instruction, etc.). The department will continue these practices and will work closely with student organizations such as SME and ISEE to identify other ways the department can contribute to a meaningful college experience for the students.

Instructional Effectiveness

4. *Faculty provide timely feedback about student progress in a course.*

   There is no policy that dictates how quickly a faculty member should return graded homework, exams, reports, etc. Some "rules-of-thumb" do exist which provide very general guidelines, but even these can vary significantly from department to department. In the past, some of the challenges within the department were that faculty members were often teaching three or four courses per semester with little or no teaching assistant support. The high workload often made it difficult to grade and return homework and such in a timely manner. Today, faculty teaching loads tend to be lower and the department has additional teaching assistant support. Overall, it is hoped that this will lead to improving the rate at which students receive feedback in their courses. However, the department faculty will also strive to improve feedback rates during this academic year and ensure that students are aware of their progress in a course.

5. *The quality of instruction I receive in most of my classes is excellent.*

   It is obviously the desire of the department faculty to provide the highest quality of instruction in the department courses. Every semester, the students complete a survey for each course that rates both the quality of the course and the instructor. The results of these surveys are used by the faculty to make changes to the course (the survey contains several questions, but also allows for written comments). Survey results are also used as a tool for promotion and tenure. To that end, the faculty are continually looking to improve instruction quality. Workshops and seminars offered both on-campus and on-line that focus on classroom instruction techniques are available for faculty to attend, along with numerous external training opportunities. The department will continue to use survey course results to improve instruction and will encourage faculty to attend seminars as possible.

6. *There is a good variety of courses provided on this campus.*

   ABET requirements dictate the subject areas that students must be exposed to before they are to be awarded an undergraduate engineering degree. These requirements set the basic curriculum for the department and occupy a significant amount of the credit hours for the BS degree in Mining Engineering. However, the department has added several new technical elective courses over the past academic year and will offer these courses on a consistent, rotating schedule. This should increase the variety and selection of courses within the department. The department will continue to refine these offerings and may increase the offerings as new faculty are added.

7. *Graduate teaching assistants are competent as classroom instructors.*

In general, the department does not use graduate teaching assistants (TAs) as classroom instructors, but rather as aides in the various laboratory sections or as graders. To the best of the department's ability, the expertise or background of a TA is closely matched to the laboratory course. Obviously this is not always possible, especially as new graduate students are accepted into the program whose previous academic record is unknown. The department will strive to ensure that TAs are best aligned for the courses they will assist with.

Additional Future Program Improvement Plans. A brief summary of additional identified program improvement plans include:

- The remodeling of the Mineral Industries Building, resulting in better utilization of the space for laboratories, classrooms, research, and offices. The renovation will also permit closer collaboration between the three mineral industries departments: mining engineering, geology/geological engineering, and metallurgical engineering. Although the university Foundation is currently raising the funds to complete the renovation (approximately $17 million), the university is also looking at ways to partner with the United States Geological Survey (USGS) to create new building space that would complement the renovation and provide significant research and learning opportunities for the students.
- The addition of new mining electives in the areas of mine planning and scheduling, mine optimization, mineral economics and finance, rock mechanics, and mine management to give students more choices and to allow them to develop either a broad or more specialized focus of interest through the electives.
- The replacement of the computers in the Maptek Mine Design computer laboratory. The computers have been upgraded within the last three years, but will need to be replaced within three additional years. The department is exploring the option of using the cloud to increase the computing capability and improve the design experience for the students using the laboratory.
- The replacement of the aging rock coring machine in the rock mechanics preparation laboratory. The department also intends to replace surveying equipment (theodolites and total stations) as the equipment ages and no longer functions. The department is exploring the possibility of acquiring a used surveying drone from one of the local mines.

C. Additional Information

Copies of the following assessment materials referenced above will be available for review at the time of the on-site review visit. These documents include:

- course files of all MEM undergraduate courses taught in the department, containing course syllabus, course-related teaching materials and samples of student work (assignments, exams, projects);
- alumni/employer surveys
- student exit surveys

} Together in 1 binder

- outcomes assessment worksheets summarizing the observed Level of Achievement of the outcome being assessed, which is a brief summary of the achievement results for the outcome. The Outcome Assessment Worksheets for AY 2012 – 13, AY 2013-14, AY 2014-15 and AY 2015-16 will be available for review within the Outcomes ***a*** – ***k*** assessment binders. The worksheets are formulated at the end of each Academic Year (AY).