ABET
Self-Study Report

BS in Metallurgical Engineering Degree

South Dakota School of Mines and Technology
Rapid City, SD

June 20, 2016

CONFIDENTIAL INFORMATION HAS BEEN REMOVED

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TABLE OF CONTENTS

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Program Self-Study Report for
ASAC of ABET Accreditation
Metallurgical Engineering
Bachelor of Science Degree
South Dakota School of Mines and Technology

BACKGROUND INFORMATION

A. Contact information

Dr. Michael West, Professor and Head
Department of Materials and Metallurgical Engineering
Mineral Industries Building
South Dakota School of Mines and Technology
501 E Saint Joseph Street
Rapid City, SD 57701

Ph: 605 394-1283
FAX: 605 394-3369

michael.west@sdsmt.edu

B. Program history

The following is a summary of program and major changes occurring since the last general review.

The metallurgical engineering program began with the establishment of then Dakota School of Mines in 1885. The state constitution specified, and continues to require, that mining and metallurgy be taught in at least one state institution.

Since 1972 the Department of Metallurgical Engineering faculty has consisted of five full-time, tenure-track faculty members, one of whom served as a chair or head. Undergraduate student numbers ranged from 40 to 70. Since the previous 2010 ABET visit, the number of both faculty and students have increased notably as a university strategic initiative to move from approximately 2000 undergraduate and 200 graduate students to 3000 undergraduate and 500 graduate students. In 2012, the university moved from a six-year rotating department chair system of departmental administration to a system of permanent department heads. In 2014 Dr. Kellar, the previous chair/head returned to full time professorship as Dr. West accepted the department head responsibilities.

At the time of the previous 2010 ABET visit, the departmental faculty consisted of five full-time tenured or tenure-track professors (Howard, Kellar, Cross, Medlin, West) with 75 years of departmental program experience. Medlin has since taken another position and Howard has retired but is actively engaged in the department and program in a part time position as Professor Emeritus and Senior Lecturer. Three new tenure-track professors have joined the department since the last review in 2010 and are actively engaged in the program (Crawford, Jasthi, and Safarzadeh). The department has been fortunate in filling these vacated positions with highly-qualified professors via open and nationally advertised search processes. Dr. Grant Crawford received his doctorate from the Arizona State University in 2008 and has three years of experience with Intel. Dr. Sadegh Safarzadeh recently received his doctorate from the University of Utah and has four and a half years of employment experience in the extractive metallurgy of Pb and Zn while Dr Bharat Jasthi has three years of experience in advanced materials processing and received his doctorate from the South Dakota School of Mines and Technology (SDSM&T).

Additionally, the department enjoys the shared appointments of two full-time faculty members secured through a nationwide search process: 1) Dr. David Salem, Director of the Composite and Polymer Engineering (CAPE) Laboratory and Professor of Metallurgical Engineering and Chemical and Biological Engineering (CBE) and 2) Dr. Christian Widener, Director of the Arbegast Advanced Manufacturing Center and Associate Professor of Mechanical Engineering and Metallurgical Engineering. Dr. Salem completed his PhD at the University of Manchester, UK and Dr. Widener completed his PhD at Wichita State University.

The biggest change in the program's curriculum has been the regental-mandated reduction in program credit hours from 136 to 130. On July 1, 2012 the program reduced the total number of required hours for degree from 136 to 130 by mandate from the South Dakota Board of Regents Policy 2:29, Sec 1. C. 1 (https://www.sdbor.edu/policy/documents/2-29.pdf). To achieve this reduction, the program faculty agreed to implement six, one-credit hour reductions: 1) eliminate a physics II laboratory, 2) reduce humanities and social science electives from 16 to 15 credits, 3) eliminate one of two credits of physical education, 4) eliminate a freshmen orientation type course MET 110, and 6) reduce the hours of required free elective from 6 to 5. Freshman students are encouraged to enroll and attend the introductory orientation style course MET 110, but it is not required.

Dr. Crawford has introduced Forensic Engineering (MET 450/550), shares in teaching the program's physical metallurgy courses (MET 330/330L, MET 332), mechanical metallurgy (MET 440/440L) ,and has focused heavily on improving the capstone design experience (MET 351, 352, 464, and 465) for our students. Dr. Safarzadeh has assumed teaching duties for most of the courses Dr. Howard taught including Metallurgical Thermodynamics (MET 320), Transport Phenomena in Metallurgical Engineering (MET 422), and High Temperature Extraction, Concentration, and Recycling (MET 321/321L)

Dr. Jasthi is responsible for Dr. Howard's previously-taught Steelmaking course (MET 426/526), offers Corrosion and Oxidation (MET 445/545), and shares teaching of the populous sections of Properties of Materials Laboratory (MET 231L). Elective course offerings have remained unchanged since 2010 except for the addition of Forensic Engineering (MET 450/550).

The second major change since the last review has been the extensive revamping of the operation of the combined junior and senior design course sequence. In 2010 the program's juniors and seniors were very engaged in the Samurai Sword Project, which produced a Samurai sword starting with local iron ores. This project, which is ongoing, integrated all aspects of metallurgical engineering, and drew heavily upon the program core curriculum. In addition, new design model cohorts junior (MET 351/352) and senior (MET 464/465) students on design teams and involved all program faculty. In 2008-9 all juniors and seniors were assigned to one of four Samurai Sword design teams: pelletizing, reduction, forging, or quenching. In 2011-12 the program having largely accomplished the Samurai project, took a new direction under the direction of Dr. Crawford in which teams of three to four students undertook a project under the mentorship of one program professor. The projects are intentionally trending towards industrially partnership and increased funding. The rather unstructured previous format is now highly structured with frequently reports and much-increased attention to project planning and management. In 2014-15 and 2015-16, there have been eight teams of four students, each with a program adviser (West, Crawford, Keller, Cross, Jasthi, Safarzadeh, Howard, and Widener).

In 2012 the Department of Metallurgical Engineering was authorized to hire Ms. Jessica Zacher as a full time senior secretary, which is a substantial improvement over the half time arrangement the department operated under during the 2010 ABET visit. This has provided for superior secretarial services, office management, and accounting focused more clearly on the department's programs and operations, which include instruction, award financial tracking, travel, scheduling, and office security.

C. Options

The BS in Metallurgical Engineering degree program has no options or tracks but the department offers a minor in *Materials Science – Metals* for other degree programs. This minor is composed of courses within the metallurgical engineering degree program so the teaching of no additional courses is required. The minor has been popular among BS Mechanical Engineering students with between 5-10 students enrolled in the minor since 2009. The BS in Metallurgical Engineering program has 17 credit hours of elective courses: five free electives; six science electives; and six directed technical electives. The department maintains and publishes a list of *BS Met. Eng. Authorized Science Courses* that qualify as science electives. A suite of 400-level MET courses are available for selection as *Directed Met Electives*, or students can take, upon approval by the head, an engineering course outside of the program if it has a Metallurgical Engineering-related component. Students have considerable freedom in selecting free electives, but program faculty advisors monitor student selections to assure substantial course selections continue.

D. Program delivery modes

The program mode of the BS Metallurgical Engineering program is a 100 percent day-time program. Cooperative education courses (CP 297/397/497) courses generally involve students completing an intern/coop experience with an off-campus industrial firm. There is no difference in this program from other engineering programs on campus.

E. Program locations

The only location where the program is delivered is on the SDSM&T campus in Rapid City, SD. However, South Dakota has an integrated university system with common course numberings, so students may take courses of the same prefix and number designation for credit at any of the other five regental system universities. There are no such courses in the BS Metallurgical Engineering (MET) program, but there are many in the sciences, mathematics, and humanities and social sciences. These courses are accepted for credit without transfer scrutiny.

F. Public disclosure

The Program Education Objectives are posted at the following locations:

- Department of Materials and Metallurgical Engineering bulletin board on the first floor of the Mineral Industries Building.
- http://www.sdsmt.edu/Academics/Departments/Materials-and-Metallurgical-Engineering/Accreditation---Assessment/
- http://ecatalog.sdsmt.edu/preview_program.php?catoid=14&poid=1132&returnto=2608

The Student Outcomes are posted on the following locations:

- Department of Materials and Metallurgical Engineering bulletin board on the first floor of the Mineral Industries Building.

- http://www.sdsmt.edu/Academics/Departments/Materials-and-Metallurgical-Engineering/Accreditation---Assessment/

Annual student enrollment and graduation data is posted or made accessible to the public at the following location:

- http://www.sdsmt.edu/Campus-Life/Career-Center/Career-Center-Placement/
- Department of Materials and Metallurgical Engineering bulletin board on the first floor of the Mineral Industries Building.

G. Deficiencies, weaknesses or concerns from previous evaluation(s) and the actions taken to address them

There were no Deficiencies, Weaknesses, or Concerns cited in the most recent (2010) ABET Final Statement. Therefore, no specific actions to address were required.

CRITERION 1 - STUDENTS

This section describes the following topics as they relate to students entering the BS Metallurgical Engineering Program:

- Student Admissions
- Evaluating Student Performance
- Transfer Students and Transfer Courses
- Advising and Career Guidance
- Work in Lieu of Courses
- Graduation Requirements
- Transcripts of Recent Graduates

A. Student admissions

Admission standards apply to the institution overall and are not differentiated by program; however, all incoming freshmen at the SDSM&T are required to declare a major. When students apply for admission, their application lands in one of three categories

- Automatically admitted,
- Individually considered, and
- Transferring student.

Each category has its own processing procedures as now described.

Automatic Admission

The University automatically admits students who meet the general educational requirements and who

- Obtain an ACT composite score of 25 and obtain an ACT math sub score of 25 (or SAT composite of 1130 and SAT Math sub score of 580) and have a minimum cumulative GPA of 2.75 or
- Are South Dakota Regents' Scholars

Considered for Admission on an Individual Basis

The university considers for acceptance applicants who meet the general education requirements and the following criteria:

- Obtain an ACT composite score of at least 20 (or SAT composite score of 940), and
- Obtain an ACT math sub score of at least 20 (or SAT math sub score of 480), and
- Achieve a high school GPA of at least 2.75 on a 4.0 scale

Applicants who do not meet the ACT/SAT score threshold may be admitted depending on their sub score.

Transfer Students

Transfer students who have earned fewer than 24 semester credits must also meet the above freshman admission requirements above. Transfer students with 24 or more semester credits are eligible to be candidates for admission if they meet the following three standards:

- Have a cumulative college grade point average of 2.75 or higher
- Have proof of college algebra readiness.

- Are in good standing with their most-recently attended university.

Non-traditional students who are 24 or older and students seeking readmission are treated according to Board of Regents Policy 2:3, which states

Students who are under the age of twenty four (24) at the start of the term and who are transferring into associate degree programs with fewer than 12 transfer credit hours must meet the associate degree admission requirements. Students with 12 or more transfer credit hours with a cumulative GPA of at least 2.0 may transfer into associate degree programs. Specific degree programs may include additional admissions requirements

Incoming students are presumed to be enrolled in College Algebra (MATH 102) unless ACT or ACCUPLACER (www.accuplacer.org) results indicate otherwise. Upon acceptance and before the first semester, most new students are required to complete ACCUPLACER testing. ACCUPLACER is used primarily for placement into appropriate math courses. Additionally, prospective students with ACT scores older than 5 years and students with an ACT of 18 or lower in English are also required to take it. Also, students who have been automatically admitted because they have an ACT of 25 or higher in math must take the ACCUPLACER to be placed correctly in the math sequence. Admitted students with a math ACT above 20 but below 25 may opt to take the ACCUPLACER to be placed in a math course higher than College Algebra (MATH 102): namely Calculus I (MATH 123) or Trigonometry (Math 120).

Table 1-1 shows the average of incoming ACT math score for the BS Metallurgical Engineering program freshman and the average math ACT for the other campus programs under current ABET review. Table 112 shows the weighted average incoming ACT scores over this six-year period for the ACT for the programs under review.

Table 1-1 Average ACT math score

Fall Semester	BS MET ENG	All Programs
2010	26.3	26.5
2011	27.1	26.8
2012	27.3	26.9
2013	29.0	26.8
2014	27.3	26.9
2015	27.4	27.1
2010-15	27.4	26.8

Table 1-2 Average incoming freshman ACT scores for 2010-15 (*weighted averages)

Item	CENG	IE	CEE	GEOE	CSC	CHE	ME	MINE	MET	EE	Wt-Ave
Wt-Ave Comp	26.7	25.1	25.2	25.3	27.2	27.3	26.0	25.3	27.4	26.7	26.2
Wt-Ave ENGL	25.0	24.1	23.5	24.1	25.8	25.7	24.3	23.6	26.1	25.1	24.7
Wt-Ave Math	27.1	26.2	26.3	25.4	27.6	27.8	27.1	25.9	27.4	27.5	26.8
Ave Reading	26.9	25.2	24.9	25.7	27.3	27.1	25.7	25.7	27.5	26.6	26.2
Ave Reasoning	27.2	24.8	25.6	25.6	27.5	27.8	26.3	25.4	27.7	27.0	26.5

Table 1-3 shows the average class ranking of SDSM&T students in the federal cohort by discipline. Percentages can be interpreted as percent of the graduating class as a whole. For example, first-time full-time freshmen entering Metallurgical Engineering (MET) in fall 2015 graduated in the top 28.6% of their high school graduating class on average. Table 1-4 shows the average high school GPA of incoming students in the federal cohort of first-time, full-time freshmen. Tables 1-5 and 1-6 show the average and minimum ACT scores by discipline.

Table 1-3 Average class ranking by top percentage of students in the federal cohort

Fall Sem	CHE	EE	CENG	CSC	CEE	IE	ME	MET	MINE	GEOE	Ave
2010	18.8	28.8	27.9	26.2	30.2	20.6	29.1	31.6	32.0	23.6	26.9
2011	25.8	29.1	31.1	32.0	27.2	36.8	28.7	39.3	33.4	24.9	30.8
2012	24.0	28.8	17.6	29.1	21.1	25.2	26.6	18.7	29.9	27.7	24.9
2013	18.5	29.1	30.8	30.7	23.8	25.6	30.1	24.6	34.0	34.1	28.1
2014	28.1	31.6	37.7	31.9	24.5	36.2	27.3	29.3	30.5	37.6	31.5
2015	24.1	26.3	32.1	30.1	26.0	19.2	27.6	28.6	33.0	28.6	27.6
Ave	23.2	28.9	29.5	30.0	25.5	27.3	28.2	28.7	32.1	29.4	28.3

Table 1-4 Average high school GPA of incoming students in the federal cohort of fall, first-time, full-time freshmen

Yr	CEE	CENG	CHE	CSC	EE	GEOE	IEEM	ME	MET	MINE	Ave
2010	3.38	3.46	3.70	3.50	3.56	3.53	3.52	3.46	3.48	3.40	3.50
2011	3.52	3.43	3.61	3.47	3.43	3.62	3.20	3.52	3.55	3.43	3.48
2012	3.56	3.58	3.59	3.43	3.42	3.57	3.66	3.57	3.59	3.42	3.54
2013	3.59	3.35	3.66	3.38	3.46	3.44	3.64	3.50	3.56	3.30	3.49
2014	3.60	3.45	3.54	3.48	3.51	3.30	3.36	3.54	3.53	3.43	3.47
2015	3.53	3.55	3.55	3.48	3.53	3.48	3.58	3.56	3.60	3.45	3.53
Ave	3.53	3.47	3.61	3.46	3.49	3.49	3.49	3.52	3.55	3.40	3.50

Table 1-5 Average ACT Math Scores of incoming fall students by discipline

Yr	CEE	CENG	CHE	CSC	EE	GEOE	IEEM	ME	MET	MINE	Ave
2010	26.3	26.9	28.3	27.5	26.8	25.6	25.2	27.4	26.3	24.3	26.5
2011	26.4	27.5	28.6	27.0	27.3	25.8	25.0	27.0	27.1	26.1	26.8
2012	26.1	27.9	27.6	27.4	26.2	26.3	26.7	27.7	27.3	25.8	26.9
2013	25.9	27.4	27.5	26.5	27.2	25.1	26.2	27.1	29.0	25.9	26.8
2014	26.7	25.5	27.3	28.3	27.7	24.8	27.2	26.8	27.3	26.9	26.9
2015	26.1	27.9	27.8	28.4	28.9	25.2	25.4	26.7	27.4	27.1	27.1
Ave	26.2	27.2	27.8	27.5	27.3	25.5	26.0	27.1	27.4	26.0	26.8

Table 1-6 Minimum ACT Math Scores of incoming fall students by discipline

Yr	CEE	CENG	CHE	CSC	EE	GEOE	IEEM	ME	MET	MINE	Ave
2010	21	23	22	20	20	21	22	18	21	18	18
2011	19	20	21	18	22	17	21	19	22	20	17
2012	21	22	19	20	17	18	22	17	23	18	17
2013	16	23	19	16	21	21	19	19	17	18	16
2014	18	16	20	20	19	19	23	18	21	22	16
2015	17	21	22	22	20	21	18	19	20	21	17
Min	16	16	19	16	17	17	18	17	17	18	16

B. Evaluating student performance

Student performance in each course is monitored by the course instructor in lecture courses through homework assignments, hour exams, and classroom participation; in laboratory courses through laboratory reports and participation; and in design courses through periodic oral reports presented to the entire design course and supervising faculty, periodic written reports that are reviewed by the instructor and returned for incorporation of improvements, and faculty interaction with the team. Students typically receive all graded work within one week of submitting it. Course exam statistics (high, low, average) are routinely reported to each class when the exams are returned along with the instructor's assessment of the students' aggregate performance. Students are invited to receive an individual performance assessment anytime during the semester. Some faculty opt to use D2L® instructional and course management system with Respondus® lockdown browser while other faculty use locally written automated grade reporting software and web sites. The university maintains an optional mid-term grading system for reporting deficient student performance. The Starfish reporting system is used to inform fellow faculty and warn the involved students of failing performance or laud them for exceptional performance. Final grades are reported to the students with 72 hours after the end of final exams via Web Adviser online system.

The SD State System general education requirements prompt the registration officer to carefully track each student's academic progression and to place a registration hold on any student who advances too far into his or her major program of study before completing their General Education requirements. These requirements must be met before the junior year, with an exception made for the SDSM&T in the case of ENGL 289, Technical Communication II, and for three credit hours of humanities or social sciences. ENGL 289 must be taken no later than the first semester of the junior year, and the fourth general education humanities or social science course may be taken during the junior or senior year.

After the completion of 48 credit hours at or above the 100 level, each student may be required to take the Collegiate Assessment of Academic Proficiency (CAAP) exam. The CAAP exam evaluates students' writing, math, reading, critical thinking and science reasoning skills. The CAAP is currently the South Dakota Board of Regents system measure for assessing the attainment of student learning in the General Education curriculum. Students must take the CAAP exam during the first semester in which they become eligible. Because satisfactory performance is required for subsequent registration and the baccalaureate degree, low exam scores provide another indicator that an intervention or targeted advising is needed. Achievement of minimum performance standards on the CAAP exam is required for graduation; however, a waiver of the requirement to take the test is granted to students who enroll having already earned an Associate's or Bachelor's degree or who have a composited ACT score of 24 or higher (provided each subscore meets or exceeds the following minimums: reading, 22; English, 18; math, 22; and science reasoning, 23).

Starting in 2014, the system undertook a review of General Education resulting in an anticipated adoption of another process for General Education outcomes assessment as early as fall 2016.

The Web Advisor system at SDSM&T allows both students and advisors to perform quickly a program evaluation that compares completed or in-progress work with the designated program requirements. Either the student or their advisor can run such a program evaluation from Web

Advisor at any time. At minimum, a program evaluation is conducted by the department head or senior advisor during the first semester of the student's senior year (the semester before graduation) and during the student's final semester.

In the semester a student plans to graduate, the major advisor completes a Degree Check for the office of the Registrar and Academic Services (RAS). A Degree Check involves retrieving the student's record from Web Advisor and performing an inventory of the student's academic record in conjunction with both general education and program requirements.
The advisor annotates the Degree Check sheet whenever a substitute course has been allowed for one of the required or recommended courses in the program. Courses entitled "Independent Study" or "Special Topics" will be noted and come under scrutiny because of the SD State System requirements for minimum course enrollment. Before a student's application for graduation will be processed by RAS, the advisor must sign and send to the registration officer a confirmation that a degree check has been performed and the student has met all requirements.

The advisor annotates the Degree Check sheet whenever a substitute course has been allowed for one of the required or recommended courses in the program. Courses entitled "Independent Study" or "Special Topics" will be noted and come under scrutiny because of the SD State System requirements for minimum course enrollment. Before a student's application for graduation will be processed by RAS, the advisor must sign and send to the registration officer a confirmation that a degree check has been performed and the student has met all requirements.

C. Transfer students and transfer courses
Transfer students are those students who enter SDSM&T with previously-earned, post-secondary credits. Interactive online checklists are created each semester to guide students through all enrollment processes once they are accepted. Student access the checklists at http://www.sdsmt.edu/Admissions/Accepted-Students/New-Student-Interactive-Checklist/ .

Upon admission, the registration officer in collaboration with the Associate Provost determines which transfer-student credits meet the general education requirements, upper-division humanities or social sciences requirements (if applicable), and physical education requirements. The registration officer sends a transcript showing the results of this credit-transfer analysis to the student's advisor for review and inclusion in the student's file.

Transfer-credit decisions for courses in the student's major are made by the academic department. All academic programs have a designated transfer advisor, and the registration officer assigns this person to an incoming transfer student as his or her initial advisor. The department head (Dr. West) serves as the designated advisor in the BS Metallurgical Engineering program. The universities in the SD State System share a common course numbering system and common course descriptions for many courses and these commonalities greatly facilitate the transfer of credit.

Transfer credits from other post-secondary schools (both domestic and foreign) are reviewed on a case-by-case and course-by-course basis. For mathematics, chemistry, physics, some of the sciences, general engineering, and some science courses the typical course of action is for the course catalog description and syllabus to be examined to determine sufficient similarity to a required course. All transfer credit appearing on the Degree Check Sheet , which is completed as part of the graduation application process, is fully documented on the Colleague Database

System maintained by RAS. The Degree Check Sheet and all associated documentation is forwarded to the Degrees Committee for final review before graduation is approved.

Table 1-7 shows the number of transfers into SDSM&T overall and into the BS Metallurgical Engineering program over the last 6 years.

Table 1-7 Transfer students

Fall Term	Number Enrolled	
	SDSM&T	BS MET. ENG.
2010	61	2
2011	55	3
2012	70	2
2013	100	5
2014	90	3
2015	90	7
Total	466	22

For a student transferring into the Metallurgical Engineering program from another SDSM&T program, the department head reviews the student's transcript as recorded online in the Datatel/Colleague System and compares it to the program's Graduation Progress Checklist shown in Table 1-8. The department head then schedules a meeting with the student to outline a semester-by-semester plan for the student to complete their degree. The student's Graduation Progress Checklist file maintained by the department head, with copies to the student, is updated routinely and ultimately used for the Degree Audit during the semester before graduation. Only courses offered at SDSM&T are listed in the second half of Table 1.8, but the six-university state system publishes a much longer list showing all courses offered in the system that would satisfy General Education Goals #3 and 4.

D. Advising students and career guidance

The process by which students are advised on curricular and career matters follows.

Academic Advising and Academic Support for key student groups

Campus-wide structures and processes for delivering targeted advising and academic support to students are described below.

- **Advisors** The office of the Registrar and Academic Services (RAS) assigns each freshman an advisor from his or her discipline or a closely related discipline. These freshman advisors are faculty members identified by the each academic program for their mentoring skills.

- **Advanced Placement** All universities in the SD state system consider College Entrance Examination Board Advanced Placement scores of 3, 4, or 5 for course credit.   Similarly, the system recognizes the rigor of the International Baccalaureate (IB) courses and the IB Diploma Program and considers higher-level courses for which students earned a five (5) or better on the final exam for credit. Details on system policies regarding AP and IB credits may be found at https://www.sdbor.edu/policy/documents/2-5.pdf

Table 1-8 BS Metallurgical Engineering 130 Credit Hour Curriculum Check Sheet

Student Name			Expected Graduation Date		
ID#			Date/Initials of Last Review		
MET		50	**Science**		8
	MET 220, S	3		CHEM 112	3
	MET 220L - S	1		CHEM 112L	1
	MET 232 - S & F	3		CHEM 114	3
	MET 231 - S & F	1		CHEM 114L	1
	MET 310 - Even S	3	**Dept-approved Science Electives**		6
	MET 310L - Even S	1			
	MET 320 - F	4			
	MET 321/321L - Odd F	4	**PHYS**		6
	MET 330 - Odd F	3		PHYS 211/211A	3
	MET 330L - Odd F	1		PHYS 213/213A	3
	MET 332 - Odd F	3	**MATH**		18
	MET 351 - F	2		MATH 123	4
	MET 352 - S	1		MATH 125	4
	MET 422 - Even F	4		MATH 225	4
	MET 433 - S	3		MATH 321	3
	MET 440 - Even S	3		MATH 373	3
	MET 440L - Even S	1	**ENG**		9
	MET Directed Elective	3		ENG 101	3
	MET 464 - F	2		ENG 279	3
	MET 465 - S	1		ENG 289	3
	MET Directed Elective	3	**HUM**		6
Others		13			
	EM 214	3			
	EM 321 or ME 216	3	**SS**		6
	IENG 301	2			
	EE 301/301L	4			
	PE	1	**Upper-level HUM-SS**		3
Free Electives		5			
				GEN ED GOAL #3	
				GEN ED GOAL #4	

Table 1-8 BS Metallurgical Engineering 130 Credit Hour Curriculum Check Sheet (cont'd)

Goal #3 - 6 Credits   Select 1 in each column but they must be in different groups

		ANTH 210	Cultural Anthropology	3
		GEOG 101	Intro to Geography	3
		GEOG 210	World Regional Geog	3
		GEOG 212	Geog of North America	3
		HIST 151	US History I	3
		HIST 152	US History II	3
		POLS 100	American Government	3
		POLS 165	Political Ideologies	3
		POLS 250	World Politics	3
		PSYC 101	General Psychology	3
		SOC 100	Intro to Sociology	3
		SOC 150	Social Problems	3
		SOC 250	Courtship & Marriage	3

Goal #4 - 6 Credits   Select 1 in each column but they must be in different groups

		ART 111	Drawing I	3
		ART 112	Drawing II	3
		ARTH 211	History of World Art I	3
		ENGL 210	Intro to Literature	3
		ENGL 212	World Literature II	3
		ENGL 221	British Literature I	3
		ENGL 222	British Literature II	3
		ENGL 241	American Literature I	3
		ENGL 242	American Literature II	3
		ENGL 250	Science Fiction	3
		HIST 121	Western Civilization I 3	3
		HIST 122	Western Civilization II	3
		HUM 100	Intro to Humanities	3
		HUM 200	Connections	3
		MUS 100	Music Appreciation	3
		MUS 117	Music in Performance 1	3
		PHIL 100	Intro to Philosophy	3
		PHIL 200	Intro to Logic	3
		PHIL 220	Intro to Ethics	3
		PHIL 233	Philosophy and Literatu	3
		CHIN 101	Intro Chinese I	4
		CHIN 102	Intro Chinese II	4
		GER 101	Intro German I	4
		GER 102	Intro German II	4
		SPAN 101	Intro to Spanish I	4
		SPAN 102	Intro to Spanish II	4

- **Traditional students** are newly graduated from high school younger than 21 enrolling in college for the first time. These students complete a Course Registration Survey that solicits the information needed for the Office of the Registrar and Academic Services to create their first year course schedules. While alterations to a student's schedule can be made readily in response to advisor input, providing a schedule for incoming students has proven to be the best way to inducted first-time, full-time students.

- **Transfer students** enter the School of Mines with previously earned post-secondary credits. Section C entitled *Transfer Students and Transfer Courses* describes in detailed how these students are advised.

- **Non-traditional students** are 21 or older, have previous post-secondary experiences and/or professional and life experiences that qualify as credit towards a degree. For such students, credit by verification processes is offered via the College Board's College Level Examination Program (CLEP). Credit by examination can be arranged on a case-by-case basis; however, credits earned through validation methods other than nationally recognized examinations. University-administered tests and verification such as military credit or prior learning are disallowed. Total credit by examination methods cannot exceed 32 credits for baccalaureate a degree. Additional details are available: https://www.sdbor.edu/policy/documents/2-5.pdf.

- **Native American** students enjoy the advocacy and support of the Office of Multicultural Affairs (OMA) and the American Indian Science and Engineering Society (AISES) student group. While OMA responds to the needs of all under-represented students, including African Americans, Latino/a students, and Asian Americans, concerted efforts are made to offer native Americans a structured support network that includes academic support services, peer mentoring, workshops focused on career and personal development, and promotion of cultural competence through access to community diversity education seminars. SDSM&T runs targeted outreach to Native American high school students and has a thriving NSF-funded Tiospaye in Engineering academic support and scholarship program designed to improve the recruitment and retention of Native American students. Additional information is available at http://multicultural.sdsmt.edu and http://tiospaye.sdsmt.edu.

- **Women** students make up roughly 30 percent of the overall student population and have been supported since 2005 by the Women in Science and Engineering (WISE) program. Between 2005 and 2010, a dedicated director position existed for the coordination of WISE programming, including a mentor and mentees (M&M) program that paired junior and senior women with freshmen and sophomore students. Since 2005 WISE has offered extensive outreach to middle- and high-school girls through the annual *Girls Day* event bringing more than 200 girls to campus for a day-long engineering and science experience. Administrative oversight of the WISE program is in transition and housed within Admissions as of the spring 2016 semester.

- **Veterans** are a growing sub-group of students with distinct needs. To supplement the support given to veterans by the Veteran's Information Registration Officer in RAS, a Veteran's Resource Center was created in 2009: http://vrc.sdsmt.edu/ . This is a dedicated space in the student center designed to support the social and academic needs of veterans by offering tutoring in math and writing; counseling and referral services regarding VA benefits, G.I. Bills, and community veterans organizations; college success workshops; assistance with resume and cover letter writing; and help with scholarship searches and applications. The VRC is sponsored jointly by the School of Mines and Western Nebraska Community College TRIO Veterans Upward Bound, a program funded by the Department of Education. Veterans and deployed and returning students are strongly supported by faculty and staff members in the Department of Military Science and by the Office of Student Affairs. Veterans are honored at graduation by the wearing of uniforms, presentation of the colors, and commissioning ceremonies. Throughout the year there are numerous veteran and active duty appreciation events.

- **International students** are supported throughout their time on campus by the Ivanhoe International Center http://www.hpcnet.org/international. A special online checklist is maintained to guide international students through the enrollment process http://www.gotomines.com/admissions/accepted/international. The Ivanhoe Center staff assist with matters ranging from visa requirements to housing. There is an annual International Exposition held on campus and a Diwali celebration.

- **At risk students** are identified via multiple indicators such as academic probation, multiple academic appeals, and/or referral to the Early Alert Team by staff and instructors. At risk students are contacted by the Director of Retention and referred to support services, including University Counseling and ADA services, the Tech Learning Center for tutoring, supplemental instruction sessions, and the Career Center for consultation on career interests and aptitudes.

  Students whose cumulative grade point average falls below a 2.0 are placed on academic probation and advised not to enroll in more than twelve (12) credits. While on academic probation, a term grade-point average of 2.0 or better must be maintained in to avoid academic suspension. Suspension means a student cannot enroll for two semesters or seek early readmission through the academic appeal process. The Academic Appeals Committee is charged with reviewing appeals from students and tailoring programs to succeed for each student.

  The SD state system policy allows a student to register for a course only three times. Any additional enrollment must be permitted by the Academic Appeals Committee. Each such appeal is considered by the Appeals Committee with foremost consideration towards student success. Each student receiving permission is required to follow a prescriptive plan most often consisting of reduced course load. In some cases, students are referred to counselling to address emotional difficulties, possible alternative career choice options, or other appropriate action.

In addition to the above advising and academic resources and support to targeted groups, the offices and programs listed and described below support students in general and specific sub-groups with distinct needs or interests.

- **Athletics** A *cap and gown* program is used in athletics such that all students with athletic scholarships must attend a proctored study hall session three times weekly. Students who maintain a minimum GPA of 3.0 can reduce or eliminate the number of study-hall sessions required. Personnel monitor all student athlete class attendance and student academic progress in terms of the numbers of credits completed per semester, overall GPA, etcetera. The net result of the close attention paid to athletes is that the average GPA of student athletes is higher than the average GPA of non-athletes at Mines.

- **Campus Ministries** A variety of groups (United Campus Ministry, Lutheran Campus Ministry, the Newman Center, the Intervarsity Christian Fellowship, International Students Incorporated, and the Muslim Student Association) provide a variety of services geared toward meeting the spiritual and material needs of students.

- **Student Activities and Leadership Center** This office seeks to enhance student engagement through enjoyable yet educational activities that promote leadership development and well-rounded students. Activities include new student orientation, the advising of student organizations, student co-curricular events and activities, and Greek life.

- **Career and Professional Development** The Career and Professional Development Center provides an array of services to help students be prepared for success in their careers after graduation. Services include career fairs, on-campus interviews, internship/co-op experiences, professional development workshops, resume and cover letter reviews, career advising, and mock interviews, as well as coordination of the Mines Advantage program that is focused on developing student competencies in communication, leadership, teamwork, career preparation, cultural and global diversity, community involvement, and personal development.

- **Counseling Services** The Counseling Department provides support to students who suffer from mental illness, emotional disruption, academic stress, substance addiction, and other difficulties. Counseling staff work with students to provide coping skills that assist students in bettering their lives and their ability to handle problems as well as referrals.

- **Disability Services/ADA** The ADA office provides students with disabilities the appropriate support in accordance to the Americans with Disabilities Act and Section 504 of the Rehabilitation Act. After providing our office with documentation of their disability, this office provides accommodations for the student for the areas that disability has affected them.

- **Ivanhoe International Center** The Ivanhoe International Center is the hub of international activities on campus, including services for international students and for students who are planning study abroad. The center provides traditional international student advising, coordinates many activities and opportunities for cultural interaction and adjustment, and initiates student success/retention plan. The Ivanhoe International Center also provides support for students who plan to study abroad, and works with departments and programs to develop innovative ways of incorporating international experiences into the curriculum.

- **Multicultural Affairs** The Office of Multicultural Affairs (OMA) is committed to building and promoting programs, services, and resources that serve to create and sustain a diverse as well as an inclusive community. The OMA provides future and current students with information on scholarships, housing, co-ops, internships, and employment placement; sponsorship of social and cultural enrichment events and activities; and support for the School of Mines student chapters of the American Indian Science and Engineering Society (AISES), the National Society of Black Engineers (NSBE), and the Society of Hispanic Professional Engineers (SHPE).

- **The Omniciye Bridge Program and Jump Start** Program The Omniciye Bridge Program is a pre-orientation curriculum for incoming American Indian students. The Jump Start Program is a state wide grant which follows American Indian and low-income students through their first three years of college. This program has a summer component where a student can earn course credit for the upcoming semester and locates internships or research experiences to help them be more engaged in their field of study

- **Tiospaye in Engineering and Tiospaye in Science Programs** These are NSF-funded scholarship and academic support programs that provide financial, academic, professional, cultural and social support for undergraduate science and engineering students. The students are provided weekly mentoring sessions, monthly mentoring with the director, weekly recitations in key classes, and biweekly lunches featuring programming for support in the five areas.

- **Women in Science and Engineering (WiSE)** The WiSE program is designed to educate, recruit, retain, and graduate academically motivated women in STEM fields and to works to connect women students with peer mentors and added resources within the campus communities. The program includes an informal social network through social media sites, professional development opportunities for mentors and mentees, and networking opportunities to form meaningful connections with other women students, women alumni, and valuable industry contacts.

- **Culture and Attitude Program** This is an NSF-funded program that began in 2009 designed to increase the number of women graduates in Metallurgical Engineering (MET) and Industrial Engineering & Engineering Management (IE). The program recently expanded to include the Mechanical Engineering (ME) department. Key program components are need-based scholarships, mentoring, professional development and program support for low-income women.

- **Dean of Students Office** Personnel in the Dean of Students office offers student advocacy by assisting with grievances or concerns or managing crises. This office advises the institution on student affairs matters and related policy in addition to advising and guiding students in professional and volunteer activities.

- **Office of Residence Life** Personnel in Residence Life oversee all aspects of providing a responsible community living and learning environment in the campus residence halls. Trained Residence Hall Assistants provide mentoring and crisis management.

- **Peer Mentoring Program** This programming is run by Enrollment Management in Academic Affairs. Upper-class students that serve as Peer Mentors are selected with the recommendation of their departments to assist first-year students with advising and registration activities, including planning class schedules, interpreting university procedures and policies, and making referrals to other university services. Peer mentors do not take the place of faculty academic advisors, but they do assist them in fulfilling their roles as academic advisors.

- Within the BS Metallurgical Engineering program, women students are encouraged to participate in the Women in Metallurgical Engineering (WIME) and the NSF-funded Culture and Attitude Scholarship Program. Additionally, the Materials Advantage student chapter promotes women serving in leadership roles.

The offices and programs listed above have distinct methods for reaching out to students and connecting them with services. For example, the Veterans' Resource Center is centrally located in the student center and is decorated and furnished to ensure that veteran students feel welcomed and respected for their service contributions. The Center director maintains a database of contact information for the approximately 150 student veterans and assiduously reaches out to them via multiple media to let them know about events, services, scholarships, employment opportunities, etcetera. The posting of flyers and other traditional methods are also used to keep veterans informed of services. A separate new-student orientation curriculum is offered for veterans to ensure that students are informed about veteran-specific resources and services.

The Starfish system is an online early-alert system implemented in fall 2012 that interfaces with Colleague, the SDBOR student information system; D2L, the SDBOR learning management software; and Pearson MyMathLab. All course instructors have the ability to send out a Starfish Alert to a student's academic advisor, or other groups the student may be associated with. Advisors receive these alerts and can contact the students to provide assistance regarding who to see or where to go to receive the required help. Starfish utilization on the SDSM&T campus was concentrated on foundational gateway courses in math, chemistry, physics, and English. The SDBOR mandated use of the software, but did not fund resources needed for full implementation. Over time, the Retention Planning Group at SDSM&T has studied the impact of Starfish notifications and have found them minimally effective and often counter-productive. Starfish remains in effect as a retention tool through March 2017, but the campus anticipates the contract will not be renewed. Resources and attention is being shifted at SDSM&T to building the capacity and functionality of the Student Success Center and focusing on networking support services and reinforcing one-on-one relationships with students.

Since 2012, the University has sought to garner funding needed to consolidate services in a one-stop Student Success Center to be centrally located in the Surbeck Center adjacent to other critical support services (e.g., the Career and Professional Development Center, Tiospaye, and the Ivanhoe International Center, the VRC-Veterans Resource Center, Multicultural Affairs, mental health counselors and ADA testing services). Creation of the Student Success Center is Action Step 1-B-1 under Strategy B-1 of the Strategic Plan. Services to be consolidated in the Student Success Center will include tutoring, advising and mentoring, testing. As the University works to marshal sufficient internal and external funding to build an addition to the student center and to appropriately staff enhanced support programs and services, Academic Affairs in collaboration with Student Development is moving ahead to create the functions of a Center. Hiring of a director and two advising staff members is anticipated over summer 2016. By the time of the site visit, the Success Center operations will be fleshed out, functioning, and can be described in much greater detail.

Coordination of student support services—academic and non-academic—is achieved through two structures: the monthly meetings of all directors and key support staff in Student Development and the bi-weekly meetings of the Retention Planning Group (RPG). The RPG ensures close collaboration between Academic Affairs and Student Development for issues of support and retention.

One additional, significant initiative to support student success targets foundational math courses. Since SDSM&T is a STEM-only institution, students who cannot or elect not to complete advanced coursework in mathematics must transfer to find a suitable program of study elsewhere. Progress to graduation is impeded by the rigor of our mathematics requirements and the struggles a significant percentage of our students exhibit in mathematics—despite the fact that the average incoming ACT score in math has been 26.8 over the past seven years.

As a consequence, in spring 2015, SDSM&T piloted a program to

- Develop more predictive placement testing processes
- Create preparatory materials to positively impact a student's success in their initial math class at SDSM&T
- Study the role of affective skill development in math success to a level of specificity that allows the creation of skill-specific interventions

Analysis of the impact to date has shown improvement in the pass rates in advanced math classes even though the 2015 freshman class came in less well prepared in math (based on ACT scores) than previous freshmen classes. While SDSM&T cannot claim causality without more data, we are pushing ahead. The South Dakota legislature made a targeted allocation of $250,000 to SDSM&T to fund a continuation and very significant expansion of this initiative. Additionally, the math faculty is awaiting a funding decision on a National Science Foundation grant proposal that will support research on the relationship of affective skills to success in mathematics.

BS metallurgical engineering program students

In addition to the Curriculum Checklist in Table 1-8, the BS Metallurgical Engineering program employs a Curriculum Flow Diagram (CFD) shown in Figure 1-2 by which faculty can assist students visualize progress towards a degree. Both the checklist and CFD are reviewed and progress updated annually by the student in conjunction with their advisor. Students are strongly encouraged to visit advisors at the beginning of every semester to complete this review. Additionally, students have 24/7 access to Web Advisor, which is online software that provides registration, prerequisite, curriculum, catalog, grade, and course information.

Each academic program has an individualized process for transitioning new students from their freshmen or transfer advisors to the advisor in the major who will remain the student's advisor throughout their undergraduate study. For the Metallurgical Engineering program, all faculty members are assigned undergraduate students for advising. Drs. West and Cross are the primary freshman advisors. Those advisees that are majoring in Metallurgical Engineering stay with these advisors through their sophomore year. Following their sophomore year, Metallurgical Engineering student advising is distributed among between the remaining BS Metallurgical Engineering program faculty members. Dr. West is responsible for the final degree audit prior to graduation.

The BS Metallurgical Engineering program maintains strong scholarship support for it students. For the most recent academic year, 75 students were awarded approximately $90,000 from the department with approximately 60% of all students receiving support.   During the review period, students in the program were awarded numerous competitive national scholarships from professional societies including TMS, ASM, SME, and AIST as well as other private and public foundations.

In additional to the curriculum list sheet and curriculum flow chart, students are provided a list of approved science electives shown in Table 1-9. Students are encouraged to review their progress by comparing their coursework completion with the curriculum given in the catalog (http://resources.sdsmt.edu/catalog/current-catalog.pdf).

New students receive emails from faculty advisors so as to establish contact and to begin to develop a secure mentoring relationship. All advisees of Metallurgical Engineering program faculty are invited to program extracurricular activities, including the weekly Hammer-In blacksmithing activities, Materials Advantage student chapter activities including periodic meetings, and other social events where they can meet their program faculty members. In addition, women advisees are invited to participate in the Women in Metallurgical Engineering (WIME) and the Culture and Attitude Scholarship Program activities. All these activities have active program faculty participation often resulting in informal discussions concerning student academic progress, general happiness and other important areas implicit in advising and mentoring college students.

Career Advising All students have easy access to the services of the Career Center located in the student center. The center actively promotes services that range from interest and aptitude inventories, career counseling; assistance with participating in the Students Emerging as Professionals (STEPS) program for professional development; resume and interview preparation; linking students with coop, internship, and employment opportunities; and seminars on the development of professional behavior. More detail can be found at http://careers.sdsmt.edu .

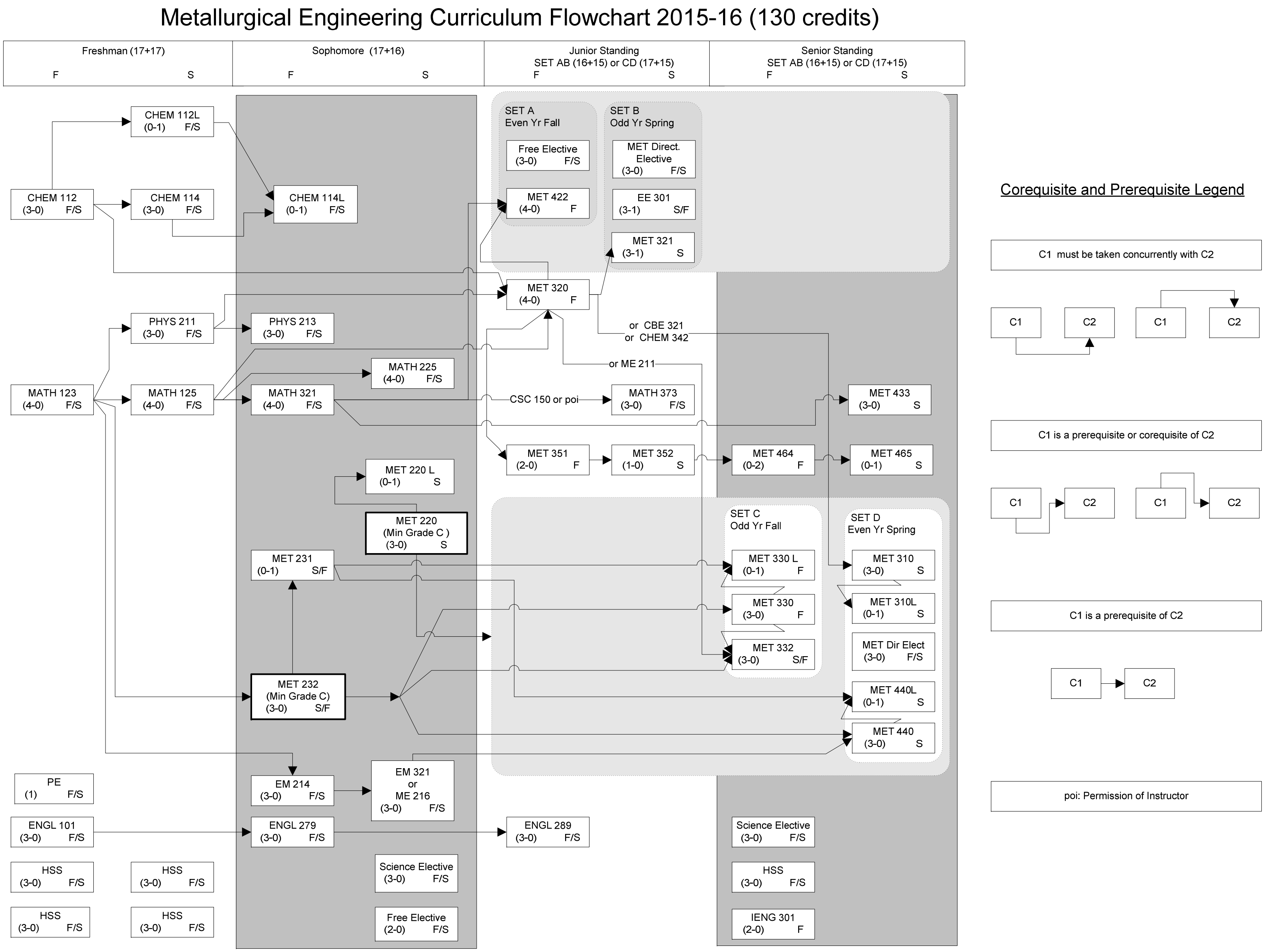

Figure 1-2 BS Metallurgical Engineering Curriculum Flow Diagram 2015-16

Table 1-9 BS Metallurgical Engineering approved science electives

(Prerequisites, if any, appear indented and beneath. All courses are 3 credits unless noted otherwise.)

AES 201 INTRODUCTION TO ATMOSPHERIC SCIENCES

AES 401/501 ATMOSPHERIC PHYSICS

    PHYS 213/213-A, MATH 321, and AES 404/504

AES 403/503 BIOGEOCHEMISTRY

    CHEM 106 or CHEM 112 ; BIOL 151 ; PHYS 111 or PHYS 211/211-A

AES 404/504 ATMOSPHERIC THERMODYNAMICS (2 or 3 credits)

    PHYS 211/211-A and MATH 225

AES 405/505 AIR QUALITY

    MATH 125, and CHEM 106 or CHEM 112

AES 406 GLOBAL ENVIRONMENTAL CHANGE

    CHEM 112, PHYS 111 or PHYS 113 or PHYS 211/211-A or PHYS 213/213-A and BIOL 311

AES 430/530 RADAR METEOROLOGY

    MATH 125 and PHYS 213/213-A

AES 450 SYNOPTIC METEOROLOGY I

    AES 201 and AES 404/504

AES 460/560 ATMOSPHERIC DYNAMICS

    MATH 321 and PHYS 211/211-A

BIOL 121 BASIC ANATOMY

BIOL 123 BASIC PHYSIOLOGY

BIOL 151 GENERAL BIOLOGY I

BIOL 153 GENERAL BIOLOGY II

    BIOL 151

BIOL 221 HUMAN ANATOMY

BIOL 311 PRINCIPLES OF ECOLOGY

BIOL 326 BIOMEDICAL PHYSIOLOGY

    Four hours of CHEM, BIOL 153 or BIOL 221

BIOL 331 MICROBIOLOGY

BIOL 341 MICROBIAL PROCESSES IN ENGINEERING AND NATURAL SCIENCES

    CHEM 112

BIOL 371 GENETICS

    BIOL 151

BIOL 375 CURRENT BIOETHICAL ISSUES

BIOL 383 BIOETHICS

BIOL 403 GLOBAL ENVIRONMENTAL CHANGE

    CHEM 112, PHYS 111 or PHYS 113 or PHYS 211/211-A or PHYS 213/213-A and BIOL 311

BIOL 423 PATHOGENESIS

    BIOL 331

BIOL 431 INDUSTRIAL MICROBIOLOGY

    BIOL 331

BIOL 444 DNA STRUCTURE AND FUNCTION

BIOL 151 and CHEM 326

BIOL 446/546 MOLECULAR CELL BIOLOGY

BIOL 151 and BIOL 371 or permission of instructor

BIOL 478/578 MICROBIAL GENETICS

BIOL 331 and BIOL 371

BIOL 480/580 BIOINFORMATICS

BIOL 331, BIOL 341, or BIOL 371 or permission of instructor

CHEM 316 FUNDAMENTALS OF ORGANIC CHEMISTRY

CHEM 114

CHEM 326 ORGANIC CHEMISTRY I

CHEM 114

CHEM 328 ORGANIC CHEMISTRY II

CHEM 326

CHEM 332 ANALYTICAL CHEMISTRY

CHEM 114

CHEM 342 PHYSICAL CHEMISTRY I

CHEM 114 and PHYS 213/213-A and MATH 225 or MATH 321

CHEM 344 PHYSICAL CHEMISTRY II

CHEM 342 and PHYS 213/213-A

CHEM 352 SYSTEMATIC INORGANIC CHEMISTRY

CHEM 114

CHEM 420/520 ORGANIC CHEMISTRY III

CHEM 328

CHEM 421/521 SPECTROSCOPIC ANALYSIS

CHEM 328

CHEM 426/526 POLYMER CHEMISTRY

CHEM 328 and CHEM 342

CHEM 434 INSTRUMENTAL ANALYSIS

CHEM 230 or CHEM 332 and CHEM 342

CHEM 452/552 INORGANIC CHEMISTRY

CHEM 352, CHEM 328 and CHEM 342

CHEM 464/564 BIOCHEMISTRY I

CHEM 465/565 BIOCHEMISTRY II

CHEM 464/564

CHEM 482/582 ENVIRONMENTAL CHEMISTRY

CHEM 316 or CHEM 328

GEOL 201 PHYSICAL GEOLOGY

GEOL 212/212L MINERALOGY AND CRYSTALLOGRAPHY

GEOL 322/322L STRUCTURAL GEOLOGY/LAB

GEOL 331/331L and GEOL 341/341L or MEM 314/314L

GEOL 323 SEARCH FOR OUR PAST

GEOL 201 or GEOE 221/221L

GEOL 331/331L STRATIGRAPHY AND SEDIMENTATION
GEOL 201 /GEOL 201L or GEOE 221/221L
GEOL 341/341L IGNEOUS AND METAMORPHIC PETROLOGY/LAB
CHEM 112 /CHEM 112L, GEOL 201L or GEOE 221/221L and GEOL 212/212L or MEM 314/314
GEOL 351 EARTH RESOURCES AND THE ENVIRONMENT
GEOL 201 or GEOE 221/221L
GEOL 361 OCEANOGRAPHY I
GEOL 372 DINOSAURS
GEOL 420/520 INTRODUCTION TO REMOTE SENSING
Junior standing
GEOL 422/422L/522/522L TECTONICS AND SEDIMENTARY BASIN ANALYSIS/LAB
GEOL 322/322L and GEOL 331/331L
GEOL 442/442L/542/542L OPTICAL PETROLOGY/LAB
GEOL 341/341L or MEM 314/314L
GEOE 451/451L ECONOMIC GEOLOGY/LAB
Junior or senior standing. GEOL 322/322L
GEOL 652 PROBLEMS IN ORE DEPOSITS
GEOE 451/451L
NANO 401 INTRODUCTION TO NANOSCIENCE
PHYS 213/213-A, PHYS 213L , CHEM 114, MATH 321
NANO 445/545 INTRODUCTION TO NANOMATERIALS
MET 232, EM 321
PHYS 183 ELEMENTS OF MODERN ASTRONOMY
PHYS 275 RELATIVITY
PHYS 111 or PHYS 211/211-A and a working knowledge of elementary algebra and trigonometry.
PHYS 312 EXPERIMENTAL PHYSICS DESIGN I (2 cr.)
CENG 244/244L
PHYS 314 EXPERIMENTAL PHYSICS DESIGN II (2 cr.)
CENG 244/244L
PHYS 321 THE PHYSICS & IMPLICATIONS OF SPACE TRAVEL
PHYS 331 INTRODUCTION TO MODERN PHYSICS
PHYS 113 or PHYS 213/213-A
PHYS 341 THERMODYNAMICS
PHYS 213/213-A, and MATH 225
PHYS 343 STATISTICAL PHYSICS
PHYS 213/213-A, and MATH 225
PHYS 361 OPTICS
PHYS 113 or PHYS 213/213-A and MATH 225
PHYS 386/386L OBSERVATIONAL ASTRONOMY/LAB
PHYS 183
PHYS 404/504 NANOPHOTONICS
Introductory quantum mechanics and electricity and magnetism; ordinary differential equations and linear systems.

PHYS 421/521 ELECTROMAGNETISM (4 cr.)
PHYS 213/213-A and MATH 321
PHYS 433/533 NUCLEAR AND ELEMENTARY PARTICLE PHYSICS
PHYS 471
PHYS 439/539 SOLID STATE PHYSICS (3 or 4 cr.)
MATH 225, MATH 321, PHYS 331
PHYS 445/545 STATISTICAL MECHANICS (4 cr.)
PHYS 451/551 and MATH 321
PHYS 451/551 CLASSICAL MECHANICS (4 cr.)
MATH 321
PHYS 471/571 QUANTUM MECHANICS (4 cr.)
MATH 321
PHYS 481/581 MATHEMATICAL PHYSICS (4 cr.)
Permission of instructor

The Career Center hosts two career fairs on campus per year, one each in the fall and the spring. In the fall of 2015, 148 employers attended the Career Fair. In spring of 2016 there were 92 companies present.

The percentage of students who graduate having completed an internships or coop experience during their tenure was 61 percent for 2015-16. The job placement rate and average starting salary for graduates from 2010-11 through 2014-15 are shown in Figure 1-1.

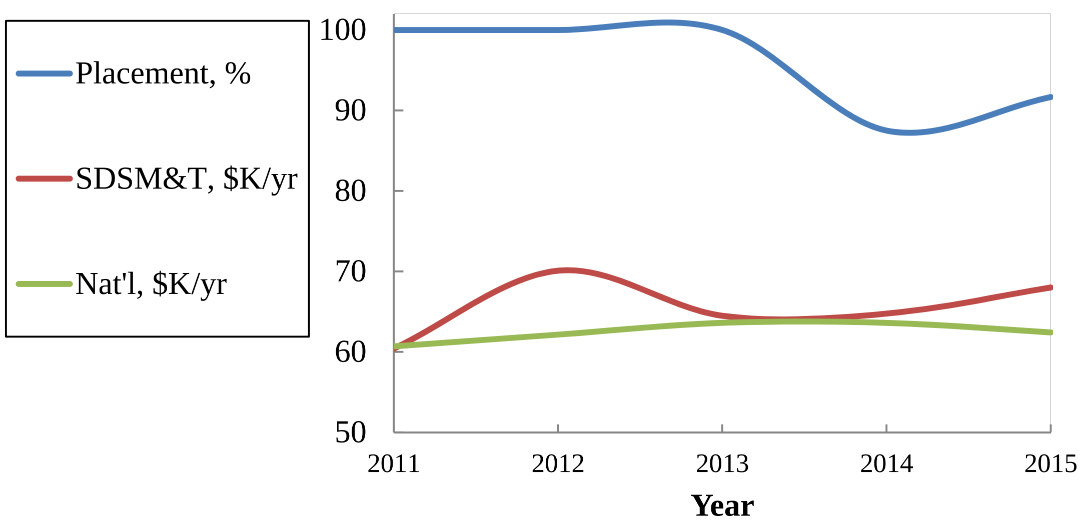

Figure 1-1 Placement and starting salaries in BS Metallurgical Engineering

In the BS Metallurgical Engineering program, a variety of career planning support is available to supplement the non-program specific efforts detailed previously. The program maintains contacts with as many program alumni as possible. These alumni often approach the department with their needs for summer interns and their companies open full-time positions. In addition, program faculty members with on-going research often hire program undergraduates as part of the team to accomplish their research. The Arbegast Advanced Materials Processing (AAMP) Laboratory, the NSF Back to the Future REU site, and the Center for Security Printing and Anti-Counterfeiting Technology (SPACT) which also hosts the NSF SPACT REU site are especially active in this regard. The program faculty members also work closely with the Materials Advantage student chapter to help bring in speakers from various metallurgical engineering related companies. Material Advantage also sponsors resumes advising sessions with program faculty help students compose professional resumes. During the summer of 2015, 18 students worked as summer interns in industry, while five were engaged in research projects.

The Registrar and Academic Services (RAS) office assigns each freshman a “freshmen advisor” from his or her discipline. Transfer students are assigned to the transfer advisor for the student’s major area of study. Freshmen and transfer advisors are faculty members identified by the academic programs for these designations because of their training, their mentoring skills, or both.

The quality of academic advising continues to be monitored at SDS&T through use of the Noel-Levitz instrument, the Student Satisfaction Survey (SSI). For over a decade, the SSI was administered to students immediately after they completed their sophomore year. While questions on the survey that contributed to benchmark scores on academic advising were targeted and useful, students taking the survey did not always have the experience with advising within the academic major needed to offer useful feedback.

Beginning in spring 2015, administration of the survey was moved to the senior year so that academic programs could gain useful and relevant feedback on advising, instructional effectiveness, concern for the individual, etcetera. In addition, an *academic advising week* was implemented in October 2015 and repeated in spring 2016. A Retention Task Force undertook a year-long project in September 2015 to improve academic advising in all programs. This project directly supports Strategic Plan Goal 1, Strategy B: *Strengthen advising, counseling, mentoring and engagement to improve retention at every stage*. The project encompassed the following goals:

- Understand the scope and extent of freshmen and sophomore needs for academic advising
- Understand freshmen and sophomore students’ perceptions of academic advising pertaining to
    - What “academic advising means or encompasses”
    - Satisfaction levels with current academic advising experiences
- Understand senior students’ perceptions of academic advising
- Identify opportunities to improve academic advising as currently delivered –or—design supplemental support processes to address the full range of student needs.

To improve the range of data available for monitoring advising quality, custom questions were added to another Noel-Levitz instrument, the Second Year Student Assessment (SYSA). Use of the SSI in the senior year and introduction of the SYSA have generated only one year of data to date; however, over time, the results will help programs ensure and improve advising quality.

The Student Satisfaction Inventory and responses for spring 2015 are shown in Tables 1-10 and 1-11. The SYSA is a Noel-Levitz survey given to all students listed in Colleague as sophomores. Approximately 535 students were surveyed and 180 responded. The *additional questions* feature was used to replicate selected questions (6, 14, 19, and 33) of the Student Satisfaction Inventory. The results above provided for gap analyses of these paired questions based on the mean scores of the responses.

E. Work in lieu of courses

All universities in the SD State System consider College Entrance Examination Board Advanced Placement scores of 3, 4, or 5 for course credit.   Similarly, the System recognizes the rigor of the International Baccalaureate (IB) courses and the IB Diploma Program and considers higher-level courses for which students earned a five (5) or better on the final exam for credit. Details on System policies regarding credit received through validation methods can be found in BOR Policy 2:5 at https://www.sdbor.edu/policy/documents/2-5.pdf .

"Non-traditional" students are 21 years of age or older and may have previous post-secondary experiences that qualify as credit towards a degree. For such students, we offer the College Board's College Level Examination Program (CLEP) and credit by verification processes. Credit by examination can be arranged on a case-by-case basis; however, credits earned through validation methods other than nationally recognized examinations (that is, university-administered tests and verification like military credit or prior learning) are not allowed. Credit by all examination methods cannot exceed 32 credits for baccalaureate degrees. The entire BOR Policy 2:5 policy is available to faculty at https://www.sdbor.edu/policy/documents/2-5.pdf .

The BS in Metallurgical Engineering program does not accept work in lieu of coursework except in the case of co-op positions, and then credit is earned through a structured course program. To obtain such academic credit, students who have accepted a co-op position must register for a Cooperative Education (CP) course of 1-3 credit hours for the semester or summer they are on co-op. Students must also complete a co-op report and supervisor evaluation to receive credit. Co-op credits may be applied toward graduation requirements in accordance with university and departmental policy. CP 297/397/497/697 (1-3 credits. Prerequisite: Permission of instructor.) Credit is available for each semester or summer work experience upon approval by the departmental cooperative education coordinator, Dr. West.

WebAdvisor shows 1 credit hour for CP courses. A student may register for more credits by changing to the appropriate number of credits. Because the work performed by a co-op student is equivalent to the workload of a full-time student, a student on co-op who is registered for co-op credit shall be considered to have full-time student status. Students must satisfy departmental requirements to earn credit for the course. Requirements include a written report of the work experience and an employer's evaluation of the work performance. Credits may be applied only under the category of free electives.

Table 1-10 Student Satisfaction Inventory (SSI) data for seniors from spring 2015

ITEM	METALLURGICAL ENGINEERING	2015 IMP	2015 SAT	2015 Gap	MINES IMP	MINES SAT	MINES GAP
Academic Advising Scale		6.20	5.73	0.47	6.21	5.40	0.81
6	My academic advisor is approachable.	6.42	6.33	0.08	6.34	5.63	0.71
14	My academic advisor is concerned about my success as an individual.	6.33	5.92	0.42	6.16	5.48	0.68
19	My academic advisor helps me set goals to work toward.	5.50	5.17	0.33	5.66	4.88	0.78
33	My academic advisor is knowledgeable about requirements in my major.	6.50	6.25	0.25	6.50	5.68	0.82
55	Major requirements are clear and reasonable.	6.25	5.00	1.25	6.40	5.34	1.06
Concern for The Individual Scale		5.38	4.48	0.90	5.94	5.19	0.75
3	Faculty care about me as an individual.	6.25	5.83	0.42	6.09	5.55	0.54
22	Counseling staff care about students as individuals.	4.08	2.50	1.58	5.64	4.99	0.65
25	Faculty are fair and unbiased in their treatment of individual students.	6.00	4.42	1.58	6.38	5.23	1.15
30	Residence hall staff are concerned about me as an individual.	3.33	2.73	0.61	4.95	4.55	0.40
59	This institution shows concern for students as individuals.	6.25	5.33	0.92	6.18	5.13	1.05
14	My academic advisor is concerned about my success as an individual.	6.33	5.92	0.42	6.16	5.48	0.68
Instructional Effectiveness		6.32	5.44	0.88	6.35	5.41	0.94
16	The instruction in my major field is excellent.	6.83	6.25	0.58	6.65	5.67	0.98
25	Faculty are fair and unbiased in their treatment of individual students.	6.00	4.42	1.58	6.38	5.23	1.15
3	Faculty care about me as an individual.	6.25	5.83	0.42	6.09	5.55	0.54
39	I am able to experience intellectual growth here.	6.90	5.82	1.08	6.56	5.94	0.62
41	There is a commitment to academic excellence on this campus.	6.42	5.75	0.67	6.44	5.82	0.62
47	Faculty provide timely feedback about student progress in a course.	6.08	3.92	2.17	6.27	4.67	1.60
53	Faculty take into consideration student differences as they teach a course.	5.58	4.83	0.75	5.68	4.82	0.86
58	The quality of instruction I receive in most of my classes is excellent.	6.67	5.58	1.08	6.68	5.54	1.14
61	Adjunct faculty are competent as classroom instructors.	6.09	5.45	0.64	6.00	5.30	0.70
65	Faculty are usually available after class and during office hours.	6.50	6.08	0.42	6.38	5.70	0.68
68	Nearly all of the faculty are knowledgeable in their field.	6.58	6.67	-0.08	6.65	6.02	0.63
69	There is a good variety of courses provided on this campus.	6.00	5.08	0.92	6.31	4.90	1.41
70	Graduate teaching assistants are competent as classroom instructors.	5.75	4.75	1.00	5.99	4.94	1.05
8	The content of the courses within my major is valuable.	6.83	5.75	1.08	6.71	5.64	1.07
Headcount			12			290	

Table 1-11 Second Year Student Assessment (SYSA) data for academic advising for MET for fall 2015

Please tell us how important it is for your institution to meet this expectation. **My Academic Advisor is approachable. This is:**	Number of respondents	Percent
7. very important to me	5	45.5%
6. important to me	5	45.5%
5. somewhat important to me	1	9.1%
4. neutral to me		0.0%
3. somewhat unimportant to me		0.0%
2. not very important to me		0.0%
1. not important at all to me		0.0%
Total	**11**	
Average	**6.4**	

Please tell us how satisfied you are that your institution has met this expectation. **My academic advisor is approachable: I am**	Number of respondents	Percent
7. very satisfied	4	36.4%
6. satisfied	2	18.2%
5. somewhat satisfied	2	18.2%
4. neutral to me		0.0%
3. somewhat dissatisfied	3	27.3%
2. not very satisfied		0.0%
1. not satisfied at all		0.0%
Total	**11**	
Average	**5.4**	

Please tell us how important it is for your institution to meet this expectation. **My academic advisor is concerned about my success as an individual: this is**	Number of respondents	Percent
7. very important to me	4	36.4%
6. important to me	5	45.5%
5. somewhat important to me	1	9.1%
4. neutral to me		0.0%
3. somewhat unimportant to me		0.0%
2. not very important to me		0.0%
1. not important at all to me	1	9.1%
Total	**11**	
Average	**5.8**	

Please tell us how satisfied you are that your institution has met this expectation. **My academic advisor is concerned about my success as an individual: I am**	Number of respondents	Percent
7. very satisfied	4	36.4%
6. satisfied	7	63.6%
5. somewhat satisfied		0.0%
4. neutral to me		0.0%
3. somewhat dissatisfied		0.0%
2. not very satisfied		0.0%
1. not satisfied at all		0.0%
Total	**11**	
Average	**6.4**	

Please tell us how important it is for your institution to meet this expectation. **My academic advisor helps me set goals to work towards: this is**	Number of respondents	Percent
7. very important to me	2	18.2%
6. important to me	3	27.3%
5. somewhat important to me	2	18.2%
4. neutral to me	3	27.3%
3. somewhat unimportant to me	1	9.1%
2. not very important to me		0.0%
1. not important at all to me		0.0%
Total	**11**	
Average	**5.2**	

Please tell us how satisfied you are that your institution has met this expectation. **My academic advisor helps me set goals to work towards: I am**	Number of respondents	Percent
7. very satisfied	3	27.3%
6. satisfied	5	45.5%
5. somewhat satisfied		0.0%
4. neutral to me	3	27.3%
3. somewhat dissatisfied		0.0%
2. not very satisfied		0.0%
1. not satisfied at all		0.0%
Total	**11**	
Average	**5.7**	

Please tell us how important it is for your institution to meet this expectation. **My academic advisor is knowledgeable about requirements in my major: this is**	Number of respondents	Percent
7. very important to me	6	54.5%
6. important to me	5	45.5%
5. somewhat important to me		0.0%
4. neutral to me		0.0%
3. somewhat unimportant to me		0.0%
2. not very important to me		0.0%
1. not important at all to me		0.0%
Total	**11**	
Average	**6.5**	

Please tell us how satisfied you are that your institution has met this expectation. **My academic advisor is knowledgeable about requirements in my major: I am**	Number of respondents	Percent
7. very satisfied	6	54.5%
6. satisfied	5	45.5%
5. somewhat satisfied		0.0%
4. neutral to me		0.0%
3. somewhat dissatisfied		0.0%
2. not very satisfied		0.0%
1. not satisfied at all		0.0%
Total	**11**	
Average	**6.5**	

F. Graduation requirements

Early in the semester prior to the semester in which the student plans to graduate, the major advisor completes a degree check for the office of the Registrar and Academic Services (RAS). A degree check involves retrieving the student's record from WebAdvisor and performing an inventory of the student's academic record in conjunction with both general education and program requirements.

The advisor annotates the degree check sheet whenever a substitute course has been allowed for one of the required or recommended courses in the program. If a course was taken on an "Independent Study" or "Special Topics" basis because of the SD State System requirements for minimum course enrollment, this will be noted. Before a student's application for graduation will be processed by RAS, the advisor must sign and send to the registration officer a confirmation that a degree check has been performed and the student has met all requirements.

The Registrar and Academic Services (RAS) maintains records of all student course records. These records are available via campus-wide digital systems: Datatel/Colleague and WebAdvisor. Faculty members electing not to use the digital system can readily and promptly secure any student's records from a variety of administrative personnel. These records are used by program faculty, in concert with each program's student participation, to maintain the BS in Metallurgical Engineering Course Check List shown in Table 1-8, which shows progress towards graduation. The check list is typically reviewed every semester but at least annually. Students failing to make programmatically specified progress towards graduation are counseled by their advisor and, depending on the seriousness of the inadequacy, the program department head. The university also effectively maintains and enforces policies 1) requiring minimum overall and recent semester GPA performance, 2) specifying no more than three attempts in any one course, 3) requiring certain grade attainment in selected prerequisite (usually math) courses, and 4) assuring satisfaction of general education goals established by the Regents.

The Degrees Committee, with the help of Registrar and Academic Services, makes a final check on all graduating students to determine that all graduation requirements have been met. Before the Degrees Committee degree check the program department head conducts a degree check using Table 1-8, Table 1-12 and Table 1-13. The head then sends these completed tables for each student considered for graduation to Registrar and Academic Services for their consideration. The evaluation using these tables is completed at least two months before the student's graduation. Twelve of the credits listed in Table 1-12 as Humanities/Social Sciences must fulfill General Education requirements specified by the South Dakota Board of Regents.

This graduation application and degree-check process is currently under review with the aim of implementing processes that would effectively eliminate instances of students not discovering missed requirements until their final semester of enrollment. Alterations to degree audit and graduation application processes will be completed by the time of the site visit and can be explained in detail at that time.

The advisor annotates the Degree Check sheet whenever a substitute course has been allowed for one of the required or recommended courses in the program. If a course was taken on an Independent Study or Special Topics basis because of the SD State System requirements for minimum course enrollment, this will be noted. Before a student's application for graduation will be processed by RAS, the advisor must sign and send to the registration officer a confirmation that a degree check has been performed and the student has met all requirements.

General Requirements

Common general graduation requirements apply for the Bachelor of Science degree in any curriculum offered by the university. Please refer to the curriculum for an individual degree program for specific course requirements. Each candidate for a degree is personally responsible for meeting all requirements for graduation. No university official can relieve a candidate of this responsibility. The South Dakota School of Mines and Technology reserves the right to change any course of study or any part of a curriculum in keeping with accreditation, educational, and scientific developments. The general education requirements must be approved by the student‘s advisor and by the Vice President for Academic Affairs/Provost. The general education requirements are summarized briefly in Table 1-12 and 1-13 below and are described in much more detail in Criterion 5 – Curriculum.

G. Transcripts of recent graduates

Student transcripts will be provided under separate cover to the PEV upon request per the Self-study guidelines. Table 1-14 is an example transcript. It includes a record of all credits accruing to the student at SDSM&T including transfer credits and credits earned at other SD regental state universities, if any, in addition to credits completed at SDSM&T. The header information describes the period of study and the institution where the study was conducted. The example transcript shows all credits beginning in 2013 that accrue to the student. The sub headings show the institution where the credit was completed and if outside the SD state university system is clearly identified as transfer credit. This student has credits from four institutions outside the SD regental system. All credits from within the SD regental system, which includes SDSM&T, are reported under the same heading since the state system has a common course numbering system. The total credits attempted and completed and GPA is reported at the end of each semester.

H. Enrollment and graduation trends (not required)

The enrollment and graduation trends for the BS Metallurgical Engineering program over the last six years are shown in Table 1-15. One unit is either a full-time equivalent student or the equivalent of 15 credits per term. As can be seen the enrollment in the program has grown significantly in the last few years. The BS Metallurgical Engineering program graduates during the evaluation period are listed in Table 1-16.

Outstanding Recent Graduate Awards

The Outstanding Recent Graduate Program honors graduates who have achieved exemplary career progress and recognition within ten years of their graduation. The program was originated and is sponsored by the SDSM&T Alumni Association and the SDSM&T Foundation. Candidates are reviewed based on nominations submitted by their undergraduate degree-granting department or program. The individuals selected for this award are considered excellent role models to show current students the importance of continued personal growth in a rapidly changing world. Typically, five awards are given yearly.

The BS Metallurgical Engineering program has a very strong record with respect to this award, and that has continued in the recent past with awards won yearly from 2005-2010. Table 1-17 lists the Recent Outstanding Recent Graduate awards from BS Metallurgical Engineering program alumni. In addition, Table 1-18 shows the graduation rates for the last six years.

Table 1-12 System-Wide General Education Requirements Checklist

Name:__________________________

Instructions: SDSM&T courses used to satisfy requirements ***must*** *be selected from those listed on the back of this form. Enter the courses as you complete them and record the semester and year completed. Consult with your advisor on transfer courses.*

Goal 1 Written communications (6 credits)			
Date	Cr. Hrs.	Course	Title (if transferred, from where?)
Goal 2 Speech Communications (3 credits)			
Date	Cr. Hrs.	Course	Title (if transferred, from where?)
Goal 3 Social Sciences (6 credits, in 2 disciplines or course prefixes)			
Date	Cr. Hrs.	Course	Title (if transferred, from where?)
Goal 4 Arts/Humanities (6 credits; in 2 disciplines, course prefixes or a sequence of a foreign language)			
Date	Cr. Hrs.	Course	Title (if transferred, from where?)
Goal 5 Mathematics (3 credits)			
Date	Cr. Hrs.	Course	Title (if transferred, from where?)
Goal 6 Science (6 credits) Lecture and Lab are required			
Date	Cr. Hrs.	Course	Title (if transferred, from where?)
Goal 7 Information Usage (9 credits) Courses indicated by * and bold on back			
Date	Cr. Hrs.	Course	Title (if transferred, from where?)

Table 1-13 General Education Requirement Goals

Goal Number	Goal Objective	Credit Hours Needed
1	Effective Writing	6
2	Communicate Effectively	3
3	Social Sciences	6
4	Arts and Humanities	6
5	Mathematics	3
6	Natural Sciences	6
7	Information	9
Globalization	Understand Global Issues	0.1 (MET 310)
Writing Intensive	Improve Writing	0.1 (MET 321)

Table 1-14 Sample transcript

Undergraduate Transcript

Page: 1 of 2
May 20, 2016

Student Attended/Attending the Following Regental Universities:
The South Dakota School of Mines and Technology, Rapid City, SD

SEND TO:

COURSE		Course Title	CRD	GRD	RPT
Beginning Fall 2003, credit earned from all six SD Regental Universities will be identified and displayed under the term header					
2009 FALL Transfer Credit - Rio Salado College					
MAT	187	PRECALCULUS	5.00	A	
		TERM ATT: 5.00 CMPL: 5.00 GPA: 4.000			
		CUM ATT: 5.00 CMPL: 5.00 GPA: 4.000			
2010 SUMMER Transfer Credit - Mesa Community College					
ART	161	CERAMICS I	3.00	A	
		TERM ATT: 3.00 CMPL: 3.00 GPA: 4.000			
		CUM ATT: 8.00 CMPL: 8.00 GPA: 4.000			
2010 FALL Transfer Credit - Rio Salado College					
PHY	111	GENERAL PHYSICS I	4.00	B	R
		TERM ATT: 4.00 CMPL: 4.00 GPA: 3.000			
		CUM ATT: 12.00 CMPL: 8.00 GPA: 4.000			
2011 SPRING Transfer Credit - Rio Salado College					
PHY	112	GENERAL PHYSICS II	4.00	A	
		TERM ATT: 4.00 CMPL: 4.00 GPA: 4.000			
		CUM ATT: 16.00 CMPL: 12.00 GPA: 4.000			
2011 FALL Transfer Credit - Arizona State University					
ENG	101	FIRST-YEAR COMPOSITION	3.00	A	R
STPE	226	ELEMENTS OF STATISTICS	3.00	A	
PGS	101	INTRODUCTION TO PSYCHOLOGY	3.00	A	
SOC	101	INTRODUCTION TO SOCIOLOGY	3.00	A	
CDE	232	HUMAN DEVELOPMENT	3.00	A	
CED	194	SPECIAL TOPICS	2.00	A	
		TERM ATT: 17.00 CMPL: 17.00 GPA: 4.000			
		CUM ATT: 33.00 CMPL: 26.00 GPA: 4.000			
2012 SPRING Transfer Credit - Arizona State University					
BIO	181	GENERAL BIOLOGY I	4.00	A	
ENG	102	FIRST-YEAR COMPOSITION	3.00	A	
EDP	310	ED PSYCHOLOGY FOR NON-TEACHERS	1.00	A	
SOC	483	HISTORY OF SOCIAL THOUGHT	3.00	B	
SOC	484	INTERNSHIP	6.00	F	
CED	194	SPECIAL TOPICS	1.00	A	
		FROM: Mesa Community College			
CHM	152	GENERAL CHEMISTRY II	3.00	A	
CHM	152L	GENERAL CHMISTRY II LAB	1.00	A	
EMT	101	CPR: BASIC CARDIAC LIFE SUPPO	0.50	S	
		TERM ATT: 22.50 CMPL: 16.50 GPA: 2.773			
		CUM ATT: 55.50 CMPL: 42.50 GPA: 3.438			
2012 SUMMER Transfer Credit - Mesa Community College					
EMT	104	BASIC EMERGNCY MED TECH	9.00	A	
		TERM ATT: 9.00 CMPL: 9.00 GPA: 4.000			
		CUM ATT: 64.50 CMPL: 51.50 GPA: 3.526			

COURSE		Course Title	CRD	GRD	RI
2012 FALL Transfer Credit - Arizona State University					
MUS	354	POPULAR MUSIC	3.00	A	
PGS	222	HUMAN SEXUAL BEHAVIOR	3.00	A	
PSY	290	RESEARCH METHODS	4.00	A	
EDP	310	ED PSYCHOLOGY FOR NON-TEACHERS	1.00	A	
SOC	352	SOCIAL CHANGE	3.00	A	
CON	101	CONST/CULTURE: A BUILT	3.00	A	
		TERM ATT: 17.00 CMPL: 17.00 GPA: 4.000			
		CUM ATT: 81.50 CMPL: 68.50 GPA: 3.635			
2013 SPRING Transfer Credit - Arizona State University					
PSY	324	MEMORY AND COGNITION	3.00	A	
PSY	323	SENSATION AND PERCEPTION	3.00	A	
PGS	443	ABNORMAL CHILD PSYCHOLOGY	3.00	A	
SOC	324	WORK AND THE WORKPLACE	3.00	A	
PGS	315	PERSONALITY THEORY/RESEARCH	3.00	A	
PGS	399	SUPERVISED RESEARCH	1.00	S	
PGS	304	EFFECTIVE THINKING	3.00	A	
		TERM ATT: 19.00 CMPL: 19.00 GPA: 4.000			
		CUM ATT: 100.50 CMPL: 87.50 GPA: 3.707			
2013 SUMMER Advanced Placement - SD Board of Regents Universities					
M CHEM	112	GENERAL CHEMISTRY I	3.00	EX	
M CHEM	112L	GENERAL CHEMISTRY I LAB	1.00	EX	
M ENGL	101	COMPOSITION I	3.00	EX	
M ENGL	210	INTRODUCTION TO LITERATURE	3.00	EX	
M MATH	123	CALCULUS I	4.00	EX	
M POLS	100	AMERICAN GOVERNMENT	3.00	EX	
		TERM ATT: 17.00 CMPL: 17.00 GPA: 0.000			
		CUM ATT: 117.50 CMPL: 104.50 GPA: 3.707			
2013 FALL		**Institutional Credit - SD Board of Regents Universities**			
M EM	214	STATICS	3.00	A	
M MATH	125	CALCULUS II	4.00	A	
M MET	231	STRUCTURE & PROP OF MAT-LAB	1.00	A	
M MET	232	PROPERTIES OF MATERIALS	3.00	A	
M PE	113	VARSITY SPORTS	1.00	A	
		FROM: Arizona State University			
PSY	341	HEALTH DEVELOPMENTAL PSYCHOLOG	3.00	A	
PSY	350	SOCIAL PSYCHOLOGY	3.00	A	
PSY	394	SPECIAL TOPICS	3.00	S	
PSY	366	ABNORMAL PSYCHOLOGY	3.00	A	
WST	100	WOMEN, GENDER, AND SOCIETY	3.00	A	
ASB	100	INTROCUDTION TO GLOBAL	3.00	A	
WST	313	WOMEN AND SEXUALITY	3.00	A	
		TERM ATT: 33.00 CMPL: 33.00 GPA: 4.000			
		CUM ATT: 150.50 CMPL: 137.50 GPA: 3.779			

*** Transcript Continues ***

Carla Cennenaro
Director of Registrar and
Academic Services

Table 1-14 Sample transcript (cont'd)

Undergraduate Transcript

Page: 2 of 2
May 20, 2016

(Continued from page 1)

COURSE		Course Title	CRD	GRD	RPT
2014 SPRING		**Institutional Credit - SD Board of Regents Universities**			
M EM	321	MECHANICS OF MATERIALS	3.00	A	
M ENGL	279	TECHNICAL COMMUNICATIONS I	3.00	A	
M IENG	301	BASIC ENGINEERING ECONOMICS	2.00	A	
M MATH	321	DIFFERENTIAL EQUATIONS	3.00	A	
M MET	220	MINERAL PROC/RESOURCE RECOVERY	3.00	A	
M MET	220L	MIN PROC&RESOURCE RECOVRY LAB	1.00	A	
M PHYS	211	UNIVERSITY PHYSICS I	3.00	A	
M PHYS	211A	UNIVERS PHYSICS I RECITATION	0.00	LR	
	TERM	ATT: 18.00 CMPL: 18.00 GPA:	4.000		
	CUM	ATT: 168.50 CMPL: 155.50 GPA:	3.807		
2014 FALL		**Institutional Credit - SD Board of Regents Universities**			
M ENGL	289	TECHNICAL COMMUNICATIONS II	3.00	A	
M MATH	225	CALCULUS III	4.00	A	
M MET	320	METALLURGICAL THERMODYNAMICS	4.00	A	
M MET	351	ENGINEERING DESIGN I	2.00	A	
M MET	422	TRANSPORT PHENOMENA	4.00	A	
	TERM	ATT: 17.00 CMPL: 17.00 GPA:	4.000		
	CUM	ATT: 185.50 CMPL: 172.50 GPA:	3.828		
2015 SPRING		**Institutional Credit - SD Board of Regents Universities**			
M EE	301	INTR CIRCUITS, MACHINES & SYST	4.00	A	
M EE	301L	INTRO CIRCUITS, MACHS&SYS LAB	0.00	LR	
M MATH	373	INTRO TO NUMERICAL ANALYSIS	3.00	A	
M MET	321	HIGH TEMP EXTRACT/CONC/RECYLIN	4.00	A	
M MET	321L	HIGH TEMP EXTRAC/CON/RECY LAB	0.00	LR	
M MET	352	ENGINEERING DESIGN II	1.00	A	
M MET	450	FORENSIC ENGINEERING	3.00	B	
	TERM	ATT: 15.00 CMPL: 15.00 GPA:	3.800		
	CUM	ATT: 200.50 CMPL: 187.50 GPA:	3.826		
2015 FALL		**Institutional Credit - SD Board of Regents Universities**			
M MET	330	PHYSICS OF METALS	3.00	A	
M MET	332	THERMOMECHANICAL PROCESSING	3.00	B	
M MET	464	ENGINEERING DESIGN III	2.00	B	
		CLEP - SD Board of Regents Universities			
M SPAN	101	INTRODUCTORY SPANISH I	4.00	EX	
M SPAN	102	INTRODUCTORY SPANISH II	4.00	EX	
	TERM	ATT: 16.00 CMPL: 16.00 GPA:	3.375		
	CUM	ATT: 216.50 CMPL: 203.50 GPA:	3.806		
2016 SPRING		**Institutional Credit - SD Board of Regents Universities**			
M MET	310	AQUEOUS EXTRACT/CONC/RECYCLNG	3.00	B	
M MET	310L	AQUEOUS EXTRACT/CONC/RECYCL L	1.00	A	
M MET	432	ADVANCED MATERIALS & PROCESSES	3.00	A	
M MET	433	PROCESS CONTROL	3.00	A	
M MET	440	MECHANICAL METALLURGY	3.00	A	
M MET	440L	MECHANICAL METALLURGY LAB	1.00	A	
M MET	465	ENGINEERING DESIGN IV	1.00	B	
M MET	491	INDEPENDENT STUDY	1.00	A	
	TERM	ATT: 16.00 CMPL: 16.00 GPA:	3.750		
	CUM	ATT: 232.50 CMPL: 219.50 GPA:	3.801		

	ATT HRS	CMPL HRS	GPA HRS	GRADE PTS	GPA
TRANSFER	146.50	133.50	110.00	413.00	3.755
INSTI SDSMT	86.00	86.00	86.00	332.00	3.860
CUM	232.50	219.50	196.00	745.00	3.801

*** End of Transcript ***

Table 1-15 Undergraduate enrollment trends for SDSM&T for the past six academic years: BS Metallurgical Engineering program

Category	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Full-time Student Summer	0	1	0	0	0	
Full-time Student Fall	84	75	63	76	101	122
Full-time Student Spring	75	62	63	72	96	103
Part-time Student Summer	15	10	9	15	12	
Part-time Student Fall	4	1	5	6	9	11
Part-time Student Spring	6	10	7	7	9	10
Student FTE1 Summer	4.7	3.9	1.7	4.7	3.5	
Student FTE Fall	85.8	76.1	64.8	76	102.3	126.2
Student FTE Spring	79.2	64.1	65.3	74.4	100.5	106.8
Total BS Degrees	12	15	14	9	11	17

Table 1-16 Program Graduates 2009-15

Last	First	Year Grad	Employer	Placed	Grad Schl	F
[redacted]	[redacted]	2009	Quarq	1		
[redacted]	[redacted]	2009	Xyvex	1	1	
[redacted]	[redacted]	2009	North American Stainless	1	1	
[redacted]	[redacted]	2009	Alcoa	1		
[redacted]	[redacted]	2009	Spirit Aerosystems	1		1
[redacted]	[redacted]	2009	Nucor Steel	1		
[redacted]	[redacted]	2010	FLSmidth Minerals	1		
[redacted]	[redacted]	2010	Hill AFB	1		
[redacted]	[redacted]	2010	RPM and Associates	1	1	
[redacted]	[redacted]	2010	Montana Precision Products	1	1	
[redacted]	[redacted]	2010	Nucor Steel	1		
[redacted]	[redacted]	2010	MS student SDSM&T	1	1	
[redacted]	[redacted]	2010	PhD student UAB	1	1	
[redacted]	[redacted]	2010	Nucor Steel	1		
[redacted]	[redacted]	2010	MS student SDSM&T	1	1	
[redacted]	[redacted]	2010	PhD student NTNU, Norway	1	1	
[redacted]	[redacted]	2010	No Response	1		
[redacted]	[redacted]	2011	McConway & Torley	1		1
[redacted]	[redacted]	2011	Alcoa	1		1
[redacted]	[redacted]	2011	MS student SDSM&T	1	1	1
[redacted]	[redacted]	2011	Sumitomo Metals Company	1		
[redacted]	[redacted]	2011	Neapco	1		
[redacted]	[redacted]	2011	RPM and Associates	1		
[redacted]	[redacted]	2011	Nucor Steel	1		1
[redacted]	[redacted]	2011	Lyondell Basell	1	1	
[redacted]	[redacted]	2011	Caterpillar	1		
[redacted]	[redacted]	2011	John Deere	1		
[redacted]	[redacted]	2011	Stupp Corporation	1		1

Table 1-16 Program Graduates 2009-15 (cont'd)

[redacted]	[redacted]	2012	Goldcorp (Marigold Mining)	1		
[redacted]	[redacted]	2012	Barrick Gold	1		
[redacted]	[redacted]	2012	Freeport McMoRan	1		1
[redacted]	[redacted]	2012	Nucor Steel	1		
[redacted]	[redacted]	2012	Logan Aluminum	1	1	
[redacted]	[redacted]	2012	Nucor Steel	1		
[redacted]	[redacted]	2012	Freeport McMoRan	1		
[redacted]	[redacted]	2012	Nucor Steel	1		
[redacted]	[redacted]	2012	Brillion Iron Works	1		
[redacted]	[redacted]	2012	Gerdau	1		1
[redacted]	[redacted]	2012	Nucor Steel	1		
[redacted]	[redacted]	2012	Freeport McMoRan	1		
[redacted]	[redacted]	2013	Strum Ruger & Co	1		
[redacted]	[redacted]	2013	PhD student CSM	1	1	
[redacted]	[redacted]	2013	US Army	1		
[redacted]	[redacted]	2013	Nucor Steel	1		
[redacted]	[redacted]	2013	Logan Aluminum	1		
[redacted]	[redacted]	2013	Hurst Metallurgical Research Lab	1		
[redacted]	[redacted]	2013	Kondex	1		
[redacted]	[redacted]	2013	L&H Industrial	1		
[redacted]	[redacted]	2013	Applied Control Equipment	1		
[redacted]	[redacted]	2013	Nucor Steel	1		
[redacted]	[redacted]	2013	MS student SDSM&T	1		
[redacted]	[redacted]	2013	MS student SDSM&T	1	1	
[redacted]	[redacted]	2013	Nucor Steel	1		
[redacted]	[redacted]	2014	Nucor Steel	1		
[redacted]	[redacted]	2014	MS student SDSM&T	1		
[redacted]	[redacted]	2014	Parker Hannifin	1		
[redacted]	[redacted]	2014	US Marine Corp	1		
[redacted]	[redacted]	2014	MS student SDSM&T	1	1	1
[redacted]	[redacted]	2014	Western States Fire Protection	1		
[redacted]	[redacted]	2014	Nucor Steel	1	1	
[redacted]	[redacted]	2014	RC Regional Health	1		
[redacted]	[redacted]	2014	Klondex Mine	1		
[redacted]	[redacted]	2014	Returned to Kuwait	1		1
[redacted]	[redacted]	2014	Looking			
[redacted]	[redacted]	2014	Spirit Aerosystems	1		
[redacted]	[redacted]	2014	Looking			
[redacted]	[redacted]	2015	MS student SDSM&T	1	1	1
[redacted]	[redacted]	2015	Nucor Steel	1		
[redacted]	[redacted]	2015	Nucor Steel	1		
[redacted]	[redacted]	2015	PhD student U of IL	1	1	
[redacted]	[redacted]	2015	Looking			
[redacted]	[redacted]	2015	Nucor Steel	1		1
[redacted]	[redacted]	2015	Looking			
[redacted]	[redacted]	2015	Walker Forge	1		
[redacted]	[redacted]	2015	MS student SDSM&T	1	1	
[redacted]	[redacted]	2015	Denso	1		
[redacted]	[redacted]	2015	MS student SDSM&T	1	1	

Table 1-16 Program Graduates 2009-15 (cont'd)

[redacted]	[redacted]	2015	No Reponse			
[redacted]	[redacted]	2015	Tinker AFB	1		
				75	20	12
				94%	25%	15%

Table 1-17 Program Outstanding Recent Graduates (2010-15)

Name	Year Graduated	Year Awarded	Employer
Grant Crawford	2004	2015	SDSM&T
Lisa Schlink	2004	2014	Freeport McMoRan
Derek Rebsom	2002	2013	Medtronic
Bert Cantu	2001	2012	John Deere
Chad Griswold	2001	2011	3M
Jeffrey Major	1999	2010	Quest Integrity Group

Table 1-18 Graduation rates in BS Metallurgical Engineering program

Fed Cohort	Student count	Grad 4 years or less	Grad 5 years or less	Grad 6 years or less	Grad 4 years or less	Grad 5 years or less	Grad 6 years or less
M2006	19	9	15	16	47.4%	78.9%	84.2%
M2007	13	4	5	5	30.8%	38.5%	38.5%
M2008	14	7	9	9	50.0%	64.3%	64.3%
M2009	16	5	9	9	31.3%	56.3%	56.3%
M2010	20	6	9	11	30.0%	45.0%	55.0%
M2011	10	4	6	6	40.0%	60.0%	60.0%
M2012	12	2	2	2	16.7%	16.7%	16.7%
M2013	21						
M2014	37						
M2015	39						

CRITERION 2 - PROGRAM EDUCATIONAL OBJECTIVES

The terms and definitions used throughout this report are consistent with ABET publications and guidelines. Appendix F contains a glossary of important terms used throughout this self-study document.

A. Mission statement

The Mission of SDSM&T is codified in state statutes (SD Codified Law Statute 13-60-61) and defined in SDBOR Policy 1:10:3. As articulated in state law, the mission is worded for lawmakers for policy purposes and does not speak clearly and effectively to the public at large. In fall 2013, the mission and vision were expressed as a single clear and aspirational statement. This statement is used for planning and is the effective mission of SDSM&T. It is found at http://www.sdsmt.edu/About/Office-of-the-President/Vision-and-Mission/ and worded as follows:

> *Our vision is for the South Dakota School of Mines and Technology to be recognized as an exceptional engineering and science university. Our mission is to prepare leaders in engineering and science, to advance knowledge and its application, and to serve the state of South Dakota, the region, and the nation.*

The goals of the Strategic Plan were established in fall 2012. Delay in full articulation and publication of the Strategic Plan was the result of then President Warton's untimely death followed by the Provost assuming for one year the dual role of Interim President and Provost.

The Executive Council revisited in 2013 the institutional values as articulated in 2011 through a campus-wide process. The value of "excellence" was added, and the values are published on the back cover of the Strategic Plan. The values of the institution are as follows: *Excellence, Respect, Integrity, Collaboration, and Service*. Between October 2013 and January 2014, the academic departments and center directors were asked to take the Strategic Plan goals articulated in 2012 and to create a 2-5 page summary of priorities, initiatives, and ideas for development. The summaries were universally shared, and an all-campus meeting that included key external stakeholders was held. Six overarching themes were discussed. The considerable feedback from this open planning session was studied and used to update and more fully flesh out the Strategic Plan goals and to ensure congruence between mission and program development. Table 2-1 shows the summary flyer of the Strategic Plan. More details and information on the Strategic Plan is available at http://www.sdsmt.edu/About/Strategic-Plan/.

The feasibility-study phase of a capital campaign was also executed in 2014. The president of the foundation and the president of the institution traveled to visit 45 major donors, partners, and alumni in 20 cities to get input on the strategic plan and issues of mutual concern. Input from these constituents was used to ensure congruence between mission, program development, and constituent needs. The *In Pursuit of Excellence: Mines Strategic Plan* was published in late spring 2014 and updated in fall 2015. The institution is managing to the six goals as articulated

Table 2-1 Mines Strategic Plan

AN EVEN GREATER TEAM

MINES STRATEGIC PLAN

GOALONE	GOALTWO	GOALTHREE	GOALFOUR	GOALFIVE	GOALSIX
Student Success	**Research**	**Facilities**	**People**	**Administration**	**Development**
Prepare more undergraduate students for leadership in engineering and science.	Increase research to prepare science and engineering experts, advance knowledge, and catalyze economic development.	Redevelop and expand needed living, learning, and research spaces.	Recruit, develop and retain excellent faculty and staff.	Responsibly steward financial and physical resources.	Establish a robust culture of philanthropy to enable the university to sustain excellence.
LEAD: PROVOST/ DEAN OF STUDENTS	**LEAD:** VICE PRESIDENT FOR RESEARCH	**LEAD:** DIRECTOR OF FACILITIES	**LEAD:** VICE PRESIDENT OF HUMAN RESOURCES	**LEAD:** VICE PRESIDENT FOR FINANCE	**LEAD:** FOUNDATION PRESIDENT
STRATEGY	**STRATEGY**	**STRATEGY**	**STRATEGY**	**STRATEGY**	**STRATEGY**
Implement aggressive enrollment plan to increase the undergraduate student body to 3,000. (1-A)	Develop sustainable funding for doctoral education sufficient to graduate 20 PhD students per year. (2-A)	Plan and secure sufficient housing on or near campus for all freshmen and sophomores. (3-A)	Increase faculty support through private funds to promote excellence and achieve greater salary equity. (4-A)	Strengthen planning and budgeting practices to optimize fiscal management and tie budgets to the strategic plan. (5-A)	Develop and implement a strategy for embedding a culture of giving in students, alumni, and friends of Mines. (6-A)
Strengthen advising, counseling, mentoring, and engagement to improve retention at every stage. (1-B)	Further develop and implement a comprehensive doctoral recruitment plan. (2-B)	Design and build an Energy Resources Center to support oil and gas research and teaching. (3-B)	Strengthen and expand professional development opportunities at all levels of the organization. (4-B)	Implement a systematic process for facility use, maintenance, and planning. (5-B)	Energize Mines fundraising and extend the culture of giving. (6-B)
Enhance engaged and experiential learning in curricular and co-curricular programs, as well as co-ops and internships. (1-C)	Improve private sector sponsorship, including intellectual property and licensing practices, to significantly expand research and catalyze innovation. (2-C)	Design and build an Innovation Center for project based learning and competitive engineering program expansion. (3-C)	Review and optimize recruitment, performance evaluation, and recognition processes to promote excellence and align with strategic goals. (4-C)	Review and improve business support services to enhance operations. (5-C)	Engage alumni, corporations, community, and champions of STEM education in active partnerships. (6-C)
Advance student professional readiness through Mines Advantage. (1-D)	Develop and implement targeted enrollment plan to expand professional Master's programs. (2-D)	Refurbish and rebuild Mining, Materials and Metallurgy Building to support research and teaching. (3-D)		Develop and implement a systematic process for risk assessment and mitigation. (5-D)	
Enhance recruitment, support, and mentoring for women, first-generation students, minorities, and international students. (1-E)		Restore and repurpose the Old Gym for teaching, performance, and faculty/staff space. (3-E)			
Fully integrate athletics into the RMAC and strengthen access to educational opportunities for scholar-athletes. (1-F)		Restore and refurbish laboratories to meet the needs of Chemistry, Applied Biology, and Physics/EE/Nano. (3-F)			
		Design and build expansion of Surbeck to accommodate expanded student dining and activity space. (3-G)			

SOUTH DAKOTA
SCHOOL OF MINES & TECHNOLOGY

in the 2014 Plan. SDSM&T follows an annual cycle to review, update, and refine the six goals of the Strategic Plan. Progress on the goals is reviewed twice annually. Additional information on the SDSM&T Foundation is available at http://foundation.sdsmt.edu/

The context of SDSM&T in the South Dakota Higher Education System helps ensure fidelity between institutional program array and mission. The institution has a clear role in the System as a demanding STEM-focused institution and members of the executive leadership team, including the president and all the vice presidents work through system-level advisory councils (e.g., The Council of Presidents and the Academic, Business, and Student Development councils). Governance of all institutions in the system by a sole Board of Regents and a broad spectrum of system-wide councils, committees, and task forces promote collaboration and reinforce the distinctive contributions and strengths of each university in the SD system.

The mission of the Department of Materials and Metallurgical Engineering appears in the catalog and on the web site at http://www.sdsmt.edu/Academics/Departments/Materials-and-Metallurgical-Engineering/Accreditation---Assessment/.

The Mission of the Department of Materials and Metallurgical Engineering is to

- Provide a quality program leading to the degree BS in Metallurgical Engineering
- Participate in multi-disciplinary programs leading to the MS and PhD degree programs in materials engineering and science
- Contribute to the expansion of knowledge in the area of materials and metallurgical engineering through scholarly activities
- Help local, regional, national and international materials and metallurgical industries through research and development activities

B. Program educational objectives

The objectives of the BS in Metallurgical Engineering Degree program are to graduate students who can

1. Successfully apply metallurgical engineering principles in their employment
2. Meet societal needs through science and technology
3. Grow professionally and personally
4. Serve their profession and community

These objectives appear on the departmental bulletin board, on the departmental web page http://www.hpcnet.org/ABETMetEngMissionObjectives, in the 2010-2011 university catalog, and on selected departmental promotional literature.

Figure 2-1 shows an overall view of the university vision; the university and department, and program mission; and the program objectives.

C. Consistency of the program educational objectives with the mission of the institution

The metallurgical engineering program objectives are derived from the institutional mission. Table 2-2 shows the relationships among the institutional and the metallurgical engineering program objectives.

The SDSM&T Vision is for

the South Dakota School of Mines & Technology to be recognized as an exceptional engineering and science university.

The SDSM&T Misson is to

- prepare leaders in engineering and science
- advance knowledge and its application;
- serve the state of South Dakota, the region, and the nation.

The Mission of the Department of Materials and Metallurgical Engineering is to

- Provide a quality program leading to the degree BS in Metallurgical Engineering
- Participate in multi-disciplinary programs leading to the MS and PhD degree programs in materials engineering and science
- Help local, regional, national and international materials and metallurgical industries through research and development activities
- Contribute to the expansion of knowledge in the area of materials and metallurgical engineering through scholarly activities

Program Educational Objectives

The objectives of the BS in Metallurgical Engineering degree program are to graduate students who can

- Successfully apply metallurgical engineering principles in their employment
- Meet societal needs through science and technology
- Grow professionally and personally
- Serve their profession and community

Figure 2-1 Overview of Vision, Missions, and Objectives

Table 2-2 Alignment of the BS Metallurgical Engineering program objectives with SDSM&T institution's objectives.

SDSM&T Mission / BS MET ENG	Prepare Leaders in Engineering and Science	Advance Knowledge and Application	Serve the State of South Dakota, Region, and Nation
Apply Met Eng Principles			
Meet Societal Needs			
Grow Prof & Personally			
Serve Community & Profession			

D. Program constituencies

The program constituents are those who employ our graduates. These are

- Private industry
- Public agencies
- University graduate programs
- Self-employed entrepreneurial alumni

Constituent input is gained during the Materials and Metallurgical Engineering Advisory Board meetings and through input from alumni as they visit campus throughout the year. The Advisory Board includes alumni so they represent now-informed (former) student interests.

Undergraduate students in the BS Metallurgical Engineering program are considered a special constituency group in the area of providing direct feedback on the quality of the classroom and laboratory instruction for required and elective courses in the program. They do not have sufficient experience or knowledge to be considered a constituency group for evaluation and revision of PEOs. Each academic semester these students have opportunity to provide feedback into the program in the form of the student evaluations that are mandatory for every class taught every semester by Assistant and Associate Professors and once every three years for Full Professors. The university uses the IDEA Student Ratings of Instruction instruments. These data are collected and maintained by the Department Head and are discussed with individual faculty each semester the student ratings are completed. Student ratings constitute substantial portions of the individual faculty member's promotion and tenure review process, as well as providing information on areas to adjust curriculum based on student expectations. Recent graduates, having gained some perspective, are highly valued as part of the program's objectives and student outcomes review process.

E. Process for establishing program educational objectives

The department has a long tradition of external evaluation dating to 1970. Periodic surveys of both alumni and their employers were routinely performed and acted on. The department was the source of the current campus student opinion surveys starting in 1971. The department was also the point of initiation for Industrial Advisory Boards (now called the Advisory Boards) beginning in 1972.

The design of the continuous improvement system began in 2000 and was followed by a staged collection of materials beginning in the 2001-2 academic year. During the subsequent two years, the system was continually refined and brought to full implementation. Although informal reviews and system refinements were occurring on a weekly basis throughout 2001-2003, the first comprehensive objective review involved all data collected up to the end of 2003. This initial "closing of the loops" occurred during the Spring Semester of 2004. During the period from 2001 to 2004 the entire department faculty has met once or twice a week during the academic year to create the continuous improvement system now in place. Departmental faculty members also attended ABET training sessions and numerous campus sessions on continuous improvement methodologies. With the substantial faculty retirements (Stone, Han, and Marquis) from 2005-2007, subsequent biannual Advisory Board reviews were renewed in 2007 with the newly contracted faculty (Medlin, West, and Cross). Subsequently, the board met in 2009, 2011, 2013, 2015, and again March 4, 2016 in review of the upcoming ABET review as well as planned implementation of new Student Educational Outcomes.

As departmental faculty members have retired and been replaced, new faculty members unfamiliar with the department's continuous improvement system undergo extensive training. As of 2015, all program faculty members are well versed and directly involved in supporting and managing the continuous improvement system. All teaching faculty members in the metallurgical engineering program are actively engaged in periodic reviews of the program educational objectives. The program faculty members are asked to review the objectives each year for appropriateness and thoroughness. Reviews are also conducted by the Advisory Board which reflects our constituents.

The Program Objectives and the Student Educational Outcomes have been reviewed periodically by the Metallurgical Engineering Advisory Board. The board is comprised historically of representatives primarily from industry but occasionally there is governmental laboratory and outside university representation. The SDSM&T MES faculty members represent graduate program representation and recent program alumni are reflections of informed student opinion.

The composition of the 2013-2018 Advisory Board is as follows:

- Terry Rasmussen, Nucor, Board Chairman
- Dr. Ray Peterson, Aleris International, Past Board Chairman
- Ms. Wendy Craig, Gerdau Steel
- Ms. Jenifer Galvin, SDSM&T MS Candidate*
- Mr. David Gildemeister, Alcoa
- Ms. Michelle Jensen, SDSM&T MS Candidate*
- Mr. Andy Johnson, AdvTech-Consulting
- Mr. Wayne Douglas, Barrick
- Mr. Christopher Misterek, John Deere
- Ms. Lisa Schlink, Freeport-McMoRan
- Mr. Shawn Veurink, RPM and Associates
- Mr. John Walenta, Caterpillar Inc.
- Mr. Richard Wensel, Micron Technology

  * Recent Alumni

The department holds regular meetings with its Advisory Board to conduct a review of Program Objectives and the department's success in achieving them. The review also includes a re-examination of the objectives to assure they are current and significant. Informational material presented to the board includes placement data, curriculum changes, continuous improvement assessment data, faculty professional activities, funding status, enrollment data, and laboratory and equipment status. The board members are selected to represent as many of the program's constituents as possible.

The Advisory Board used to be provided surveys from employers and constituents but that has been replaced by populating the board with those who have first-hand knowledge of graduate performance through their employer positions. The board is asked to offer input on specific topics such as the currency of the program and the adequacy of education objectives. The board is encouraged to offer any constructive comments. The Advisory Board reviews are held approximately every two years. They also serve as the constituent focus group. The program faculty members consider and implement recommendations of the board. The review culminates with action statements that are posted on the program's continuous improvement web site (www.ABETMetEng.or/SD). Figure 2-2 shows the process to determine progress in meeting program outcomes.

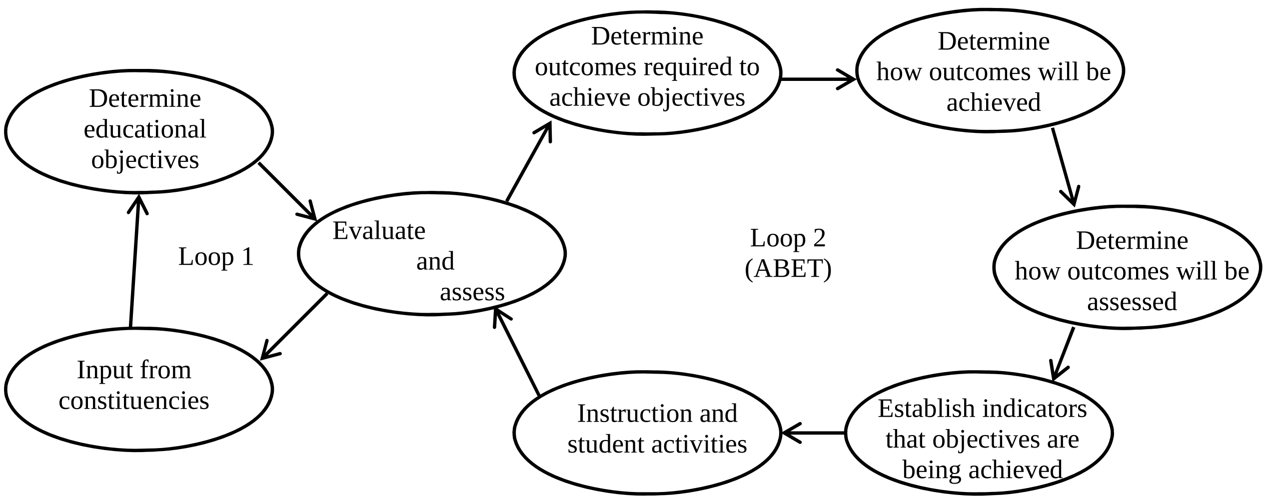

Figure 2-2 Continuous Improvement System (CIS) for the metallurgical engineering program

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CRITERION 3 - STUDENT OUTCOMES

This chapter describes the process for establishing student outcomes and revising them and the relationship of student outcomes to program educational objectives.

A. Process for the establishment and revision of the student outcomes

Program outcomes were established in 2002. Initially, the same (a)-(k) outcomes suggested by ABET were selected. Program faculty members attended numerous national assessment conferences and ABET seminars during that period so as to equip themselves with current ideas and best practices. During this period the initial (a)-(k) had grown to include several additional outcomes. Some outcomes such as communication were broken into two separate outcomes: oral and written. However, by the end of 2002, the need for such separations appeared weak and so was not adopted. Suggested new outcomes were also abandoned because they were found to be unrelated to a focused and systematic continuous improvement process. Consequently, the original (a)-(k) were adopted as the program outcomes. This selection is reviewed and discussed several times a year by program faculty, usually during the periodic outcome reviews. The same suggestions arise as were proposed in 2002 and are rejected for the same reasons they were rejected then.

Program faculty members remain vigilant through ABET seminars and by serving as continuous improvement consultants for new technical and societal trends that may need to be addressed by additional outcomes; however, none has risen to the level of importance warranting adoption. The program faculty members have always supported student's addressing economic, ethical, societal context, environmental, and safety issues but have embedded these into the design component of the current outcomes. These matters are now addressed in the revised (1) –(7) outcomes being proposed by ABET. This more formal collection of these topics is certainly agreeable to the program faculty members since it closely aligns with their practice and thinking.

Since 2002, the outcomes have been reviewed many times by the program faculty and the Metallurgical Engineering Advisor Board. Both the faculty and the board have ruled that the outcomes are appropriate and adequate within the requirements established by ABET. Now that ABET proposes to change the (a) – (k) requirements in a way that combines the elements of some of the (a) – (k) into new outcomes (1) – (7), the program faculty and the Advisory Board recommend adoption of that structural change and further have found at the March 2016 meeting that the (1) – (7) as proposed by ABET are adequate and appropriate. However, the current review is entirely based on the (a) – (k) outcomes.

B. Student outcomes

The Outcomes for the BS Metallurgical Engineering Program correspond to the criteria for accrediting engineering programs during the 2010 to 2015 accreditation cycle so no additional mapping is needed. These outcomes are shown in Table 3-1.

All program continuous improvement system (CIS) program documents are posted on the program CIS website: www.ABETMetEng.org/SD . This website reflects all of the program CIS documents, which reside on and are backed up on program computers. The website provides for selective controlled-user access. All program faculty members have complete download access to all CIS documents. The introduction of new documents to the CIS is controlled by the program designated CIS officer.

Table 3-1 Student Outcomes

a) Apply knowledge of mathematics, science, and engineering
b) Design and conduct experiments and analyze and interpret data
c) Design a system, component, or process with realistic economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints
d) Function on multidisciplinary teams
e) Identify, formulate, and solve engineering problems
f) Know professional and ethical responsibility
g) Communicate effectively
h) Know the impact of engineering on global, economic, environmental, and societal issues
i) Recognize the need for life-long learning
j) Know contemporary issues
k) Use the techniques, skills, and modern engineering tools necessary for engineering practice.

In addition to the (a) – (k) outcomes, the university has general education outcomes and measures of achieving their satisfaction. These measures have been improving over the last few years and are now at a point where the program plans to include them in them in the CIS beginning in 2016. The BS Metallurgical Engineering Program assesses on a calendar year basis; consequently, no reference is made to hyphenated academic years. The results of those measurements are included here to provide a view of the planned inclusion.

Student outcomes are posted on the department bulletin board located outside MI 114.

C. Relationship of student outcomes to program educational objectives

Table 3-2 shows the relationship of the metallurgical engineering program objectives to the program outcomes.

Table 3-2 The relationship between metallurgical engineering program objectives and program outcomes

Outcomes / Objectives	a	b	c	d	e	f	g	h	i	j	k
1 Apply Met Eng Prin.											
2 Meet Societal Needs											
3 Grow Prof & Personally.											
4 Serve Comm. & Profession.											

Table 3-3 is a quality function deployment matrix (QFDM) that shows the relationship of curricular elements, which are shown along the top row, to the program outcomes, which are shown in the first column. A value of *9* indicates the curricular element is high important to the program outcome; whereas, a *1* indicates a low importance. No value indicates that there is no functional relationship. A non-linear scale (*0, 1, 3, 9*) is used to give emphasis to most important curricular elements since two elements rating 3 would not be as significant to achievement of a particular outcome as one element rated 9. Table 3-3 compares similar courses groups and also shows extra-curricular elements since the program graduate is formed by both course work and extra-curricular activities.

A second QFDM for specific courses in the metallurgical engineering program is shown in Table 3-4. In this case the highest rating is 5 rather than 9 because 0, 1, 3, and 5 ratings better describe the effect of coursework on each outcome since effect is somewhat related to time-in-class spent on each outcome. The table at the bottom indicates the total importance to program outcomes of each element. The last column shows the number of *high importance* elements (highest rated) for each outcome.

The QFDM is used to determine where in the curriculum action should be directed to achieve improvement in a particular outcome. Of course, this information also satisfies this element of the self-study.

Table 3-3 Quality function deployment matrix for metallurgical engineering curriculum

Desired Outcomes		Advising	Indiv. assistance	Met 351/352	Met 464/465	Scholarship program	Math sequence	H&SS curriculum	Lab curriculum	Met Eng (lecture)	Elective courses	out-of-dept tech elect	PE, Music, MS	Student org act	TLC	Library services	ENGL seq	Study groups	Met electives	Free electives	Chem/physics seq	Placement Prog
	Processes																					
System will	Retain students	9	9			9		3	1		1	1	3	3	3			3		1		1
	Facilitate student employment	3	9			1		1	9	9	9	3	1	1		1	3		3			9
Graduates will	(a) Apply math, sci and eng prin		3	3	3	1	9		3	9	3	1			3	1		1	3		3	
	(b1) Design and Conduct exps		1	9	9		3	1	9	1						1			1		1	
	(b2) Analyze and interpret data and		1	9	3		3		9	9		1				1		1	1		3	
	(c1) Optimally select material		1	9	9		1		1	3						1		1	3			
	(c2) Design materials treatment and prod		1	9	9		1		1	3						1		1	3			
	(d) multidisciplinary teaming	1		9	9			1	3	1			3	9			1		1		1	
	(e) Ident, form, & solve eng prob		1	9	9		3		3	9	1			1		1			3		1	
	(f) Knowing prof and ethic respon	1	1	3	1			1		3						1			1			
	(g) Communicate effectively		1		3		1	1	9	1							9	3	1			
	(h) impact of eng in a glob context		1	3	3			9	1	3				1		1		1	1			
	(i) Be life-long learner	1	1	1	1			1	9	1	2	1		1		9		1	3	9		
	(j) Know contemporary issues		1					9		3				1		1			1			
	(k) Use tech, skills, & mod tools		3	1	1				9	3						1			1			
	LEGEND	15	34	65	60	11	21	27	67	58	16	7	7	17	6	20	13	12	26	10	9	10

- 9 High importance
- 3 Medium Importance
- 1 Low Importance
- No importance

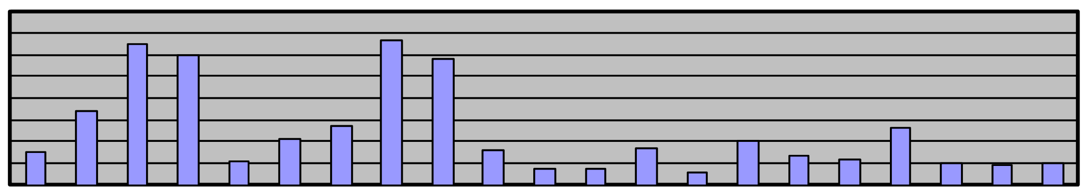
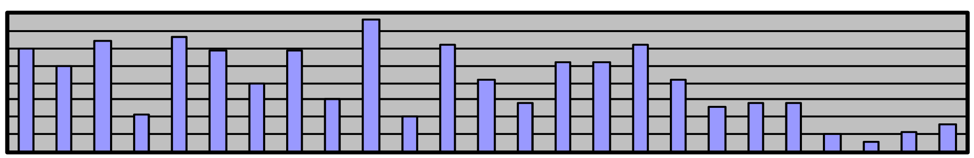


Table 3-4 Quality function deployment matrix for metallurgical engineering courses

Outcome Criteria	Course: MET 220	MET 220L	MET 231	MET 232	MET 310	MET 310L	MET 320	MET 321	MET 330	MET 330L	MET 332	MET 351/352	MET 422	MET 433	MET 440	MET 440L	MET 464/465	MET Electives	Math sequence	Required Eng Courses	H&SS curriculum	Elective Courses	PE, Music, Band, MS	ENGL Sequence	Chem/Physics Seq
(a) Apply mathematics, science and engineering principles	5	3	3	5	5	3	5	3	5	5	5	1	5	5	3	3	1	3	5	5		3			3
(b) Ability to design and conduct experiments and interpret data	3	5	5		3	5	3	3	3	5		1	3		3	5	1	3	3						3
(c) Ability to design a system, component, or process to meet design needs	3			3	3	3	3	5				5	5	3	3	3	5	3	1						
(d) Ability to function on multidisciplinary teams	1	3	5		1	1				5		5			1	3	5	1			1		3	1	1
(e) Ability to identify, formulate, and solve engineering problems	5	3	3	3	3	3	3	5	5	5	5	5	5	1	5	3	5	3	3	5		1			1
(f) Understanding of professional and ethical responsibility	3	1	1		3	1	1	5	1	3		3			3	1	3	1			1				
(g) Ability to communicate effectively	3	5	3		3	5	1	3		3		5			3	5	5	1	1		1			5	
(h) The broad education necessary to understand the impact of engineering solutions in a global	3		5		3	1	1			3								1		1	5				
(i) Recognition of the need for and an ability to engage in life-long learning			3		3	1				3		1			1		1	3			1	1			
(j) Knowledge of contemporary issues	3		1		1	1		5	1	1					1			1			5				
(k) Ability to use the techniques, skills, and modern engineering tools necessary for	1	5	3		5	5	3			5		5	3	5	3	3	5	1		3					
	30	25	32	11	33	29	20	29	15	38	10	31	21	14	26	26	31	21	13	14	14	5	3	6	8

LEGEND

5 High importance
3 Medium Importance
1 Low Importance
No importance



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CRITERION 4 - CONTINUOUS IMPROVEMENT

This chapter contains information on the Continuous Improvement System (CIS) developed and employed by the BS. Met Engineering Degree Program

A. Student outcomes

The student educational was reviewed by program faculty and the department's Advisory Board and upheld as appropriate during the period 2009-2016.

a) Apply Knowledge of Math, Science, and Engineering
b) Design and Conduct Experiments and Analyze and Interpret Data and Information
c) Optimally Select Material and Design Materials Treatment and Production Processes
d) Function Well on Teams
e) Identify, Formulate, and Solve Engineering Problems
f) Know Professional and Ethical Responsibilities and Practices
g) Communicate Effectively
h) Know Engineering's Global Societal Context
i) Engage in Life-Long learning
j) Know Contemporary Issues
k) Use Engineering Techniques, Skills, and Tools

B. Continuous improvement

The BS Metallurgical Engineering Program has employed a Continuous Improvement System (CIS) since 1970. Since 2003 all of the routine tabulation and presentation of results are performed by Excel VBA MACRO automation and posted at www.ABETMetEng.org. This makes all CIS results and data easily available to program faculty, administrators, students, Advisory Board members, and other interested parties at any time. For the ABET visit all CIS documents will be available in hard copy. This Self Study Report contains pertinent summary data and examples of collection documents so that the Program Evaluator will have clear understanding of what documents and records are available for detailed inspection. The CIS process is shown in Figure 4-1. The upper part of the figure shows the process for the continuous evaluation of program objectives, no longer required by ABET, while the lower half shows the process for outcome assessment.

The Metallurgical Engineering Department does not view operating the CIS as an ABET requirement but rather are of the position that ABET requirements will be met as a consequence of the department's long-established CIS system. Of course, the system has been modified over the years to meet ABET's interests and requirement for the sake of efficiency. ABET's discontinuance of Program Objective Evaluation since the last visit would not mean that the program would discontinue that long-established endeavor in the CIS program. Therefore, diagrams such as Figure 4-1 may show processes beyond the scope of the ABET review but are, nevertheless, an integral part of the program's Continuous Improvement System.

Next, the system for assessing outcomes (e.g. - student educational outcomes) will be discussed. Before presenting the details of the assessment process, it should be noted that the CIS keeps no

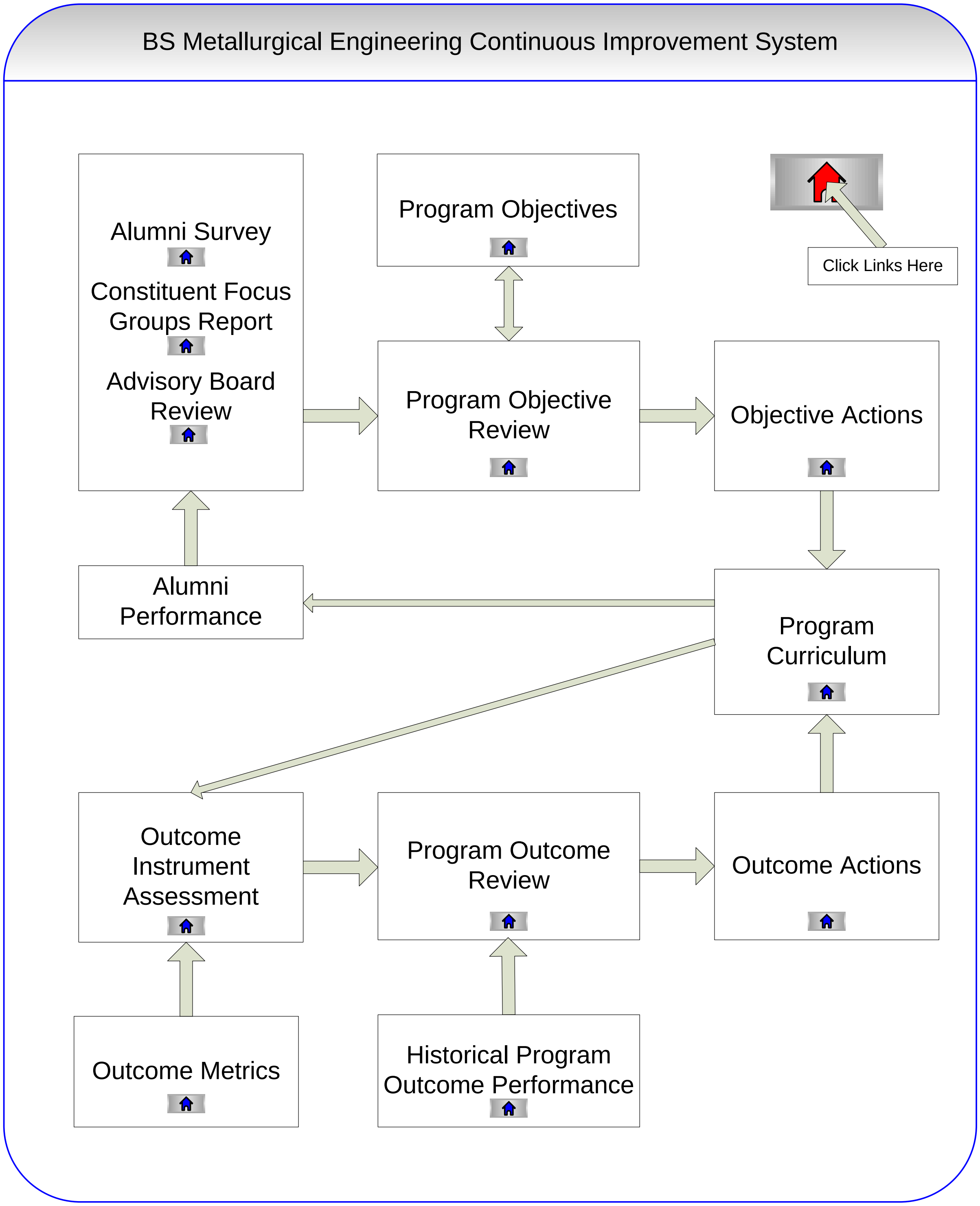


Figure 4-1 – The BS Metallurgical Engineering Continuous Improvement System data by academic year, because using the historical academic year referencing proved very confusing, was the source of many time-consuming recording errors, and stymied clarity in discussions of curriculum among program faculty. Consequently, all dates in the CIS are strictly calendar year style and everything in the CIS runs by calendar year and has since 2003.

Figure 4-2 shows the Annual Assessment cycle starting in January.   The annual reviews of the calendar year's assessments are completed in the early part of the spring semester and necessary changes to curriculum are made. Changes in curriculum are planned and implemented for the next course offerings. In some cases, those are implemented immediately, but the great majority of changes, the remainder of the spring semester and the summer is available to implement the modifications. Changes occurring immediately are usually anticipated from the results of the previous spring semester interim assessments and so spring semester course syllabi are able to accommodate such adjustments. Experience shows that it is less efficient to implement changes in the summer break, because there is less faculty availability during the summer than during the winter break since faculty are salaried for academic curriculum work during the winter semester break but not during the summer break.

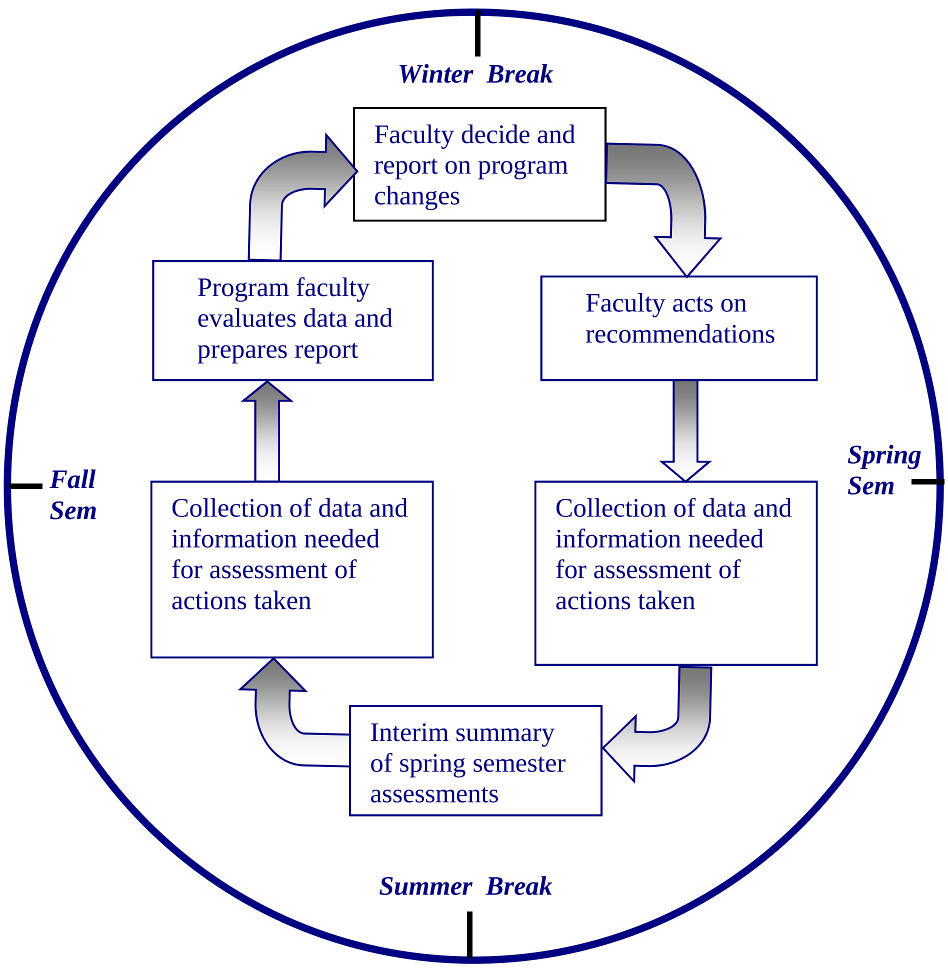


Figure 4-2 - The Annual Cycle of Outcome Assessment and Evaluation

Before describing the CIS system, a description of terms is in order.

Program Educational Objectives: Information for program educational object evaluation is derived from meetings with the Advisory Board, surveys of alumni, and meetings with constituent focus groups. The reports from these groups and the surveys and the program review including actions and accomplishments are stored digitally in the Continuous Improvement System (CIS) computers and uploaded to the CIS website. Access to these files may be attained by contacting Dr. Michael West, Head, Department of Materials and Metallurgical Engineering.

Program Outcomes: Information for the program outcomes is derived from a wide range of sources (called instruments), including student work, presentations, surveys, exams, etc. To the extent that the source of the information is concrete (viz.-student reports, homework), it is stored in hard copy form in the CIS Archive located in the departmental office, MI 115. Currently, these files fill a file cabinet in MI 115. Each of these archival records is accompanied by its score card onto which assessment scores are recorded. When abstract information is used to assess outcomes (viz.- presentations, design fairs), the score cards completed by the assessor are filed in the CIS hard copy archives often with a summary document describing the instrument. All of the score card information is recorded and rendered into summary format digitally and uploaded onto the CIS website. Any file requested by the program evaluator will be available in hard copy at the time of the visit.

To assist the program evaluator in finding and indicating the documents need to review the program's processes, a summary of its salient elements are listed in Table 4-1 in the order in which information flows for outcome assessment. Each of the items in the table is a document except for abstract instruments such as an oral presentation. Figure 4-3 shows the flow of assessment elements in the CIS. The entire process begins with the Instrument Inventory. There is an Instrument Inventory for each calendar year. It contains a listing of all instruments used for the entire assessment of Outcomes (a – k). Table 4-2 shows the 2015 Instrument Inventory. The inventory consists of instruments that encompass a range of assessment methodologies as described in the headers in columns two through four: Method 1 - *Archival Records/Portfolios*; Method 2 - *Standardized Exams, Simulations, Performance Appraisals, External Examiner, and Oral Exam*; and Method 3 - *Surveys, Exit Interviews*. Using a range of method provides for assessment triangulation that mitigates the effects and identifies the question use of biased methodology.

The inventory is used to automatically generate score cards for each instrument. Figure 4-4 shows a typical score card. There are specific metrics for assessment of each (a-k) outcome. Example metrics are shown in Table 4-3. For each metric there is column on the score card to record assessment results, which consist of a 1, 3, or 5 corresponding to poor, moderate, and high achievement.

The results for each score cards for one year and for one outcome are summarized on an Outcome Summary an example of which is shown in Table 4-4. The outcome summaries are consolidated the Assessment Summary, which shows all outcome results for one year. Table 4-5 shows an example Assessment Summary. Assessment summaries are consolidated over the

Table 4-1 Elements of CIS Outcome Assessment

Instrument	The collection of a specific document, one per student or team, used to assess a Program Outcome. Examples of the specific document may be a completed homework assignment or an exam, faculty member-completed oral presentation assessment form, or students' standardized exam results.
Score Card	A Microsoft Excel® table document on which the Program Outcome assessment results for one instrument are recorded. These are typically completed by one designated faculty assessor.
Outcome Summary	A Microsoft Excel® table document for a specified Program Outcome onto which the all the score card assessment results for the specified outcome are summarized and tabulated for one calendar year.
Assessment Summary	A Microsoft Excel® document consisting of a Table and a Chart onto which all Program Outcomes results are organized for one academic year.
Grand Summary	A Microsoft Excel® document that shows the assessment results for all outcomes for all years, any one outcome over time, or all outcomes for any selected year.
Outcome Review	A Microsoft Excel® worksheet onto which a designated metallurgical engineering faculty member documents his critical review of a selected Program Outcome for a specified academic year and includes actions needed.
Outcome Review Summary	A Microsoft Excel® worksheet that contains a complete sequential history of the evaluation, actions, and results for one Outcome Review for all years.

years into what is called the Grand Summary. The Grand Summary is a bar chart that shows all the annual results for each outcome over time: a summary of all Assessment summaries. Figure 4-5 shows the Grand Summary for the period 2004 through the last completed assessment year, 2015. Since the CIS is a web-based system, there are many other data presentation and viewing configurations available to the user, but those are of peripheral importance to the Self Study Report so are not described here.

Average outcome assessment showing student achievement above 4.0 is considered to be satisfactory warranting no corrective action. A continuing or trending downward to an average outcome assessment below 3.5 is of great concern and requires action. A watch is usually issued for possible transient moves below 3.5. If the low performance persists, an action is needed. For performance between 3.5 and 4.0, a watch is invoked most often. However, depending on faculty workload and status, actions may be imitated for outcomes scoring in the 3.5 to 4.0 range. Faculty status includes such things as the level of key faculty experience for a particular outcome. That is, new faculty would be expected to improve as they gain experience. This could affect the construction of questions used in archival work used for assessment, their assessment of instruments used in CIS, as well as their instructional effectiveness. These are all considered when deciding on when to initiate an action.

In the CIS the word *review* is used to determine what action is taken based on the Outcome Summary. (The word *evaluation* is used to describe program objectives information processing

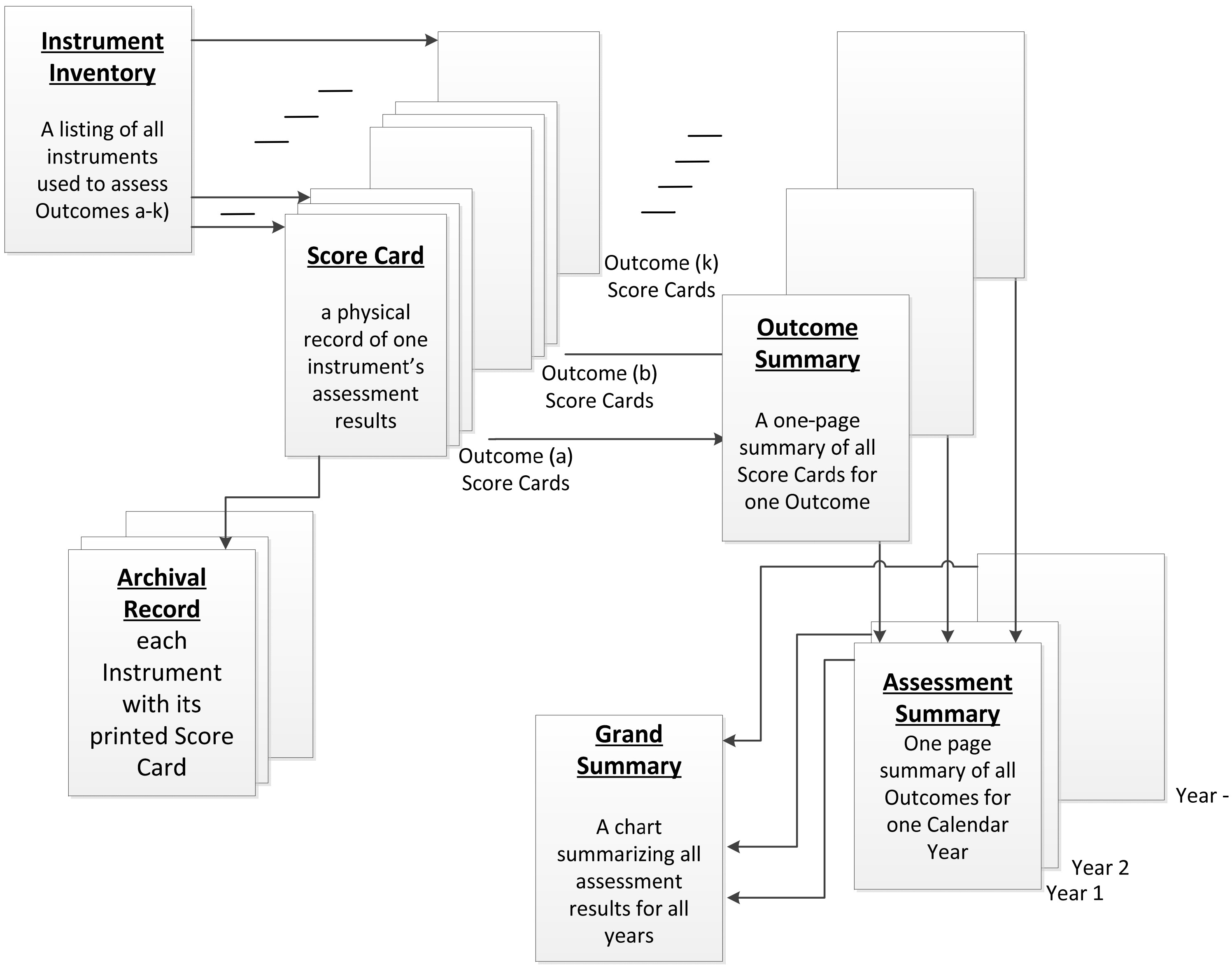


Figure 4-3 Schematic of the CIS Assessment Process Records

Table 4-2 Instrument Inventory for 2015

Outcome Assessment Plan - Instrument Inventory			**2015**
Criteria	**Method 1** Archival Records/Portfolios	**Method 2** Standardized Exams, Simulations, Performance Appraisals, External Examiner, and Oral Exam.	**Method 3** Surveys, Exit Interviews
a Apply knowledge of math, science, and engineering	**MET 320** - (F) . Final Exam **MET 330** - (F-odd) . Final Exam **MET 332** - (F-odd) . Final Exam	**MET 465 - (S)** . Local Exam	**MET 465 - (S)** . Senior Survey
b Design and conduct experiments Analyze and interpret data and information	**MET 330** - (F-odd) . Tool Lab **MET 231** - (S or F) . Hardness and Statistics Labs	**MET 465 - (S)** . Local Exam	**MET 465 - (S)** . Senior Survey
c Optimally select material and design materials treatment and production processes	**MET 465 - (S)** **. Final Design Report** **MET 465 - (S)** . Design Fair Presentation Evaluations	**MET 465 - (S)** **. Local Exam**	**MET 465 - (S)** **. Senior Survey**
d Function well on teams	**MET 465** - (S) . Final Design Report	**MET 465 - (S)** . Local Exam	**MET 465 - (S)** . Senior Survey
e Identify, formulate, and solve engineering problems	**MET 321** - (S-odd) . Final Exam (or All Exams)	**MET 465 - (S)** . Local Exam	**MET 465 - (S)** . Senior Survey
f Know professional and ethical responsibilities and practices	**MET 465** - (S) . Final Design Report	**MET 465** - (S) . Local Exam	**MET 465 - (S)** . Senior Survey
g Communicate effectively	**MET 231** - (S or F) . Charpy Impact Lab **MET 330** - (F-odd) . Student Choice Lab Report **MET 465** - (S) . Final Design Report **MET 465** - (S) . Design Fair Presentation	**MET 465 - (S)** . Local Exam	**MET 465 - (S)** . Senior Survey
h Know engineering's global societal context	**MET 321** - (S-odd) . Pyromet Processing Issues **MET 465** - (S) . Design Report Global-Societal Considerations	**MET 465 - (S)** . Local Exam	**MET 465 - (S)** . Senior Survey

Table 4-2 Instrument Inventory for 2015 (cont'd)

i Engage in life-long learning	**MET 321** - (S-odd) . Cognitive Devel Writing Assignment	**MET 465 - (S)** . Local Exam	**MET 465 - (S)** . Senior Survey
j Know contemporary issues	**MET 321** - (S-odd) . Pyromet Processing Issues	**MET 465 - (S)** . Local Exam	**MET 465 - (S)** . Senior Survey
k Use engineering techniques, skills, and tools	**MET 220** - (S) . Microtrack Lab Report **MET 320** - (F) . ThermoCalc **MET 321** - (S-odd) . Excel Worksheets	**MET 465 - (S)** . Local Exam	**MET 465 - (S)** . Senior Survey

rather than outcomes.) As show in Figure 4-2, the program faculty members meet and review the performance of the students as measured by the assessment of the instruments in the inventory.

The usual practice (except for training new faculty) is for each Outcome Summary to be reviewed by a single faculty member. The result of the review is a completed Review an example of which is shown in Figure 4-6. The final step in the review process is for the entire teaching faculty to review all decisions and agree on any needed remedial courses of action. Of course the action is then implemented into the curriculum of the assessment process as needed.

The review process may take into consideration as much additional information as the reviewer deems necessary. Certainly the review must take into consideration the previous year's recommendations, if any. If the results show consistently high performance, there may be no need to look further into the results; however, large differences in scores among outcomes may require additional analysis. Each review always consists of two parts: 1) review of curricular effectiveness based on assessed student performance and 2) assessment of the functioning of the assessment system. The former having implications on curricular change while the latter suggests changes in the means of measurement.

Every review of each outcome each year results in one of four possible entries being placed on the review form for both the curriculum and the system review: N, W, A, or C denoting the following:

- N - No action
- W - Watch for possible future action
- A - Action
- C - Comment

The last three entries require a written input in the action table on the review form. If no action is needed, no further description is required. The review form shows the previous year's summary statements and requires a summary statement be entered for the current year. These statements may be thought of as *start-of-the-year* and *end-of-the-year* statements or, if an action was required, *actions needed* and *results achieved.* Table 4-6 shows an example summary of all reviews called a Review Summary for all specified years for one outcome. A Review Summary is available for each outcome in Appendix E.

2015 Outcome Score Card | **(a)** | *(a) Apply knowledge of math, science, and engineering*

MET_332
FinalExam

☐ Check Here if Teams

Rate the performance using
1 Lowest
5 Highest

Do not change file name

Leave metric column blank if it does not apply.

Enter your initials and date.

Team / Student	Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in Basic Science	
Max	**5.00**	**5.00**	**5.00**	
Ave	**3.26**	**3.82**	**3.62**	
Min	**1.00**	**1.00**	**1.00**	
1	1	1	1	
2	3	5	5	
3	5	3	3	
4	1	1	3	
5	3	3	5	
6	1	1	1	
7	3	5	3	
8	3	3	3	
9	5	5	5	
10	5	5	5	
11	5	3	5	
12	3	5	3	
13	5	3	5	
14	3	3	1	
15	3	5	5	
16	3	3	5	
17	3	3	3	
18	3	3	5	
19	3	5	5	
20	5	5	5	
21	3	3	5	
22	3	5	3	
23	3	1	3	
24	3	5	3	
25	3	5	5	
26	1	5	3	
27	3	1	1	
28	3	5	5	
29	5	5	1	
30	3	3	1	
31	5	5	3	
32	5	5	3	
33	3	5	5	
34	3	5	3	
35	5	5	5	
36	1	5	3	
37	1	3	5	
38	3	3	5	
39	5	5	3	
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				

Notes

Method	1
Count	117
Assessor's Initials	MW
Date	12/19/2015

Figure 4-4 –Score Card for Outcome (a) 2015, MET 332 Final Exam example

Table 4-3 Metrics for Outcome (a) example

Metric Title	(a) Apply Knowledge of Math, Science, and Engineer		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
Proficient in Fundamental Concepts and Skills	· No application of statistics to analysis of data · No use of math software · Calculations not performed or performed incorrectly by hand · Mathematical terms are interpreted incorrectly or not at all · Does not understand the application of calculus and linear algebra in solving engineering problems	· Minor errors in statistical analysis of data · Some use of math software · Minor errors in calculations by hand · Most mathematical terms are interpreted correctly · Shows nearly complete understanding of applications of calculus and/or linear algebra in problem-solving	· Correctly analyzes data sets using statistical concepts · Uses mathematical software · Executes calculations correctly by hand · Translates academic theory into engineering applications and accepts limitations of mathematical models of physical reality · Shows appropriate engineering interpretation of mathematical and scientific terms
Proficient in Theoretical and Practical Relationships	· Does not appear to grasp the connection between theory and the problem · Does not understand the connection between mathematical models and chemical, physical, and/or in engineering systems	· Some gaps in understanding the application of theory to the problem and expects theory to predict reality · Chooses a mathematical model or scientific principle that applies to an engineering problem, but has trouble in model development	· Translates academic theory into engineering applications and accepts limitations of mathematical models of physical reality · Combines mathematical &/or scientific principles to formulate chemical and physical models for relevant to engineering
Proficient in Basic Science	Student applies basic science concepts as minimal components of work or has major misconceptions.	Student applies concepts from basic science as significant components of work with few errors.	Student applies concepts from basic science as essential components of work with virtually no conceptual errors.

Table 4-4 Outcome Summary (a) 2015 example

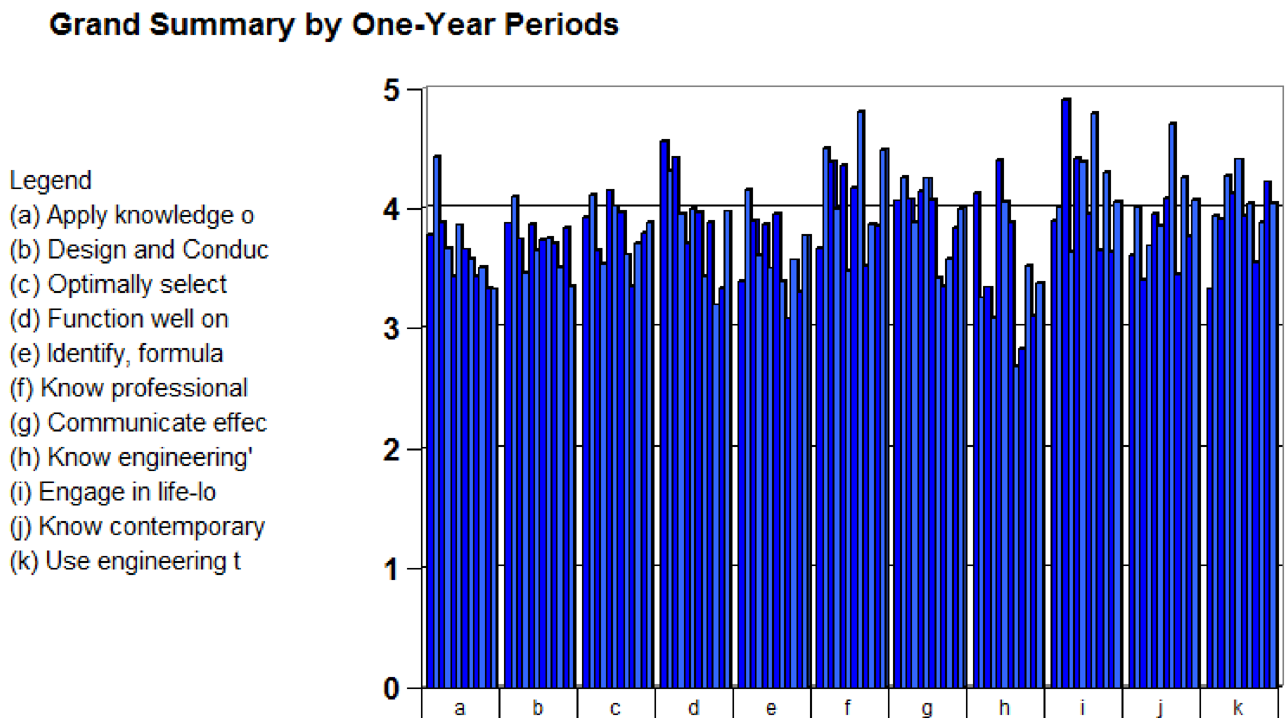
Outcome Summary				2015	(a) Apply knowledge of math, science, and engineering			
		Average Summary		Max	4.14	3.82	3.62	
		324 # Assessments		Ave	3.48	3.22	3.26	
		11 # Averages		Min	2.74	2.69	2.74	
Instrument					Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in Basic Science	
MET_320								
(a)	FinalExam	1	Method	Max	5.00			
SMH		36	# Assessments	Ave	3.61			
12/21/15				Min	1.00			
MET_330								
(a)	FinalExam	1	Method	Max	5.00	5.00	5.00	
GAC		117	# Assessments	Ave	2.74	2.69	2.74	
12/29/15				Min	1.00	1.00	1.00	
MET_332								
(a)	FinalExam	1	Method	Max	5.00	5.00	5.00	
MW		117	# Assessments	Ave	3.26	3.82	3.62	
12/19/15				Min	1.00	1.00	1.00	
MET_465								
(a)	LocalExam	2	Method	Max	5.00			
SMH		12	# Assessments	Ave	3.67			
6/6/15				Min	1.00			
MET_465								
(a)	SeniorSurvey	3	Method	Max	5.00	5.00	5.00	
SEN		42	# Assessments	Ave	4.14	3.14	3.43	
1/20/16				Min	3.00	3.00	3.00	

Table 4-5 Assessment Summary 2015 example

Outcome	Description	Performance Objective 1	Performance Objective 2	Performance Objective 3	Performance Objective 4		
a	(a) Apply knowledge of math, science, and engineering	Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in Basic Science		Instrument Average	
#Totals		4.14	3.82	3.62		Max	3.48
324		3.48	3.22	3.26		Ave	3.32
11		2.74	2.69	2.74		Min	3.22
b	(b) Design and Conduct experiments Analyze and interpret data and information	Conducts the design of experiments.	Operates equipment and collects data for analysis.	Compares results for experimental measurements to the literature and conducts interpretation of results in written reports.	Is able to collect global information and to use this information in evaluation and interpretation of laboratory data	Instrument Average	
#Totals		3.57	4.57	4.29	3.75	Max	3.77
106		2.84	3.77	3.51	3.23	Ave	3.34
11		1.67	3.00	3.00	2.71	Min	2.84
c	(c) Optimally select material and design materials treatment and production processes	Understand the engineering design process	Formulate possible engineering solutions	Master the iterative process in engineering design	Recognize and observe constraints in engineering design	Instrument Average	
#Totals		4.14	3.75	4.21	4.00	Max	4.00
100		3.91	3.75	3.86	4.00	Ave	3.88
8		3.75	3.75	3.50	4.00	Min	3.75
d	(d) Function well on teams	Responsible Participation	Interaction Skills	Assimilation and Receptiveness Skills		Instrument Average	
#Totals		4.43	4.29	3.75		Max	4.14
64		4.14	4.02	3.75		Ave	3.97
6		4.00	3.75	3.75		Min	3.75
e	(e) Identify, formulate, and solve engineering problems	Identify	Formulate	Solve		Instrument Average	
#Totals		4.43	4.07	4.03		Max	4.05
155		3.31	4.05	3.95		Ave	3.77
7		2.66	4.03	3.86		Min	3.31
f	(f) Know professional and ethical responsibilities and practices	Carries out responsibilities in a professional and ethical manner	Understands basic engineering principles and practices, in terms of professional ethics and behavior			Instrument Average	
#Totals		4.57	4.75			Max	4.66
56		4.30	4.66			Ave	4.48
5		3.83	4.57			Min	4.30

Table 4-5 Assessment Summary 2015 example (cont'd)

g	(g) Communicate effectively	The content of the written or oral presentation is effective.	The organization of memorandum and technical reports is consistent with styles accepted by the person's primary professional engineering society.	The design of slides shows an understanding of vision limitation of the audience and the total time the presenter plans to spend on the visual aid during oral presentations.		Instrument Average	
#Totals		5.00	4.29	4.43		Max	4.19
118		4.07	3.73	4.19		Ave	4.00
13		3.29	2.71	3.90		Min	3.73
h	(h) Know engineering's global societal context	Has the broad education necessary to understanding impact of engineering solutions in global and societal context	Awareness of contemporary state of knowledge and relationship to engineering solutions	Recognizes the need to be aware of societal issues especially those that can be engaged by engineering solutions		Instrument Average	
#Totals		4.67	3.86	3.00		Max	3.84
76		3.84	3.26	3.00		Ave	3.37
7		3.00	2.75	3.00		Min	3.00
I	(i) Engage in life-long learning	Ability to adapt to changing technology.	Understanding of the need to continually update one's skills and knowledge.	Cognitive Level Assessment		Instrument Average	
#Totals		4.38	4.43	3.83		Max	4.30
104		4.02	4.30	3.83		Ave	4.05
6		3.83	4.17	3.83		Min	3.83
j	(j) Know contemporary issues	Ability to identify basic problems and contemporary issues in engineering.	Application of knowledge of contemporary issues to Metallurgical Engineering			Instrument Average	
#Totals		4.33	4.14			Max	4.15
64		4.15	3.99			Ave	4.07
5		3.83	3.83			Min	3.99
k	(k) Use engineering techniques, skills, and tools	Capable of using tools such as Excel, SolidWorks, MathCAD ---	Proficient in operating equipment used in the laboratory program such as the MTS machine, rolling mill, hardness tester ---	Understands the engineering design method and can apply this method in developing solutions to engineering problems.		Instrument Average	
#Totals		4.50	4.43	4.43	4.26	Max	4.26
168		4.24	3.71	3.91	4.26	Ave	4.03
10		3.80	3.00	3.40	4.26	Min	3.71



	a	b	c	d	e	f	g	h	i	j	k
2004	3.77	3.87	3.92	4.55	3.38	3.67	4.06	4.13	3.89	3.60	3.32
2005	4.42	4.09	4.11	4.31	4.15	4.50	4.25	3.25	4.00	4.00	3.93
2006	3.88	3.74	3.65	4.42	3.90	4.39	4.07	3.34	4.90	3.40	3.90
2007	3.66	3.45	3.53	3.95	3.61	3.99	3.88	3.08	3.64	3.68	4.26
2008	3.43	3.87	4.14	3.70	3.86	4.35	4.14	4.40	4.41	3.95	4.12
2009	3.86	3.64	4.01	3.99	3.50	3.48	4.24	4.05	4.39	3.85	4.40
2010	3.65	3.73	3.96	3.97	3.95	4.17	4.07	3.88	3.94	4.08	3.93
2011	3.58	3.75	3.61	3.43	3.38	4.80	3.42	2.68	4.79	4.70	4.03
2012	3.43	3.70	3.34	3.87	3.08	3.52	3.35	2.82	3.65	3.45	3.54
2013	3.50	3.51	3.71	3.19	3.57	3.87	3.57	3.51	4.29	4.25	3.88
2014	3.33	3.83	3.79	3.33	3.29	3.85	3.83	3.09	3.63	3.77	4.22
2015	3.32	3.34	3.88	3.97	3.77	4.48	4.00	3.37	4.05	4.07	4.03

Figure 4-5 Grand Summary of assessment results 2004-2015

Outcome Review

2015	(a) Apply knowledge of math, science, and engineering	Reviewer	
		Date	

Instruments for Review

Course	Instrument		Unused
MET_320	(a)	FinalExam	
MET_330	(a)	FinalExam	
MET_332	(a)	FinalExam	
MET_465	(a)	LocalExam	
MET_465	(a)	SeniorSurvey	

Reviews

Curriculum

Previous Curriculum Action Review Summary

The average score has dropped to 3.3 from 3.50. This drop is reflected in the non-subjective Exit exam scores, too. Therefore, it appears to be a real decrease unrelated to reviewer subjectiveness. Some Action is needed to determine the cause of this decrease. One item that should be reviewed is average class GPA.

Curriculum Review Summary

The average score has remained low and is reflected in the non-subjective decreasing Senior Exit Exam scores from 2010 to 2015: 4.67, 4.71, 4.60, 3.78, 3.55, 3.67. It seems very unlikely this drop is the result of variations in student learning but rather because something has changed in the assessment methodology. Therefore, action is focused on assessment processes. Otherwise, a review of basic (Freshman & Sophomore)science and math instruction will be needed but only if other programs note the same decrease.

Code	Curriculum Action Title	Curriculum Action Brief Description
W	Low a) watch	If there is no improvement in a) assessments, a review of instructional methods is needed.

Assessment Process

Previous Assessment Process Action Review Summary

Continue the Watch from 2013 per 2-year cohort system.

Assessment Process Review Summary

The results from MET 330 remain significantly lower than from other instruments. Conduct training and review on a) Metrics for faculty members.

Code	Assessment Process Acti	Assessment Process Action Brief Description
A	Metrics Training and Review	Conduct a comparative review of a) outcome metrics and procedures.
A	Increase Senior Exam Prestige	Move the exit exam to earlier in the semester and have the Dept Head administer the testing.

Figure 4-6 Example review of Outcome (a): 2015

Table 4-6 Review Summary for Outcome (a) example

2010

Previous Curriculum Action Review Summary

Mean Student performance improved from 2008 to 2009, while the variation betweeninstruments was considerably reduced. MATH 373 has ceased being a useful assessment tool.

Curriculum Review Summary

Math 373 was removed and not considered as an assessment tool for 2010.

Code	Curriculum Action Title	Curriculum Action Brief Description
N		

Previous Assessment Process Action Review Summary

As previously, all student assessments for the local exam were the same. They were all very good, but with no variation. This may indicate some changes in questions or how the scores are apportioned is needed. No results were returned for MATH 373. Scores have stabilized so the extra faculty training is likely having an effect.

Assessment Process Review Summary

MATH 373 has been removed. Significant variability in 2010 was observed. However, much of the variability can be related to less number of students taking the FE Exam. So the watch has been removed.

Code	Assessment Process Action Title	Assessment Process Action Brief Description
N		

2011

Previous Curriculum Action Review Summary

Math 373 was removed and not considered as an assessment tool for 2010.

Curriculum Review Summary

The outcome review scores were consistent with the previous year and therefore no action is needed.

Code	Curriculum Action Title	Curriculum Action Brief Description
N		

Previous Assessment Process Action Review Summary

MATH 373 has been removed. Significant variability in 2010 was observed. However, much of the variability can be related to less number of students taking the FE Exam. So the watch has been removed.

Assessment Process Review Summary

The variability in 2011 has been decreased when compared to previous year. Therefore no action is needed.

Code	Assessment Process Action Title	Assessment Process Action Brief Description
N		

2012

Previous Curriculum Action Review Summary

The outcome review scores were consistent with the previous year and therefore no action is needed.

Curriculum Review Summary

The outcome review scores were consistent with the previous year. Therefore no action is needed

Code	Curriculum Action Title	Curriculum Action Brief Description
N		

Previous Assessment Process Action Review Summary

The variability in 2011 has been decreased when compared to previous year. Therefore no action is needed.

Assessment Process Review Summary

The variability has been decreased when compared to 2011. Much of the variability can be related to number of students taking the FE Exam.

Code	Assessment Process Action Title	Assessment Process Action Brief Description
N		

Table 4-6 Review Summary for Outcome (a) example (cont'd)

2013

Previous Curriculum Action Review Summary

The outcome review scores were consistent with the previous year. Therefore no action is needed

Curriculum Review Summary

The outcome review scores were consistent with 2012; therefore, no action is needed.

Code	Curriculum Action Title	Curriculum Action Brief Description
N	No Action	

Previous Assessment Process Action Review Summary

The variability has been decreased when compared to 2011. Much of the variability can be related to number of students taking the FE Exam.

Assessment Process Review Summary

The average of 3.50 was the same as the previous year. There seems to be a trend downwards; however, one reviewer scored student performance particularly low in one course. It is recommended that a watch be placed on this item to determine if the low ratings remain reviewer specific and if so then seek more uniform assesment methods.

Code	Assessment Process Action Title	Assessment Process Action Brief Description
W	Instrument Scoring Variability	Determine if the the MET 330 instrument yields low scores in 2015.

2014

Previous Curriculum Action Review Summary

The outcome review scores were consistent with 2012; therefore, no action is needed.

Curriculum Review Summary

The average score has dropped to 3.3 from 3.50. This drop is reflected in the non-subjective Exit exam scores, too. Therefore, it appears to be a real decrease unrelated to reviewer subjectness. Some Action is needed to determine the cause of this decrease. One item that should be reviewed is average class GPA.

Code	Curriculum Action Title	Curriculum Action Brief Description
A	Remedy Low a)	Administer Exit exam in a more formal setting so as to make it appear more important to students.

Previous Assessment Process Action Review Summary

The average of 3.50 was the same as the previous year. There seems to be a trend downwards; however, one reviewer scored student performance particularly low in one course. It is recommended that a watch be placed on this item to determine if the low ratings remain reviewer specific and if so then seek more uniform assesment methods.

Assessment Process Review Summary

Continue the Watch from 2013 per 2-year cohort system.

Code	Assessment Process Action Title	Assessment Process Action Brief Description
W	Instrument Scoring Variability	Determine if the the MET 330 instrument yields low scores in 2015.

2015

Previous Curriculum Action Review Summary

The average score has dropped to 3.3 from 3.50. This drop is reflected in the non-subjective Exit exam scores, too. Therefore, it appears to be a real decrease unrelated to reviewer subjectiveness. Some Action is needed to determine the cause of this decrease. One item that should be reviewed is average class GPA.

Curriculum Review Summary

The average score has remained low and is reflected in the non-subjective decreasing Senior Exit Exam scores from 2010 to 2015: 4.67, 4.71, 4.60, 3.78, 3.55, 3.67. It seems very unlikely this drop is the result of variations in student learning but rather because something has changed in the assessment methodology. Therefore, action is focused on assessment processes. Otherwise, a review of basic (Freshman & Sophomore)science and math instruction will be needed but only if other programs note the same decrease.

Code	Curriculum Action Title	Curriculum Action Brief Description
W	Low a) watch	If there is no improvement in a) assessments, a review of instructional methods is needed.

Previous Assessment Process Action Review Summary

Continue the Watch from 2013 per 2-year cohort system.

Assessment Process Review Summary

The results from MET 330 remain significantly lower than from other instruments. Conduct training and review on a) Metrics for faculty members.

Code	Assessment Process Action Title	Assessment Process Action Brief Description
A	Metrics Training and Review	Conduct a comparative review of a) outcome metrics and procedures.
A	Increase Senior Exam Prestige	Move the exit exam to earlier in the semester and have the Dept Head administer the testing.

C. Additional information

Appendix E contains the following additional assessment and evaluation documents for Outcome (a-k):

Items not present in Appendix E but available in hard copy form at the time of review are

- Archival Records
- Score Cards
- Outcome Summaries
- A panoply of Grand Summary renderings including
  - Graphical Summary of each outcome over time
  - Graphical Summary of all outcomes for each year
  - Two-year Averaged Grand Summary

All of this information is also continuously available to program faculty via the CIS web site.

D. Major curricular changes during 2010-15

Program faculty implemented a number of substantial changes into the curriculum during the last six years since the last ABET visit. These are cited below by outcome and by course.

The outcomes are listed here for convenient reference.

a) Apply knowledge of mathematics, science, and engineering
b) Design and conduct experiments, as well as to analyze and interpret data
c) Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d) Function on multidisciplinary teams
e) Identify, formulate, and solve engineering problems
f) Understand professional and ethical responsibility
g) Communicate effectively
h) Know the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i) Recognize the need for life-long learning
j) Know of contemporary issues
k) Use the techniques, skills, and modern engineering tools necessary for engineering practice.

<u>*Outcomes*</u>

(b)

New design of experiments exercises were introduced in MET 310L beginning in 2012.

(c)

Substantial changes were made to the MET 351/352 and MET 464/465 design sequence in 2012 with more emphasis on material and process selection. In 2013, more open-ended material selection problems were introduced into MET 332 course. **(c)**

(g)

Both junior and senior faculty made presentations in the design class (Met 351/464) to students attended so the department can form cohesive standards. All faculty members attend their colleagues presentations, and the overall effort led by Dr. Crawford.

(h)

The Global Societal Instructional Module was relocated in the curriculum to the combined Junior-Senior Design Sequence (MET 351/352/464/465).

<u>*Courses*</u>

MET 110 Introduction to Metallurgical Engineering

Beginning in fall of 2014, Dr. West made the following changes to the MET 110 course content.

1) Introduction of lab specific modules where students were expected to analyze data using software (excel). These changes address analyzing and interpreting data **(b),** ability to use tools **(k).**
2) Introduction of a new capstone project on “forensics of artifacts.” In this project, several reputed metallurgical artifacts and materials were gathered from a variety of sources (e.g. reputable galleries, ebay, internet). Student teams then conducted a metallurgical investigation to determine the authenticity of the artifacts. The investigation involved designing a plan using available departmental equipment and extensive use of lab characterization equipment used in metallurgical engineering. The investigation also included historical context of the time periods of metallurgy. These changes are connected to designing and conducting experiments **(b),** teamwork **(d)**, and modern engineering tools **(k)**.

MET 220L Mineral Processing and Resource Recovery

In the spring semester 2014 Dr. Kellar made substantial changes to the MET 220L course content. Specifically, the scientific and engineering content surrounding individual unit operations remained, but roughly 50 percent of the class was devoted to use of the unit operations on a team-based “real world” mineral separation problem. These changes were made to better engage the students in the laboratory with the goals of improving teaming **(d)**, communications **(g)**, analyze data **(a)** and to better solve engineering problems **(e)**. For example in 2016 the student teams were separate garnet from spent water jet cutting residue. Some background is warranted here. The water jet in question takes dry garnet (Barton minerals) and injects it with water under high pressure to cut the material in question. The spent water/garnet/fines slurry drops into a collection bed beneath the cut object. The slurry is typically removed and land filled. The manufacturer of the water jet cutter, OMAX, had an interest in recovering and reusing the garnet that still meets the original spec. We use the 80 HPA grade for the waterjet cutter located in the foundry. The MET 220 students found that approximately 30 percent of the garnet falls out of specification during water jet cutting, so the challenge was how to recover the garnet that can be dried and reused. The material from the cutting piece is typically very fine and would report with the smaller, out of specification garnet. The MET 220 project was deliberately left open ended and the students tried sieving, tabling, and magnetic and flotation to separate the materials. The most valuable results were found by dry screening. During this process the student teams had a Q & A session with an OMAX engineer, and gave both final oral and written reports. The final written report was shared with OMAX. http://www.barton.com/wp-content/uploads/2012/03/HPA_PSD_Graph.pdf

MET 231 Properties of Materials Laboratory

Dr. West and Dr. Jasthi developed two new course modules in the last reporting period. In 2013, they developed a lab critique module where students provide feedback to other students on a written laboratory report. In 2014, they developed a new laboratory assignment on mechanical properties of polymers. This was developed in conjunction with mechanical engineering faculty to introduce students to time dependent deformation principles. In 2015, they introduced a new seminar and workshop on technical report writing. In this workshop, faculty worked directly with student teams to re-write one of their early labs. The changes address engineering principles **(a)**, conducting experiments **(b)**, written communication **(g)**, and ability to use engineering tools **(k)**.

MET 310 Aqueous Extraction, Concentration and Recycling (2010, 2012, 2014)

The primary changes in MET 310 related to ABET curriculum outcomes have occurred to address **outcomes e, f, h and k**. With respect to **outcome (e) and (k),** homework problems specifically focused on formulating and solving engineering problems and using excel add-ins, like solver, to obtain answers for the engineering problems were added in 2014 and continued in 2016. An ethics-related writing component was added in 2014 and continued in 2016 **(outcome (f)).** In addition, global and societal context **(outcome (h))** was more directly included in a writing assignment beginning in 2014 and continuing in 2016.

MET 310L Aqueous Extraction, Concentration and Recycling Lab (2010, 2012)

Beginning in 2010 and continuing in 2012, Design of Experiments (DOE) components were added to MET 310L. These included multiple lectures on statistics and how they relate to DOE, lectures on using statistical software to perform DOE, and guiding the student groups through designing and performing a 2^2 full factorial experiment related to leaching of minerals. These changes relate to **outcome (b).** In the spring of 2014, Dr. Safarzadeh applied some modifications to the MET 310L course content. These modifications include the introduction of experimental design approach for systematic implementation of the experiments to improve **(b)**, and addition of three new experiments which would impact the students' skills in data analysis **(a)** and to better solve engineering problems (**outcome e**). In spring of 2015, professional and ethical responsibilities **(f)** were emphasized through lectures highlighting the importance of proper literature citations and cases of plagiarism.

MET 320 Metallurgical Thermodynamics

In the fall of 2015, Dr. Safarzadeh offered additional problem-solving sessions (in addition to the regular class meetings) to improve students' capabilities to apply their knowledge to solve engineering problems **(a)**.

MET 321 High Temperature Extraction, Concentration, and Recycling

In the spring of 2015, Dr. Safarzadeh offered two additional homework to emphasize the contemporary issues **(j)** and also the global societal context **(h)** in the context of high temperature processing (pyrometallurgy) of metals. In these homework, the students were assigned two papers to read and submit a summary of the global issues associated with smelting operations.

MET 332 Thermomechanical Processing

In 2011, Dr. West introduced two new in-class team problem solving exercises - one on hardenability of steels and the other on identification of an unknown aluminum alloy using heat treating. In 2013, Dr. West introduced several open-ended alloy selection take-home problems. The changes are linked to applying knowledge of engineering **(a)**, ability to solve engineering problems **(e)**, and teaming **(d)**.

MET 351/352/464/465 Metallurgical Engineering Design

Broadened outcomes **(c)** and **(h)** – All design reports were broadened to include formal sections on outcomes (c) and (h). Additionally, faculty members begin making presentations on 1) economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints and 2) global, economic, environmental, and societal issues .

Design Student Evaluations - Implementation of self-evaluations, peer-evaluations, and faculty evaluations of individual student design performance in the areas of quality, timeliness, teamwork, and overall contribution. The primary reasons for implementing this evaluation program were to (1) encourage strong team performance and contribution from all members, (2) provide a mechanism for evaluating individual student performance in the design course. **(d)**

Group Evaluations - Group evaluations were developed as anonymous surveys (grouped by design team) where students reflect on their overall group performance, team effectiveness, project suitability, and, more generally, about the design course itself. **(d)**

Industry inspired design projects - In the Fall of 2013, a new initiative was started to develop industry inspired design projects. In the first year, five industry inspired design projects were developed with five different industry partners. In subsequent years (2014 and 2015), seven industry inspired design projects were conducted each year. In each case, an industry lead and Met faculty member mutually identify ideal design project areas. Industry leads then actively participate as design advisors through weekly design meetings with the student design team. In many cases the industry partners have invited students for onsite visits of their facility. The overall objectives of this initiative were to engage students in practical industry design problems and to provide a mechanism for strengthening ties with relevant industry partners. To date the program has been an extreme success and will be continued in the future. **(c), (h), (e)**

Round-robin faculty evaluations - During this evaluation period we have modified the manner in which design reports and student oral presentations are evaluated. In this regard, semester design reports are now evaluated by a minimum of three faculty members and all comments are collected and returned to the student team. Furthermore, group oral reports (three per semester) are now evaluated by all faculty members and feedback is collected and returned to the student teams. This form of immediate and broad review has proved beneficial in helping students avoid pitfalls in the design process while also providing significant improvement in technical communication skills. **(g)**

Individual Technical Assignments – During this evaluation period a each student is required to complete an individual technical assignment which is directly supportive of their design project. This activity was initiated to (1) ensure application of technical skills developed through the MET undergraduate curriculum in the design process, and (2) to encourage full group participation in the design project (preventing so-called “social loafing”). **(a), (e), (k)**

Project Management Design Content **–** During this evaluation period, program faculty have made a concerted effort to increase student exposure to project management based content through the introduction of both formal lectures and practical training exercises into the design sequence. **(g), (g)**

MET 330/330L

Primary changes involve increased emphasis on state-of-the-art materials characterization tools and techniques. **(k)** Introduction of new laboratory exercises including a new lab focused on teaching the basics of dislocation properties using the “Bubble Raft” model. **(a), (b)**

MET 422 Transport Phenomena

In fall of 2014, Dr. Safarzadeh emphasized the application of students’ knowledge in transport phenomena in solving metallurgical engineering problems **(a)** by assigning homework problems that were directly linked to the real-world metallurgical problems.

MET 426 Steelmaking

Dr. Jasthi added the topics on “Early history of Iron and Steel Making” to bring a historical perspective to the students. He also demonstrated several steel making process simulations on “Steel University”. These interactive simulations have been designed as an educational and training tool for students for better understanding of steelmaking operations. These changes are linked to the selection of materials and design of materials for a specific production processes (**c)**.

MET 430/430L Welding Metallurgy and Engineering

Dr. Jasthi developed additional lab modules on laser welding, cold spray and corrosion testing of weld joints. The changes address selection of materials **(c)**, conducting experiments **(b)**, and ability to use engineering tools **(k)**. Dr. Jasthi also added several new sections to the course curriculum related to welding issues and corrosion in weldments. These topics are connected to the application of knowledge of science and engineering **(a)** and with the materials selection **(c)**

MET 440/440L Mechanical Metallurgy and Mechanical Metallurgy Laboratory

Introduction of new laboratory exercises including laboratories on fracture toughness testing, fatigue testing, and nanoindentation. **(b), (k)**

MET 445 Oxidation and Corrosion of Metals

Dr. Jasthi developed few lab modules on electrochemical corrosion testing during the last reporting period. With this introduction of these new lab modules, the students were able to get hands-on experience and were able to conduct experiments, analyze and interpret the data (**b**).

MET 450 Forensic Engineering

Course module on failure analysis of microelectronics was added. **(e)**

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CRITERION 5 - CURRICULUM

This chapter provides a detailed description of the program curriculum and how it achieves the program goals and outcomes.

A. Program curriculum

Table 5-1 summarizes the new 130-credit semester hour curriculum BS Metallurgical Engineering, which was reduced from 136 credits in 2013. One credit hour is earned for completing a lecture class that meets one hour a week for the entire semester, which is approximately 15 weeks in duration. One credit is awarded for each three hours of laboratory work per week for the entire semester.

The 130 credit hours required for a BS Metallurgical Engineering Degree are allocated as follows:

• Math and basic science	39 credits	30.0%
• Engineering topics	61 credits	46.9%
• General ed. less math and basic science	24 credits	18.5%
• Other	6 credits	4.6%

The curriculum satisfies all ABET requirements having

- 39 semester hours of basic science and mathematics beginning with
  - College chemistry and
  - Calculus I,
- 49 credit hours of discipline-specific courses (MET),
- 12 credits of technical out-of-department credits including
  - Statics
  - Engineering mechanics
  - Engineering economics
  - Electrical engineering,
- 24 credits of general education credits including
  - Humanities and social science -15 credits and
  - Technical communication – 9 credits,
- 5 credits free elective, and
- 1 credit of physical education.

Table 5-2 is a list of all program-approved science electives for the BS Metallurgical Engineering. Prerequisites, if any, are indicated below each approved course and indented. Each course is three credits unless indicated otherwise.

In addition to ABET requirements, there are regental requirements that must be satisfied. The South Dakota Regents specify General Education Requirement for all four-year degree South Dakota college graduates. The mathematics and science requirements are easily satisfied by engineering students. The humanities and social science requirements generally do not add

Table 5-1 Curriculum for BS Metallurgical Engineering

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year. Freshmen: Fall, Spring Sophomore: Fall, Spring Junior: Fall, Spring Senior: Fall, Spring	R-Required E-Elective SE-Selected Elective[1]	*Curricular Area (Credit Hours)*				Last Two Terms the Course was Offered: Year and Semester	Average Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Discipline Specific Topics	General Education	Other		
MATH 123 Calculus I	R	4				16S, 15F	32.6
CHEM 112 General Chemistry	R	3				16S, 15F	115.9
ENGL 101 Composition I	R			3		16S, 15F	22.1
MET 110 Intro to Engineering	SE		0			15F, 14F	40.5
PE Physical Education	R				1		
HSS Hum or Soc Sci Elective	SE			3			
HSS Hum or Soc Sci Elective	SE			3			
MATH 125 Calculus II	R	4				16S, 15F	35.7
CHEM 114 General Chemistry II	R	3				16S, 15F	130.0
PHYS 211 University Physics I	R	3				16S, 15F	81.5
CHEM 112L General Chem Lab	R	1				16S, 15F	21.4
HSS Hum or Soc Sci Elective	SE			3			
HSS Hum or Soc Sci Elective	SE			3			

Table 5-1 Curriculum (cont'd)

MET 232 Prop of Materials	R		3			16S, 15F	106.0
MET 231 Structure & Prop of Mat Lab	R		1			16S, 15F	14.2
MATH 321 Differential Eqs	R	3				16S, 15F	36.8
PHYS 213 University Physics II	R	3				16S, 15F	66.8
CHEM 114L Gen Chem II Lab	R	1				16S, 15F	22.7
ENGL 279 Technical Comm I	R			3		16S, 15F	22.9
EM 214 Statics	R				3	16S, 15F	49.0
MATH 225 Calculus III	R	4				16S, 15F	33.4
EM 321 Mechanics of Materials -OR- ME 216 Intro to Solid Mechanics	R				3	16S, 15F 16S, 15F	54.5 36.0
MET 220 Min Proc & Resource Rec	R		3			16S, 15S	61.0
MET 220L Min Proc & Resource Rec Lab	R		1			16S, 15S	23.5
Science Elective	SE	3					
Free Elective	E				2		
ENGL 289 Tech Comm II	R			3		16S, 15F	20.9
MET 320 Metallurgical Thermo	R		4			15F, 14F	35.5
MET 351 Eng Design I	R		2			15F, 14F	16.5
Set A or C (7) (see below)							
MET 352 Engineering Design II	R		1			16S, 15S	16.0
MATH 373 Intro to Numerical Analysis	R	3				16S, 15F	33.8
Set B or D (11) (see below)	R						
MET 464 Engineering Design III	R		2			15F, 14F	15.5
IENG 301 Basic Engineering Economics	R				2	16S, 15F	32.0
HSS Hum or Soc Sci Elective	SE			3			
Sci Elective	SE	3					
Set A or C (7) (see below)							32.0
MET 433 Process Control	R		3			16S, 15F	
MET 465 Engineering Design IV	R		1			16S, 15S	6.5
Set B or D (11)	R						14.0

Table 5-1 Curriculum (cont'd)

A (Fall Even Calendar Years)							
MET 422 Transport Phenomena	R		4			14F, 12F	29.5
Elective Free Elective	E				3		
B (Spring Odd Calendar Years)							
MET 321 High Temp Extract/Conc/Rec	R		4			15S, 13S	30.0
Directed MET Elective	SE		3				
EE 301 Intro Circuits, Machines, Sys	R				4	16S, 15F	28.8
C (Fall Even Calendar Years)							
MET 330 Physics of Metals	R		3			15F, 13F	36.5
MET 330L Physics of Metals Lab	R		1			15F, 13F	22.3
MET 332 Thermomechanical Treatment	R		3			15F, 13F	36.5
D (Spring Odd Calendar Years)							
MET 440 Mechanical Metallurgy	R		3			16S, 14S	33.0
MET 440L Mechanical Metallurgy Lab	R		1			16S, 14S	21.5
Directed MET Elective	SE		3				0.0
MET 310 Aqueous Extract/Conc/Rec	R		3			16S, 14S	29.5
MET 310L Aqueous Extract/Conc/Rec Lab	R		1			16S, 14S	26.5
Subtotals		38	50	24	18		
Total					130		

1. Required courses are required of all students in the program, elective courses are optional for students, and selected electives are courses where students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the average enrollment in each element.

Table 5-2 BS Metallurgical Engineering approved science electives for 2015-16

AES 201 INTRODUCTION TO ATMOSPHERIC SCIENCES
AES 401/501 ATMOSPHERIC PHYSICS
PHYS 213/213-A, MATH 321, and AES 404/504
AES 403/503 BIOGEOCHEMISTRY
CHEM 106 or CHEM 112 ; BIOL 151 ; PHYS 111 or PHYS 211/211-A
AES 404/504 ATMOSPHERIC THERMODYNAMICS (2 or 3 credits)
PHYS 211/211-A and MATH 225
AES 405/505 AIR QUALITY
MATH 125, and CHEM 106 or CHEM 112
AES 406 GLOBAL ENVIRONMENTAL CHANGE
CHEM 112, PHYS 111 or PHYS 113 or PHYS 211/211-A or PHYS 213/213-A and BIOL 311
AES 430/530 RADAR METEOROLOGY
MATH 125 and PHYS 213/213-A
AES 450 SYNOPTIC METEOROLOGY I
AES 201 and AES 404/504
AES 460/560 ATMOSPHERIC DYNAMICS
MATH 321 and PHYS 211/211-A
BIOL 121 BASIC ANATOMY
BIOL 123 BASIC PHYSIOLOGY
BIOL 151 GENERAL BIOLOGY I
BIOL 153 GENERAL BIOLOGY II
BIOL 151
BIOL 221 HUMAN ANATOMY
BIOL 311 PRINCIPLES OF ECOLOGY
BIOL 326 BIOMEDICAL PHYSIOLOGY
Four hours of CHEM, BIOL 153 or BIOL 221
BIOL 331 MICROBIOLOGY
BIOL 341 MICROBIAL PROCESSES IN ENGINEERING AND NATURAL SCIENCES
CHEM 112
BIOL 371 GENETICS
BIOL 151

Table 5-2 BS Metallurgical Engineering approved science electives for 2015-16, (cont'd)

BIOL 375 CURRENT BIOETHICAL ISSUES
BIOL 383 BIOETHICS
BIOL 403 GLOBAL ENVIRONMENTAL CHANGE
CHEM 112, PHYS 111 or PHYS 113 or PHYS 211/211-A or PHYS 213/213-A and BIOL 311
BIOL 423 PATHOGENESIS
BIOL 331
BIOL 431 INDUSTRIAL MICROBIOLOGY
BIOL 331
BIOL 444 DNA STRUCTURE AND FUNCTION
BIOL 151 and CHEM 326
BIOL 446/546 MOLECULAR CELL BIOLOGY
BIOL 151 and BIOL 371 or permission of instructor
BIOL 478/578 MICROBIAL GENETICS
BIOL 331 and BIOL 371
BIOL 480/580 BIOINFORMATICS
BIOL 331, BIOL 341, or BIOL 371 or permission of instructor
CHEM 316 FUNDAMENTALS OF ORGANIC CHEMISTRY
CHEM 114
CHEM 326 ORGANIC CHEMISTRY I
CHEM 114
CHEM 328 ORGANIC CHEMISTRY II
CHEM 326
CHEM 332 ANALYTICAL CHEMISTRY
CHEM 114
CHEM 342 PHYSICAL CHEMISTRY I
CHEM 114 and PHYS 213/213-A and MATH 225 or MATH 321
CHEM 344 PHYSICAL CHEMISTRY II
CHEM 342 and PHYS 213/213-A
CHEM 352 SYSTEMATIC INORGANIC CHEMISTRY
CHEM 114
CHEM 420/520 ORGANIC CHEMISTRY III
CHEM 328

Table 5-2 BS Metallurgical Engineering approved science electives for 2015-16 (cont'd)

CHEM 421/521 SPECTROSCOPIC ANALYSIS
CHEM 328
CHEM 426/526 POLYMER CHEMISTRY
CHEM 328 and CHEM 342
CHEM 434 INSTRUMENTAL ANALYSIS
CHEM 230 or CHEM 332 and CHEM 342
CHEM 452/552 INORGANIC CHEMISTRY
CHEM 352, CHEM 328 and CHEM 342
CHEM 464/564 BIOCHEMISTRY I
CHEM 465/565 BIOCHEMISTRY II
CHEM 464/564
CHEM 482/582 ENVIRONMENTAL CHEMISTRY
CHEM 316 or CHEM 328
GEOL 201 PHYSICAL GEOLOGY
GEOL 212/212L MINERALOGY AND CRYSTALLOGRAPHY
GEOL 322/322L STRUCTURAL GEOLOGY/LAB
GEOL 331/331L and GEOL 341/341L or MEM 314/314L
GEOL 323 SEARCH FOR OUR PAST
GEOL 201 or GEOE 221/221L
GEOL 331/331L STRATIGRAPHY AND SEDIMENTATION
GEOL 201 /GEOL 201L or GEOE 221/221L
GEOL 341/341L IGNEOUS AND METAMORPHIC PETROLOGY/LAB
CHEM 112 /CHEM 112L, GEOL 201L or GEOE 221/221L and GEOL 212/212L or MEM 314/314
GEOL 351 EARTH RESOURCES AND THE ENVIRONMENT
GEOL 201 or GEOE 221/221L
GEOL 361 OCEANOGRAPHY I
GEOL 372 DINOSAURS
GEOL 420/520 INTRODUCTION TO REMOTE SENSING
Junior standing
GEOL 422/422L/522/522L TECTONICS AND SEDIMENTARY BASIN ANALYSIS/LAB
GEOL 322/322L and GEOL 331/331L
GEOL 442/442L/542/542L OPTICAL PETROLOGY/LAB
GEOL 341/341L or MEM 314/314L
GEOE 451/451L ECONOMIC GEOLOGY/LAB
Junior or senior standing. GEOL 322/322L
GEOL 652 PROBLEMS IN ORE DEPOSITS
GEOE 451/451L

Table 5-2 BS Metallurgical Engineering approved science electives for 2015-16 (cont'd)

PHYS 213/213-A, PHYS 213L , CHEM 114, MATH 321
NANO 445/545 INTRODUCTION TO NANOMATERIALS
MET 232, EM 321
PHYS 183 ELEMENTS OF MODERN ASTRONOMY
PHYS 275 RELATIVITY
PHYS 111 or PHYS 211/211-A and a working knowledge of elementary algebra and trigonometry.
PHYS 312 EXPERIMENTAL PHYSICS DESIGN I (2 cr.)
CENG 244/244L
PHYS 314 EXPERIMENTAL PHYSICS DESIGN II (2 cr.)
CENG 244/244L
PHYS 321 THE PHYSICS & IMPLICATIONS OF SPACE TRAVEL
PHYS 331 INTRODUCTION TO MODERN PHYSICS
PHYS 113 or PHYS 213/213-A
PHYS 341 THERMODYNAMICS
PHYS 213/213-A, and MATH 225
PHYS 343 STATISTICAL PHYSICS
PHYS 213/213-A, and MATH 225
PHYS 361 OPTICS
PHYS 113 or PHYS 213/213-A and MATH 225
PHYS 386/386L OBSERVATIONAL ASTRONOMY/LAB
PHYS 183
PHYS 404/504 NANOPHOTONICS
Introductory quantum mechanics and electricity and magnetism; ordinary differential equations and linear systems.
PHYS 421/521 ELECTROMAGNETISM (4 cr.)
PHYS 213/213-A and MATH 321
PHYS 433/533 NUCLEAR AND ELEMENTARY PARTICLE PHYSICS
PHYS 471
PHYS 439/539 SOLID STATE PHYSICS (3 or 4 cr.)
MATH 225, MATH 321, PHYS 331
PHYS 445/545 STATISTICAL MECHANICS (4 cr.)
PHYS 451/551 and MATH 321
PHYS 451/551 CLASSICAL MECHANICS (4 cr.)
MATH 321
PHYS 471/571 QUANTUM MECHANICS (4 cr.)
MATH 321
PHYS 481/581 MATHEMATICAL PHYSICS (4 cr.)
Permission of instructor

additional requirements beyond those required by ABET except for ENGL 101 Composition I, ENGL 279/289 Technical Communications I and II; however, they do require some planning to meet the Regent's expectations. The Regent's general education requirement consists of a 30-credit hour system-wide.

- 9 credits of written and oral communications,
- 6 credits of humanities,
- 6 credits of social sciences,
- 6 credits of a science with laboratory
- 3 credits of mathematics

This general education requirement supports the following program outcomes:

- (a) Apply Knowledge of Math, Science, and Engineering
- (f) Know Professional and Ethical Responsibilities and Practices
- (g) Communicate Effectively
- (h) Know Engineering's Global Societal Context
- (j) Know Contemporary Issues

South Dakota School of Mines and Technology BS Metallurgical Engineering graduates must complete an additional 3 credits of humanities or social science at the upper division level, as well as mathematics and science courses far in excess of those required to satisfy the general education and the ABET requirements.

The general education requirements are now described in some detail followed by a description of the university and BS Metallurgical Engineering degree program requirements.

General Education Requirements
The following seven learning outcomes for general education are held in common by all schools in the South Dakota Board of Regents system:

1. Students will write effectively and responsibly and will understand and interpret the written expression of others
2. Students will communicate effectively and responsibly through listening and speaking
3. Students will understand the organization, potential, and diversity of the human community through study of the social sciences
4. Students will understand the diversity and complexity of the human experience through study of the arts and humanities
5. Students will understand and apply fundamental mathematical processes and reasoning
6. Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world
7. Students will recognize when information is needed and have the ability to locate, organize, critically evaluate, and effectively use information from a variety of sources with intellectual integrity

The following rules on graduation requirements apply for the BS degree in any curriculum offered by the university. General education core requirements must be completed within the first 64 credits of course work. Requests for exceptions to these general education requirements must be approved by the student's advisor and by the Vice President for Academic Affairs/Provost.

The regent's general education requirements prescribe that the following seven goals be accomplished.

Goal #1: Students will write effectively and responsibly and understand and interpret the written expression of others. Student Learning Outcomes: As a result of taking courses meeting this goal, a student will

1. Write using standard American English, including correct punctuation, grammar, and sentence structure;
2. Write logically;
3. Write persuasively, with a variety of rhetorical strategies (e.g., expository, argumentative, descriptive);
4. Incorporate formal research and documentation in their writing, including research obtained through modern, technology-based research tools.

Credit Hours: 6 hours
Courses:
ENGL 101 Composition I
ENGL 201 Composition II
ENGL 279/289 Technical Communications I and II
Note: Engineering and sciences students at SDSM&T take this six credit sequence in the sophomore and junior years. Both courses develop written and speech communications in an integrated fashion in the context of the major. Students must finish the entire sequence, as well as ENGL 101, to satisfy the requirements of Goal #1 and Goal #2.

Goal #2: Students will communicate effectively and responsibly through speaking and listening. Student Learning Outcomes: Courses satisfying this goal will require students to

1. Prepare and deliver speeches for a variety of audiences and settings;
2. Demonstrate speaking competencies including choice and use of topic, supporting materials, organizational pattern, language usage, presentational aids, and delivery;
3. Demonstrate listening competencies by summarizing, analyzing, and paraphrasing ideas, perspectives and emotional content.

Credit Hours: 3 hours
Courses:
ENGL 279/289 Technical Communications I and II
SPCM 101 Fundamentals of Speech
Note: Technical Communications I and II develop written and speech communications in an integrated fashion in the context of the major. Students must finish the entire sequence, as well as ENGL 101, to satisfy the requirements of Goal #1 and Goal #2.

Goal #3: Students will understand the organization, potential, and diversity of the human community through study of the social sciences. Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Identify and explain basic concepts, terminology and theories of the selected social science disciplines from different spatial, temporal, cultural, and/or institutional contents.

2. Apply selected social science concepts and theories to contemporary issues;
3. Identify and explain the social or aesthetic values of different cultures. In addition, as a result of taking course meeting this goal, students will be able to demonstrate a basic understanding of at least one of the following:
   - The origin and evolution of human institutions;
   - The allocation of human or natural resources within societies;
   - The impact of diverse philosophical, ethical or religious views.

Credit Hours: 6 hours in two disciplines
Courses:
ANTH 210 Cultural Anthropology
ECON 201 Principles of Microeconomics
ECON 202 Principles of Macroeconomics
GEOG 101 Introduction to Geography
GEOG 212 Geography of North America
HIST 151/152 United States History I/II
POLS 100 American Government
POLS 210 State and Local Government
PSYC 101 General Psychology
SOC 100 Introduction to Sociology
SOC 150 Social Problems
SOC 250 Courtship and Marriage

Goal #4: Students will understand the diversity and complexity of the human experience through study of the arts and humanities. Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Demonstrate knowledge of the diversity of values, beliefs, and ideas embodied in the human experience;
2. Identify and explain basic concepts of the selected disciplines within the arts and humanities. In addition, as a result of taking courses meeting this goal, students will be able to do at least one of the following:
   - Identify and explain the contributions of other cultures from the perspective of the selected disciplines within the arts and humanities;
   - Demonstrate creative and aesthetic understanding;
   - Explain and interpret formal and stylistic elements of the literary or fine arts;
   - Demonstrate foundational competency in reading, writing, and speaking a non-English language.

Credit Hours: 6 hours in two disciplines or in a sequence of foreign language courses
Courses:
ART 111/112 Drawing I and II
ARTH 211 History of World Art I
ENGL 221/222 British Literature I and II
ENGL 241/242 American Lit I and II
ENGL 250 Science Fiction
FREN 101/102 Introductory French I and II
GER 101/102 Introductory German I and II
HIST 121/122 Western Civilization I and II

HUM 100 Introduction to Humanities
HUM 200 Connections: Humanities and Technology
LAKL 101/102 Introductory Lakota I and II
MUS 100 Music Appreciation
PHIL 100 Introduction to Philosophy
PHIL 200 Introduction to Logic
PHIL 220 Introduction to Ethics
PHIL 233 Philosophy and Literature
SPAN 101/102 Introductory Spanish I and II

Goal #5: Students will understand and apply fundamental mathematical processes and reasoning. Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Use mathematical symbols and mathematical structure to model and solve real world problems;
2. Demonstrate appropriate communication skills related to mathematical terms and concepts;
3. Demonstrate the correct use of quantifiable measurements of real world situations.

Credit Hours: 3 hours
Courses:
MATH 102 College Algebra
MATH 115 Precalculus
MATH 120 Trigonometry
MATH 123 Calculus I
MATH 125 Calculus II
MATH 225 Calculus III
MATH 281 Statistics

Goal #6: Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world. Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Demonstrate the scientific method in a laboratory experience;
2. Gather and critically evaluate data using the scientific method;
3. Identify and explain the basic concepts, terminology and theories of the selected natural sciences;
4. Apply selected natural science concepts and theories to contemporary issues.

Credit Hours: 6 hours
Courses:
BIOL 151/151L General Biology I and Laboratory
BIOL 153/153L General Biology II and Laboratory
CHEM 106/106L Chemistry Survey/Laboratory
CHEM 108/108L Organic Chemistry/Laboratory
CHEM 112/112L General Chemistry I and Laboratory
CHEM 114/114L General Chemistry II and Laboratory
GEOL 201/201L Physical Geology/Laboratory
PHYS 111/111L Introduction to Physics I and Laboratory
PHYS 113/113L Introduction to Physics II and Laboratory

PHYS 211 University Physics I
PHYS 213/213L University Physics II and Laboratory

Goal #7: Students will recognize when information is needed and have the ability to locate, organize, critically evaluate, and effectively use information from a variety of sources with intellectual integrity. Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Determine the extent of information needed;
2. Access the needed information effectively and efficiently;
3. Evaluate information and its sources critically;
4. Use information effectively to accomplish a specific purpose;
5. Use information in an ethical and legal manner.

Credit Hours*:* 9 hours
Courses:
ENGL 101 Composition I
SPCM 101 Fundamentals of Speech
ENGL 201 Composition II
ENGL 279/289 Technical Communications I and II

In addition to these seven system-wide general education requirements, all students will achieve learning outcomes focused on advancing their writing skills and their knowledge of global issues. Each academic program has designated one or more classes (the equivalent of one credit hour of study) as meeting each of these requirements. The syllabi of the courses designated state the requirement(s) met and explain how student achievement of the outcomes are assessed and factored into the course grade.

Globalization/global issues goal statement
Students will understand the implications of global issues for the human community and for the practice of their disciplines. As a result of taking courses meeting this goal, students will

1. Identify and analyze global issues, including how multiple perspectives impact such issues; and
2. Demonstrate a basic understanding of the impact of global issues on the practice of their discipline.

Writing intensive goal statement
Students will write effectively and responsibly in accordance with the needs of their own disciplines. As a result of taking courses meeting this goal, students will

1. Produce documents written for technical, professional, and general audiences within the context of their disciplines;
2. Identify, evaluate, and use potential sources of information from within their disciplines for writing assignments that require research and study; and,
3. Use instructor feedback throughout the semester to improve the quality of their writing.

Students entering the South Dakota School of Mines and Technology are expected to have prepared themselves to start with the curriculum show in Table 5-1. Students who are not able to begin at that level are deemed in need of remedial courses. These pre-general education courses include ENGL 031, ENGL 032, ENGL 033, READ 041, MATH 021, and MATH 101. Students taking pre-general education courses have the following requirements:

1. Students placed in pre general education courses must enroll in and complete the courses within the first 30 credits hours attempted.
2. If a student does not complete the pre general education course(s) within the first 30 credit hours attempted, a registration hold is placed on the student's record. During the next 12 credit hours attempted, the student must enroll in and complete the pre general education course(s).
3. If the pre general education course(s) is not completed within the first 42 credit hours attempted, the only course(s) in which a student may enroll is the pre-general education course(s); and the student's status is changed from degree seeking to non-degree seeking.
4. Students transferring from non-regental institutions must enroll in pre-general education courses during the first 30 attempted regental credit hours. These students may enroll in other courses concurrently with the pre-general education courses. If the student does not complete the pre-general education courses during the first 30 Regental credit hours attempted during the next 12 credit hours attempted, the student must enroll in and complete the pre-general education course(s). If the student does not successfully complete the pre-general education course(s) within 42 attempted Regental credit hours, the only course(s) in which a student may enroll in the pre-general education course(s); and the student's status is changed from degree seeking to non-degree seeking. The Vice President for Academic Affairs/Provost may grant an exception.

Credit hours for the pre-general education courses are included in the total number of credit hours attempted. The grades assigned for courses numbered less than 100 will be RI, RS and RU.

University Requirements

All BS programs require the general education core requirements as described earlier. Other requirements for each degree are determined by the faculty in each program, with approval through the university curriculum approval process. The SDSM&T curricular requirements are shown in Table 5-3.

Transfer credit may be allowed for previous college education if the courses are equivalent to required or elective courses at this university and if each course presented is of passing quality. The acceptability of transfer credit is determined by the student's major department.

BS Metallurgical Engineering Program requirements

The 130 credits of course work in program consists of

- 18 credits of math starting at or above the level of calculus.
- 20 credits of college level basic science 6 credits of which are program-approved science electives,
- 15 credits of humanities and social science courses,
- 9 credits of writing (ENGL 101, 279, and 289),
- 6 credits composed of 1 credits of physical education and 5 credits of free electives, and
- 50 credits of metallurgical engineering coursework (including 6 credits of Met-directed electives),
- 12 credits of other engineering coursework including 2 credits of engineering economics; 6 credits of statics and strengths; and 4 credits of electrical engineering.

Table 5-3 University curricular requirements

Humanities and social sciences requirements

All courses numbered 300 and above are upper level courses.

This subject area must include 6 credits in humanities and 6 credits in social sciences. The number required for each major is listed in the department section of the catalog. Students majoring in engineering must complete at least three of these credits at an advanced level.

Humanities

Art

ART 111/111A Drawing I Credits: (3-0) 3
ART 112/112A Drawing II Credits: (3-0) 3
ARTH 211 History of World Art I Credits: (3-0) 3
ARTH 321 Modern and Contemporary Art Credits: (3-0) 3
ARTH 491 Independent Study Credits: 1 to 9
ARTH 492 Topics Credits: 1 to 6

English

ENGL 210 Introduction to Literature Credits: (3-0) 3
ENGL 212 World Literature II Credits: (3-0) 3
ENGL 221 British Literature I Credits: (3-0) 3
ENGL 222 British Literature II Credits: (3-0) 3
ENGL 241 American Literature I Credits: (3-0) 3
ENGL 242 American Literature II Credits: (3-0) 3
ENGL 250 Science Fiction Credits: (3-0) 3
ENGL 300 The Literary Experience of Nature Credits: (3-0) 3
ENGL 330 Shakespeare Credits: (3-0) 3
ENGL 343 Selected Authors Credits: (1-0) 1
ENGL 350 Humor in American Culture Credits: (3-0) 3
ENGL 360 Studies in European Literature Credits: (3-0) 3
ENGL 374 Studies in American Literature Credits: 1 to 3
ENGL 383 Creative Writing Credits: (3-0) 3
ENGL 391 Independent Study Credits: 1 to 3
ENGL 392 Topics Credits: 1 to 3

Foreign Language

CHIN 101 Introductory Chinese I Credits: (4-0) 4
CHIN 102 Introductory Chinese II Credits: (4-0) 4
GER 101 Introductory German I Credits: (4-0) 4
GER 102 Introductory German II Credits: (4-0) 4
SPAN 101 Introductory Spanish I Credits: (4-0) 4
SPAN 102 Introductory Spanish II Credits: (4-0) 4

Table 5-3 University curricular requirements (cont'd)

History
HIST 121 Western Civilization I Credits: (3-0) 3
HIST 122 Western Civilization II Credits: (3-0) 3

Humanities
HUM 100 Introduction to Humanities Credits: (3-0) 3
HUM 200 Connections: Humanities & Technology Credits: (3-0) 3
HUM 291 Independent Study Credits: 1 to 4
HUM 292 Topics Credits: 1 to 3
HUM 350 American Social History Credits: (3-0) 3
HUM 375 Computers in Society Credits: (3-0) 3
HUM 491 Independent Study Credits: 1 to 4
HUM 492 Topics Credits: 1 to 3

Music
MUAP 200 Applied Music-Voice Credits: 1 to 4
MUAP 201 Applied Music-Voice Credits: 1 to 4
MUS 100 Music Appreciation Credits: (3-0) 3
MUS 110 Basic Music Theory I Credits: 2 to 4
MUS 217 Music in Performance I Credits: (3-0) 3
MUS 317 Music in Performance II Credits: (3-0) 3

Philosophy
PHIL 100 Introduction to Philosophy Credits: (3-0) 3
PHIL 200 Introduction to Logic Credits: (3-0) 3
PHIL 220 Introduction to Ethics Credits: (3-0) 3
PHIL 233 Philosophy and Literature Credits: (3-0) 3

Social Sciences

Anthropology
ANTH 210 Cultural Anthropology Credits: (3-0) 3

Geography
GEOG 101 Introduction to Geography Credits: (3-0) 3
GEOG 210 World Regional Geography Credits: (3-0) 3
GEOG 212 Geography of North America Credits: (3-0) 3
GEOG 400 Cultural Geography Credits: (3-0) 3
GEOG 492 Topics Credits: 1 to 3

History
HIST 151 United States History I Credits: (3-0) 3
HIST 152 United States History II Credits: (3-0) 3
HIST 492 Topics Credits: 1 to 4

Table 5-3 University curricular requirements (cont'd)

Political Science
POLS 100 American Government Credits: (3-0) 3
POLS 250 World Politics Credits: (3-0) 3
POLS 350 International Relations Credits: (3-0) 3
POLS 407 Environmental Law & Policy Credits: (3-0) 3
POLS 492 Topics Credits: 1 to 3

Psychology
PSYC 101 General Psychology Credits: (3-0) 3
PSYC 319 Teams and Teaming Credits: (1-0) 1
PSYC 323 Human Develop Through the Lifespan Credits: (4-0) 4
PSYC 331 Industrial and Organizational Psychology Credits: (3-0) 3
PSYC 391 Independent Study Credits: 1 to 3
PSYC 392 Topics Credits: 1 to 3
PSYC 451 Psychology of Abnormal Behavior Credits: (3-0) 3
PSYC 461 Theories of Personality Credits: (3-0) 3

Sociology
SOC 100 Introduction to Sociology Credits: (3-0) 3
SOC 150 Social Problems Credits: (3-0) 3
SOC 250 Courtship and Marriage Credits: (3-0) 3
SOC 351 Criminology Credits: (3-0) 3
SOC 391 Independent Study Credits: 1 to 3
SOC 392 Topics Credits: 1 to 3
SOC 411 Licit and Illicit Drugs Credits: (3-0) 3
SOC 420 Alcohol Use and Abuse Credits: (3-0) 3

All degree candidates must complete
ENGL 101 Composition I Credits: (3-0) 3
ENGL 279 Technical Communications I Credits: (3-0) 3
ENGL 289 Technical Communications II Credits: (3-0) 3
These courses cannot be used to meet the humanities and social sciences requirements.

Electives
Free Electives vary with the individual department. Any course may be selected which is at freshman level or higher (i.e. 100 level or higher). ROTC credits may be accepted, depending on the number of degree electives available in each department.

Science Electives
Courses may be selected —from biology, chemistry, geology, physics, or atmospheric science.

The General Education Requirements, the University General Requirements, and the ABET curricular requirements are satisfied by the BS Metallurgical Engineering curriculum as show in Table 5-4.

Military Science credits may apply to all degrees as free electives. This option varies with the number of free electives available in an individual curriculum. A veteran may petition the Registrar and Director of Academic Services to receive credit for basic military science and physical education.

Prerequisites are managed through a system established by Registrar and Academic Services (RAS). Students cannot enroll through the digital system unless they fulfill all prerequisites including *permission of instructor*. In unusual cases, an override is possible providing the instructor and the department head for the course signs a waiver that the requesting student delivers to the RAS. In addition to the course descriptions, program faculty and students have available the Curriculum Flow Diagram (CFD) shown in Figure 5-1.

Table 5-4 Comparison of curricular requirements

Category	Gen Ed	ABET	BS Met Eng
Hum and Soc Sci	12	Sufficient[1]	15
Engl and Comp	9	-	9
Basic Science	6	32	20
Mathematics	3		18
Engineering	-	48	50
Other Engineering	-	-	12
Free Electives and PE	-	-	6
Total	30	92	130

[1] previous ABET requirement was 12 credits hours

The metallurgical engineering curriculum is designed to provide students with a well-rounded knowledge of metal origins, production, treatment, use, failure analysis, and recycling. Well rounded includes associated knowledge on the societal effects of engineering and the context of engineering in a global society. Safety, economics, environmental, and ethical grounding is an essential element of each graduate's educational experience.

Graduates with the BS Metallurgical Engineering Degree are very adaptable in that they possess a wide range of engineering skills pertaining to metallurgical engineering. To assure the graduates from the program have strong fundamental skills which allow them to continue life-long learning through the application of fundamental engineering principles, they are required to complete eight credits of college-level chemistry/biology, six credits of calculus-based physics, 18 credits of calculus-based mathematics including differential equations and introduction to numerical analysis. To foster the students' awareness of the historical, political, and societal context of their potent engineering skills and the ethical application of those skills, each student is required to complete 15 credits of course work in the humanities and social sciences. Of these 15 credits, 12 are part of the system general education

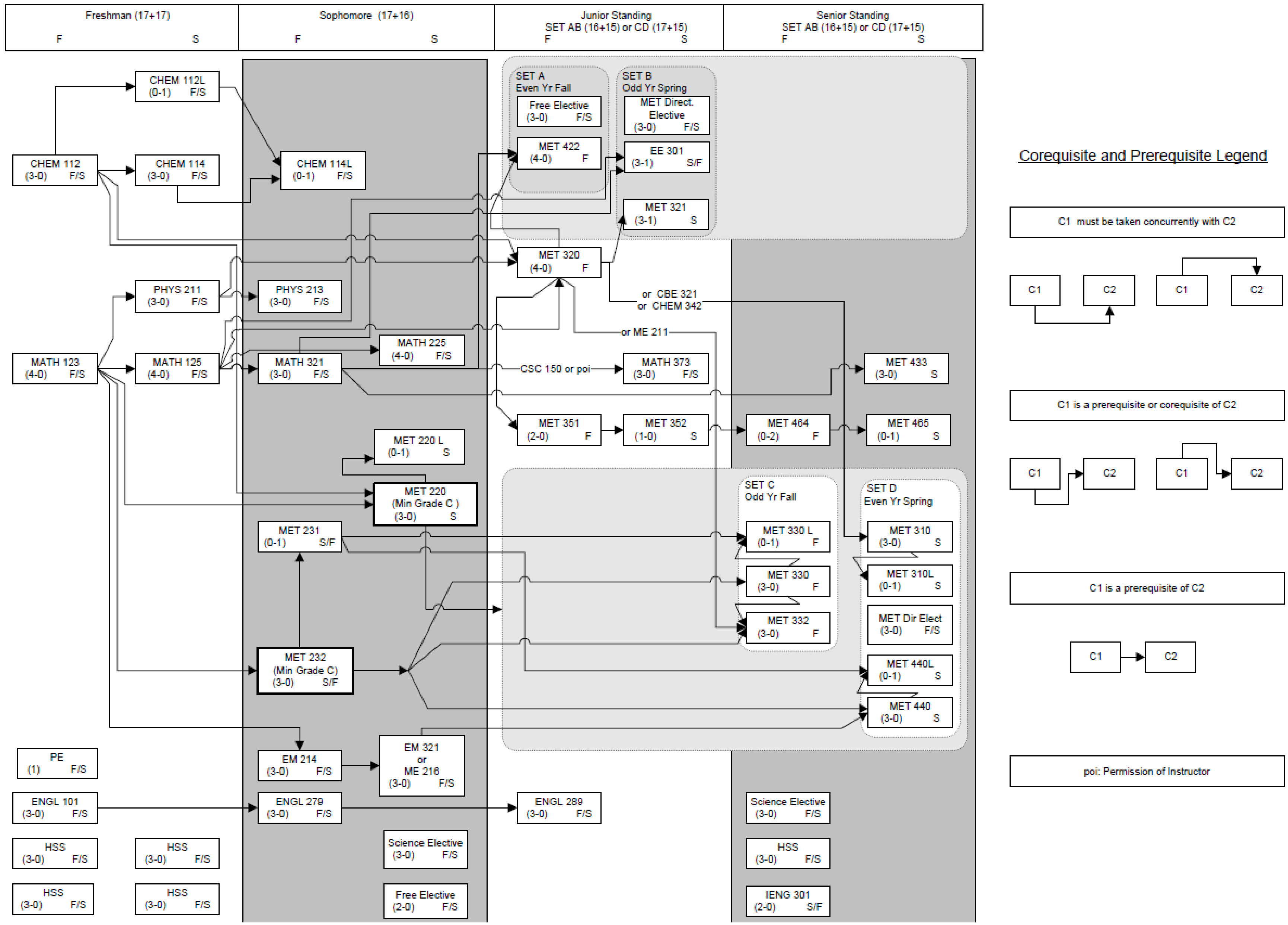


Figure 5-1 Curriculum Flow Diagram

requirement, discussed earlier. The BS Metallurgical Engineering program is a strong advocate for not falling to the minimal standard in this critical area.

A total of 50 credits of metallurgical engineering course work are required: 12 in process/extractive metallurgy, 15 in physical and mechanical behavior of metals and materials, 11 in general metallurgical engineering sciences, and six in design. These courses provide each student with a solid fundamental knowledge that allows them to adapt to a wide range of industrial processes, as well as an excellent foundation for graduate studies. These intrinsic metallurgical engineering skills are bolstered with courses in statics and strengths of materials, engineering economics, and electrical engineering system analysis. To assure the graduates possess excellent communication skills, each one is required to complete nine credits of English/technical communication. Additionally, their technical course work requires numerous laboratory reports, both oral and written. The laboratory credits required in the curriculum give the students first-hand knowledge of natural systems and an opportunity to develop their experimental and practical skills. Design assignments are common throughout the curriculum. The design experience includes experiences in both the
junior and senior years and culminates in the senior year with a capstone design project where the many elements of their course work are assimilated in the final hierarchy of learning. All of the students work in teams and are required to present their work in written and oral format and participate in periodic reviews of all program design projects which are trending towards 100 percent industrial sponsorship. In addition, they are required to participate in the campus annual design fair in the spring semester.

Metallurgical Engineering Program Criteria

An important aspect of this undergraduate metallurgical engineering program is the integrated understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing, and performance related to metallurgical engineering systems.

Structure: The fundamental scientific and engineering principles associated with the microstructure of metallurgical elements and alloys is taught is several of the undergraduate lecture courses including MET 232 (Properties of Materials), MET 330 (Physics of Metals), MET 332 (Thermomechanical Treatment), and additional coverage of this topic is incorporated in several of the Directed Met Elective courses. In addition, students obtain hands-on laboratory experience with microstructural principles and the application of these principles to engineering problems and materials selection issues in the following laboratories: MET 231(Structure and Properties of Materials Laboratory) and MET 330L (Physics of Metals Laboratory). The specific topics can be reviewed in the course syllabi contained in the Appendix of this section and in the examples of course examinations and design problems. MET 440 and MET 440L inform the student about the practical relationship between structure and aspects of mechanical behavior, deformation processing, and failure analysis of metals and alloys.

Properties: The fundamental principles associated with material properties and their application to solving engineering problems and material selection is taught in MET 232 (Properties of Materials), MET 330 (Physics of Metals), MET 332 (Thermomechanical Treatment), MET 440

(Mechanical Metallurgy), and several of the Directed Met Elective courses. In addition laboratory experience with understanding how to measure and use material properties is taught in MET 231(Structure and Properties of Materials Laboratory), MET 330L (Physics of Metals Laboratory) and MET 440L (Mechanical Metallurgy Laboratory). The specific topics can be reviewed in the course syllabi contained in the Appendix of this section and in the examples of course examinations and design problems.

Processing: The fundamental principles and application to engineering problems of metallurgical processing is taught in several of the courses including: MET 220 (Mineral Processing), MET 232 (Properties of Materials), MET 310 (Aqueous Extractive Metallurgy), MET 320 (Metallurgical Thermodynamics), MET 321 (High Temperature Extractive Metallurgy), MET 332 (Thermomechanical Processing), and MET 442 (Transport Phenomena). Additional hands on laboratory experience and application to engineering problems is taught in MET 220L (Mineral Processing) and MET 310L (Aqueous Extractive Metallurgy). The specific topics can be reviewed in the course syllabi contained in the Appendix of this section and in the examples of course examinations and design problems.

Performance: Understanding the application of microstructure, properties and processing to the performance of a material in an engineering design is a critical component in the undergraduate curriculum. This topic is covered in MET 232 (Properties of Materials), MET 330L (Physics of Metals Laboratory), MET 332 (Thermomechanical Processing), and MET 440/440L (Mechanical Metallurgy/Laboratory). The professors in this program spend a significant amount of time explaining to students the importance of material performance. Students are actively involved with design projects and applied homework assignments that specifically concentrate on using the principles of microstructure, properties and/or processing to solve engineering problems specifically applied to metallurgical engineering. In addition, students cover the performance of systems important to metallurgical engineering practice in MET 220 (Mineral Processing), MET 321 (High Temperature Extractive Metallurgy), and MET 433 (Process Control).

Understanding Statistical and Computational Methods: Aspects of statistics and statistical data analysis are covered in several courses within the program curriculum. These begin with MET 231 (Properties of Materials Laboratory), usually the first laboratory course MET program students take followed by MET 220L (Mineral Processing and Resource Recovery Laboratory). Upper division courses with significant statistics and statistical data analysis content are MET 310L (Aqueous Extraction, Purification and Recycling Laboratory) and MET 440L (Mechanical Metallurgy Laboratory). Generally, these are designed so that the experiences in MET 310L and MET 440L build upon and extend the materials covered during MET 231 and MET 220L. At the end of this series, the students are expected to be able to calculate basic statistical measures, such as mean and standard deviation, perform hypothesis testing and determine confidence intervals, and design experiments, including randomization, repeatability and reproducibility, to determine if data sets from experimental procedures are from the same population. A synopsis of the statistical and computational elements of each course follows.

MET 231
The first laboratory assignment in MET 231 involves an introduction to basic statistics calculations, including mean, standard deviation, variance and significance. In addition, later laboratory reports require least squares data fits and the determination and use of means and standard deviation data to properly interpret data.

MET 310L
In this course, the background from MET 231 and MET 220L are expanded through inclusion of design and analysis of experiments concepts. This includes factorial design, analysis of variance (ANOVA) and procedures for linking experimentation with analysis. All student group performed laboratories involving designing a set of experiments to test a hypothesis and analyzing the experimental results through proper procedures such as ANOVA or Yates method.

MET 440L
In this course, the background from MET 231 are used and expanded on through three laboratory assignments – hardness reproducibility and repeatability, fatigue analysis and statistical process control. In addition to using means, standard deviations and confidence intervals, the students learn and use non-parametric statistics through the runs test and learn Six Sigma procedures for process control.

A more complete analysis of how the curriculum satisfies the ABET Program Criteria for Met Eng appears in the section titled Program Criteria.

The design experience is critical to the student's incorporation of fundamental engineering skills into a coherent understanding of the practice of engineering. This integrated understanding is an underlying program criterion for the successful practice of metallurgical engineering. As such it is specifically labeled here for easy reference in the program curriculum. Additionally an extensive summary of the students' design experience is provided.

Integrated Understanding: Many of the courses in the curriculum apply several of the four major elements of the field together in the course content; however, the four capstone design courses are designed to specifically challenge and stimulate the students' knowledge and problem solving abilities in these fundamental elements. The capstone design courses are

- MET 351 (Metallurgical Design I)
- MET 352 (Metallurgical Design II)
- MET 464 (Metallurgical Design III)
- MET 465 (Metallurgical Design IV)

This sequence of courses requires students to work on a design team and solve a specific metallurgical engineering problem. In 2008 and during the first few years of the current ABET accreditation cycle (through 2011), multiple student teams worked on a Samurai Sword Design Project. The goal of this project was to design and make a traditional Samurai sword using iron ore from the Black Hills and have comparable mechanical properties and appearance to a traditional sword. Four design teams were developed:

- Agglomeration Team
- Furnace Team

- Forge Welding Team
- Forge Drawing Team

The faculty presented a paper on the project that is published in the 2009 TMS Conference Proceedings: Kellar, Howard, Cross, West, Medlin, Kellogg, *The Samurai Sword Design Project and Opportunities for Metallurgical Programs*, TMS Conference Proceedings, October 2009, Pittsburgh, PA.

The Agglomeration Team took iron ore collected from the dewatering process at the Deep Underground Science and Engineering Laboratory, removed impurities, added fluxes and made pellets for the Furnace Team. The team designed a process that would develop the optimum iron reducing pellets for the Furnace team and then made the pellets.

The Furnace Team designed a small blast furnace to reduce the pellets that the Agglomeration Team produced and made a high and low carbon iron for the Forge Welding Team. The team designed and made two difference blast furnaces and reduced several pounds of steel. The first blast furnace was made from two joined water heaters and masonry refractory. The Team needed more time to develop a higher quality steel for this project, however, the design and development of two furnaces was remarkable.

The Forge Drawing Team was designed to take the low and high carbon steel from the previous two teams and forge weld together a rough blank for a sword. The team designed two different sword designs based on historical evidence of Japanese swords and modern metallurgical engineering science. Because the previous two teams did not make sufficient quantity and quality steel, the Forge Welding Team used modern steels to create their rough blank sword. They also design the heat treatment procedure for the sword so the final sword would have the distinctive curved shape. The final sword blank had the distinctive curved shape and was free from quench cracking.

The Forge Drawing Team took the sword blank developed by the Forge Welding Team and designed a thermomechanical process to make a final sword. This involved designing a process to forge draw the sword blank using traditional blacksmithing techniques, as well as designing a more efficient system that utilized an air hammer. Temperature and forge strain rate limits needed to be accounted for in this process. The team also evaluated the forge weld quality and microstructural consistency of the final sword and what properties would be expected.

In 2010 Drs. Medlin, Kellar, West, and other supporting university faculty members were awarded a $150,000 NSF CCLI grant to integrate the kinesthetic blacksmithing activities into a metallurgical engineering program to improve student learning and motivation. The project was redesigned sophomore- through senior-level laboratories to include metalworking components to help students develop a better understanding of how microstructural development relate to mechanical properties. Additional project activities included: 1) expanding a weekly open forge time for all interested campus science and engineering students, 2) establishing an annual exhibit featuring undergraduate student work at the campus art gallery, 3) building and equipping a mobile trailer for outreach activities, and 4) training undergraduate students in technical communications. The project included strong outreach to Native American high schools and two-year colleges. Program outcomes were measured through five interrelated assessment instruments including materials concept inventories, longitudinal student tracking, and the Teamwork KSA inventories. A blueprint teaching and implementation strategy for other schools and a web-based seminar were used to disseminate the project. The project's progress was filmed by personnel from the Road Show of the South Dakota Public Broadcast Service (SDPBS).

The blacksmithing activity was supported by local resident Mr. Jack Parks, a board member of the Artist Blacksmith Association of North America (ABANA). This association continues to today. He advises our students during our HammerIn activities held every Friday afternoon. Food is also served as students from across campus are invited to learn the art of blacksmithing and the associated microstructural changes. The department sponsors a local Blacksmithing Club for those wishing to participate regularly.

The departmental association with ABANA led to the association holding its Annual Meeting in Rapid City in July 2012. They set up their workshops at the Pennington County Fairgrounds, which are immediately across the street from SDSM&T. Students led and participated in outdoor workshops at the fairgrounds. In the afternoon artists attended SDSM&T sponsored lectures by the metallurgical engineering faculty and students on campus.

As an outgrowth of these activities, faculty pitched the concept of the integrated Material Advantage sponsored blade contest at the annual Materials Science and Technology Meeting (MS&T), but it did not receive adequate support for fruition. However, in 2014 Dr. Howard led a new effort under the auspices of TMS. The result was the first student Bladesmithing Competition which was held at the TMS Annual Meeting in Orlando in 2015 and the first Student Bladesmithing Symposium in Nashville in 2016 with more planned. Over 20 student teams from all over the world have participated in this competition.

After a few years of conducting the Samurai Sword design project, the metallurgical engineering program faculty, realized that a new portfolio of design projects was needed. In 2013, a decision was made to integrate several industrially-linked projects in an effort to 1) increase the portfolio of design projects and 2) increase the student interest and excitement. The industrially-linked projects were defined between faculty and an industry partner. Student teams work on current metallurgical engineering problems faced by industry with frequent contact from an industrial mentor. These industrially linked and sponsored programs have grown over the last several years and are strongly supported by the program faculty. The goal is to have one faculty advisor per group of three or four students. This has been the norm for several years.
A brief summary of design projects undertaken since 2013 is given below with sponsored projects titled with the sponsor's name.

<u>2013</u>

- *Nucor Steel* – Design a process for joining high-strength low-alloy steel.
- *Freeport McMoRan* – Design a sequential metal extraction plant to remove iron and aluminum from copper streams.
- *Micron* – Investigate and design a process change to increase reliability in solder joints.

- *Kondex* – Design a process for laser deposition to increase the wear resistance of straw-chopper blades.
- *Boston Scientific* – Investigate and design a material change to replace Platinum in endovascular coils.
- *Steelmaking* – Design a process to produce steel from local iron ore sources.
- Bench Scale Solvent Extraction – Design and build a bench-scale mixer settler.
- *Aerodesign team* – Design landing gear for the aerodesign competition vehicle.
- Human powered vehicle – Design and build the frame for the human powered competition vehicle.

2014

- *Nucor Steel* – Investigate and design process change to prevent hot cracking in rolled steel.
- *Freeport McMoRan* – Design a system to utilize bioprocess off-gas to precipitate copper sulfides.
- *Micron* – Design an optimal test to improve reliability of microelectronic interconnects.
- *Barrick Gold* – Design a process to recover gold from mine tailings.
- *Wharf Resources* – Design and investigate process economics for different crushed ore size gold recovery.
- *PVD Team* – Design a wear resistant coating using physical vapor deposition.
- *Chromium Melting for Univ of Virginia*– Design a process to melt and recover high purity chromium.
- *3-D Printing/Casting* – Design a process to rapidly prototype cast aluminum parts using 3-D printing capabilities on SDSM&T campus.

2015

- *Nucor Steel* - Design a process for the extraction of manganese from South Dakota manganese nodules
- *Freeport McMoRan* - Design and model a high-temperature concentrate leach process plant addition, and perform a scoping study, including cost estimates of equipment, necessary to evaluate the merit of the design and economic viability of the addition
- *Real Alloy* - Design a rapid NaCl-KCl flux composition analysis method for aluminum melting processes.
- *Logan Aluminum* - Design a process change to prevent hot cracking in rolled aluminum
- *Nordson-Xaloy* - Design and demonstrate direct laser hard facing of a blade
- *Sapa Extrusions* - Design a joining process for a Al extrusion to a base plate
- *Barrick Goldstrike* - Design a method for reducing Au loss to carbonaceous gangue
- Vacuum Induction Melting - Design and build a vacuum induction billet caster

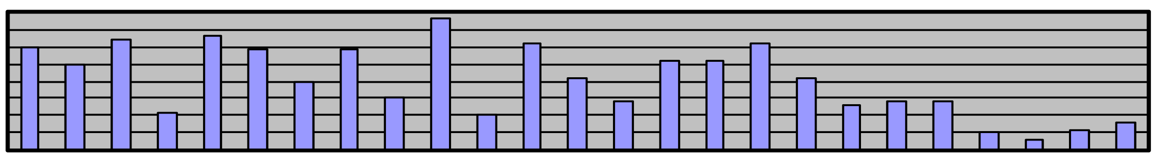
The program faculty continues their interest in graduating students who are as prepared as possible for the rigors of the post university world. One means of determining where in the curriculum students receive value-added qualities is via the Quality Function Deployment Matrix (QDFM). Table 5-5 (duplicate here from Table 3-4 for convenience) shows the QFDM for the BS Metallurgical Engineeering Degree program. Each program outcome is shown in the first column while program courses are shown in the top row. The functional importance of each

Table 5-5 Quality function deployment matrix for metallurgical engineering courses

Outcome Criteria	Course																								
	MET 220	MET 220L	MET 231	MET 232	MET 310	MET 310L	MET 320	MET 321	MET 330	MET 330L	MET 332	MET 351/352	MET 422	MET 433	MET 440	MET 440L	MET 464/465	MET Electives	Math sequence	Required Eng Courses	H&SS curriculum	Elective Courses	PE, Music, Band, MS	ENGL Sequence	Chem/Physics Seq
(a) Apply math, sci and eng prin	**5**	3	3	**5**	**5**	**3**	**5**	3	**5**	**5**	**5**	1	**5**	5	3	3	1	3	**5**	**5**		3			3
(b) Design & cond exp/interpret	3	**5**	**5**		3	**5**	3	3	3	**5**		1	3		3	**5**	1	3	3						3
(c) Design to meet design needs	3			3	3	3	3	**5**				**5**	**5**	3	3	3	**5**	3	1						
(d) multidisciplinary teaming	1	3	**5**		1	1				**5**		**5**			1	3	**5**	1			1		3	1	1
(e) Ident, form, & solve eng prob	**5**	3	3	3	3	3	3	**5**	**5**	**5**	**5**	**5**	**5**	1	**5**	3	**5**	3	3	5		1			1
(f) Knowing prof and ethic respon	3	1	1		3	1	1	**5**	1	3		3			3	1	3	1			1				
(g) communicate effectively	3	**5**	3		3	**5**	1	3		3		**5**			3	**5**	**5**	1	1		1			**5**	
(h) impact of eng in a glob context	3		**5**		3	1	1			3								1		1	**5**				
(i) Be life-long learner			3		3	1				3		1			1		1	3			1	1			
(j) Know contemporary issues	3		1		1	1		**5**	1	1					1			1			**5**				
(k) Use tech, skills, & mod tools	1	5	3		**5**	**5**	3			**5**		**5**	3	**5**	3	3	**5**	1		3					
	30	25	32	11	33	29	20	29	15	38	10	31	21	14	26	26	31	21	13	14	14	5	3	6	8

LEGEND

5 High importance
3 Medium Importance
1 Low Importance
No importance



ourse to each outcome is assigned an importance from a high of 5 to a low of 1. If there is no functional relationship, the cell is blank. Along the bottom the functional ratings are totaled and plotted. The last column totals the number of curricular functions having the highest functional relationship to the outcome. Every outcome has significant representation in the last column except for Outcome (i): Recognition of the need for and an ability to engage in life-long learning. There is no one place for the attainment of this outcome because it is believed to be a diffuse outcome that is captured by the students through their entire educational experience and in particular by their interaction with program faculty who are now communicating the need to develop a life-long learning plan. Additionally, each student is required to write a life-long learning plan as an assignment in MET 440. The QFDM shows the desired uniform and well balanced distribution of metallurgical engineering course function to program outcomes. A second QFDM for a broader spectrum of campus activities is shown in Appendix E.

Learning outcomes in the SDSM&T required general education program can be aligned with the ABET (a)-(k) outcomes. The first way to relate the general education requirements to outcomes (a)-(k) is through the stated intent of the requirements. This relationship is shown in the panels in Table 5-6 for general education requirements 1-7. The (a)-(k) outcomes directly related to the general education requirement are highlighted while those that do not relate to the specific general education objective are left dimmed. The second way to relate the general education requirements to outcomes (a)-(k) is through the courses students take in fulfillment of the general education requirements since a set of courses account for nearly all general education credit hours.

The panels in Table 5-6 are based on an analysis of all students between 2012 to the 2016. The shading indicates which ABET (a - k) outcomes these courses address to a high degree. The dark blue shaded courses are required courses required of all BS Metallurgical Engineering students while the light blue shaded courses are elective courses that 70 percent to 90 percent of all students take to meet the general education requirements. Even if students take other elective courses, they are still required to meet the general education requirement related to the (a)-(k) outcomes as shown by the highlighted headers.

Finally, the program outcomes map to each of the seven General Educational Requirements as shown in Table 5-6.

As described in Criterion 1, Section B, the assessment of the attainment of general education outcomes is the Collegiate Assessment of Academic Proficiency (CAAP) exam. Between 1995 and 2014, all students were required to take and pass the CAAP exam. Beginning in 2014, students with ACT scores of a certain level were exempt from the requirement to pass the CAAP exam. This exemption provision appears to be reducing the number of SDSM&T students taking the CAAP by approximately 90 percent.

Historically, SDSM&T student outperform students system wide in all four subject areas of the test. Table 5-7 below shows the percentage of SDSM&T students passing the CAAP at the first attempt as compared to all other students attending a public university in South Dakota. SDSM&T students score the highest in Math and science reasoning, as expected.

Engineering programs typically find difficult inculcating their students with the *soft skills* of professional, ethical, social, health and safety, and economic awareness compared with the *hard*

Table 5-6 Relationship of General Education Requirements to ABET Outcomes (a)-(k)

Objective #1: *Students will write effectively and responsibly and understand and interpret the written expression of others.*											
ABET Outcomes → **High-Enrollment GenEd courses that meet Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
ENGL 101 - Composition I											
ENGL 201 - Composition II											
ENGL 279 - Technical Communications I											
ENGL 289 - Technical Communications II											

GEP Objective #2: *Students will communicate effectively and responsibly through speaking and listening.*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
SPCM 101 - Fundamentals of Speech											
ENGL 279 - Technical Communications I											
ENGL 289 - Technical Communications II											

GEP Objective #3: *Students will understand the organization, potential, and diversity of the human community through study of the social sciences*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
PSYC 101 - General Psychology											
SOC 100 - Introduction to Sociology											
HIST 151 - American History I											
GEOG 101 – Introduction to Geography											
POLS 100 – American Government											

Table 5-6 Relationship of General Education Requirements to ABET Outcomes (a)-(k) (cont'd)

GEP Objective #4: *Students will understand the diversity and complexity of the human experience through study of the arts and humanities*

ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
HIST 121 - Western Civilization I											
HIST 122 - Western Civilization II											
HUM 100 - Introduction to Humanities											
PHIL 100 - Introduction to Philosophy											
ENGL 210 – Introduction to Literature											

GEP Objective #5: *Students will understand and apply fundamental mathematical processes and reasoning.*

ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
MATH 102/102L - College Algebra											

GEP Objective #6: *Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world.*

ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
Chemistry 112 – General Chemistry											
CHEM 114 – General Chemistry II											
GEOL 201 – Physical Geology											
Physics 211 – University Physics I											
Physics 213 – University Physics II											

Objective #7: *Students will recognize when information is needed and have the ability to locate, organize, critically evaluate, and effectively use information from a variety of sources with intellectual integrity*

ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
ENGL 101 - Composition I											
ENGL 201 - Composition II											
ENGL 279 - Technical Communications I											
ENGL 289 - Technical Communications II											

Table 5-7 Pass Rates on CAAP proficiency exam by sub-scores for SDSM&T

	Writing		Math		Reading		Science	
Year	Mines	System	Mines	System	Mines	System	Mines	System
2014	94.9%	89.4%	100%	98.0%	96.2%	93.3%	100%	98.80%
2013	96.1%	91.7%	99.8%	98.2%	98.8%	93.7%	99.8%	99.0%
2012	93.8%	90.4%	100%	97.8%	97.8%	94.1%	100%	98.2%
2011	93.6%	91.9%	100%	97.7%	96.4%	94.6%	99.7%	98.8%
2010	96.5%	92.4%	100%	98.0%	97.2%	94.6%	100%	99.0%

engineering skills associated with typical engineering science and practice courses. In recognition of the importance of these *soft skills*, the program works to assure the program students achieve professional temperament, skill, understanding, and appreciation in each one through a deliberate pedagogy as described below.

Professional Awareness
Students in the program often interact one-on-one with the faculty. Faculty members are very careful to always project their dedication to ethical practice, social obligations, safe practice, and the importance of economics to engineering. The senior capstone design projects require attention to professional concerns including ethics, social obligations, safety, and economics. The junior and senior students in the design courses are required to discuss, coordinate and develop plans and strategies for these issues and incorporate their plans into weekly verbal and written update reports and the final design report.

Program students are active in Materials Advantage. They hold monthly meetings and engage in several community service projects each year, sponsor profession meetings, participate in scholarship programs, and send representatives to selected professional meetings as funding permits.

The department has a plasma screen TV and a digital display board to help with student professional awareness. The display board and projector runs informational videos from professional societies (TMS/ASM), industry, and alumni testimonials as well as other topical areas specific to the program. The displays are updated regularly and contain historical information (such as the history of steelmaking) as well as other topical information such as the “Metal of the Week”, current metal prices, scholarships and other program opportunities (e.g. job openings, student chapter meetings, seminar notices, field trips).

Ethical Awareness
Ethical practice is a frequent item for discussion in the metallurgical engineering classroom. Each professor in the department discusses ethical issues during their semester when issues regarding ethics correspond to the discussion. Many metallurgical engineering students are inducted into the Order of the Engineer during Engineers Week. Part of this ceremony is a pledge to ethical practice.

Every student enrolled in required MET 422, Transport Phenomena, and MET 321, High Temperature Extraction, Concentration, and Recycling, participates in two half-hour discussions on ethical problems and the hierarchy of values needed to successfully address such issues. Every student is given a copy of the Code of Conduct for Professional Engineers during their senior or junior year as a prelude to discussions of ethics. Every departmental professor is asked to spend at least a portion of one class period during the spring semester discussing ethical issues. Copies of the Code of Conduct for Professional Engineers in made available to any student who has not already received one during the semester.

Every student enrolled in MET 310, Aqueous Extraction, Concentration and Recycling, will write an essay on the ethics and global impacts of metal extraction processes. All senior capstone design projects include an ethical component during their final presentation and report.

Social Awareness

Items contributing to overall student social awareness are listed below:

- The program's moderate enrollment permits a great deal of discussion between faculty and students. The faculty frequently engages the students in informal discussions outside the classroom, for example in the student lounge or at the annual Materials Advantage picnic. The faculty knows all the students and spends considerable effort with them to assure their professional and social growth.
- Students exit interviews routinely indicate that the students are clearly aware of the devotion of the faculty to the students' development and success. The students recognize this devotion exceeds professional obligations and is a measure of the faculty's interest in the students' success. This extra measure given by the faculty fosters a deep connection between professional practice and service in each student.
- Students' social skills are honed through social events including barbecues, banquets, local professional meetings, and trips to the Annual TMS and SME meetings. Typically, when the department has an important guest visiting, one or two undergraduate students are invited to join the faculty and the guest at lunch or dinner. Faculty members routinely host students at the local SME meetings where the subjects frequently focus on abiding environmental obligations and responsibilities.
- Students are involved in a weekly Hammer-In. This is a blacksmithing activity held every Friday afternoon where students are encouraged to design and make a variety of blacksmithing items. Occasionally, students will have a barbecue and local professional blacksmiths will participate in this activity to give students tips on what to do.
- Culture and Attitude program students along with the Women in Science and Engineering sponsor laboratory and technical skills workshops for women students in the department including welding, casting, and metalworking.
- Students are advised and guided by the faculty on matters of conduct with other professionals. Students frequently visit with their advisors on a wide range of social and professional issues. Students are routinely asked to visit their advisors before interview trips and professional activities to assure they have a good sense of what behavior is expected as young professionals.
- Meetings of the student Materials Advantage chapter are a frequent crucible of discussion of good and bad practices. In the course of conducting chapter business, students discuss a variety of proposals and arrive at good practices. The faculty advisor occasionally is needed to help students consider potentially troublesome consequences in their deliberations.
- The Materials Advantage Chapter members perform highway cleanup during the year.

Health and Safety Awareness

Items contributing to overall student health and safety awareness are listed below:

- Each year campus safety personnel present a safety training class in the fall semester to all metallurgical engineer juniors and senior enrolled in design. The course covers the proper handling and use of chemicals, general hazards, understanding chemical safety information labels, response to injury, safe workplace, safety responsibility, electrical hazards, explosion hazards, and safe disposal.
- Students' awareness of safety concerns is most strongly reinforced by their laboratory activity. Every laboratory involving hazardous activity includes instructions on safe practice. These are always presented orally and in most instances they are also written. The laboratory handouts in the course materials may be reviewed for a more detailed accounting of safety instruction.
- Safety issues are also experienced during the weekly Hammer-Ins where the blacksmithing activities incorporate several safety issues and students must take the time to educate new students on all this important safety concerns.

Economic Awareness

Items contributing to overall student economic awareness are listed below:

- Every metallurgical engineering student completes a two credit course in engineering economics: IENG 301. Students are expected to perform some economic analysis in departmental design assignments.
- All senior capstone designs must include an economic analysis during the preliminary proposal presentation, the final presentation, and final report.
- The majority of the program students is involved with the campus Materials Advantage chapter and routinely solicits the campus student association for chapter funding. This activity requires the students to write a proposal, including a proposed budget, and to manage and account for all funds secured.
- Every two years all junior and senior students taking the capstone engineering design courses participate in the "Dollars and Tons" activity sponsored by NUCOR Steel. Representatives from NUCOR Steel visit campus and teach the students about business economics during an 8 hour business simulation game. Students work in teams and learn how to build a steel mill and participate in the world steel market. Typically, during the last 2-3 hours of the game, students get very intense about this activity in trying to win.

The program faculty is actively involved in support and leading students in professional maturation. Some of the salient activities of the program faculty are described below.

Professional Societies

Dr. Howard serves as the Materials Advantage chapter advisor. The students meet monthly and engage in a variety of professional and community service projects. The chapter has sponsored the numerous industrial and university speakers. Approximately 75 percent of all students in the program are members of Materials Advantage. The department also has a student chapter of SME. The membership for the SME chapter is made up of geological, mining, and metallurgical engineering students. Students regularly attend at least one area SME meeting each year. Every year approximately ten students attend either the annual TMS or SME meeting. A few students typically also attend the fall MS&T meeting. Dr. West initiated the student chapter of the American Welding Society (AWS) in 2008 and advises it and the Blacksmithing Club. The department actively supports (including financially) the Material Advantage, the local

SME chapter, and the student chapter of the American Welding Society (AWS). It also supports the local Blacksmithing Club. SME is largely advised by the Mining Engineering Department but faculty members from Materials and Metallurgical Engineering co-advise students and attend the Annual SME meeting with the students.

Professional Practice

As mentioned earlier, many of the students in the program have at least one intern experience before graduation. In addition, some students are hired by the faculty to work on research projects during the summer, and still others participate in the undergraduate research programs funded by various federal agencies, particularly in the Advanced Materials Processing Center. It is rare for a student who wants an intern position not to find one.

Metallurgical engineering students may participate in large campus-wide CAMP Program designing competitive systems such as the Super mileage Vehicle, The Mini Indy Racer, Aero Team, and the Mini Baja. Students may also participate in the many specialized centers as members of these teams, as student part-time employees, or students having been assigned certain experiments relying on the centers' specialized equipment. These centers include the Center for Advanced Manufacturing and Production, the Advanced Materials Processing (CAMP) Laboratory, Center for Polymers Engineering (CAPE), or Security Printing and Anti-Counterfeiting Technology center (SPACT).

Program faculty members provide considerable professional counseling to students. They help them with

- Advice on seeking employment
- Advice and editing of professional letters
- Advice on writing of resumes
- Writing recommendation letters for them
- Identifying and applying for scholarships
- Counsel on conflict resolution, professional demeanor, and professional practice
- Frequent (unremitting) advice on professional bearing and communication
- Lively discussion on professional matters
- Advice on special projects outside normal departmental sphere of activity
- Sponsor and invite students to social skill seminars, dinners, and other such events

Professional Examination and Registration

Students in the metallurgical engineering program are encouraged to take the Fundamentals in Engineering Examination. Topic review sessions are periodically offered by the university. Faculty member Dr. Howard is been active within TMS and NCEES in writing PE exam questions for the Materials Engineering Exam and serving on cut score panels, etc.

Internships

Many program graduates complete at least one intern experience during their academic career. The variety of these intern experiences vary from industrial to academic research. Students may obtain course credit for a co-op position (CP 297, CP 397, CP 497), but most do not opt to pay tuition. Students typically apply directly to prospective employers for available co-op/intern positions similar to the manner in which graduating seniors apply for full-time positions.

The Career Center staff and faculty members assist students in identifying Co-op/intern opportunities and in applying for available positions. Career services provided to students include career fairs each fall and spring semester, campus interviews, resume and cover letter reviews, online job postings, and a series of career development workshops. The first step in this process involves a visit between the student and the program coop/intern coordinator to determine how many co-op credits the student should register for. SDSM&T's co-op policy allows 1-3 credit hours for the semester students are on co-op. Co-op credits may be applied toward graduation requirements in accordance with university policy and individual department curricular requirements. Because the work performed by a co-op student is equivalent to the workload of a full-time student, a student on a co-op assignment who is registered for credit is considered to have full-time status. Before returning to campus, students must turn in a formal co-op/intern report (using a format specified by the Career Planning Center) along with an employer evaluation form to the program department head to receive credit for the coop/intern experience. The department uses email and classroom announcements to keep students aware of co-op opportunities.

Peer mentors
Table 5-8 shows the students engaged as peer mentors during the 2015-16 year.

Organization of review materials for the PEV
Table 5-9 shows the materials to be displayed in the review room for evaluation by the program Evaluator (PEV). In addition to the syllabi for each course, there be for each course notebooks containing examples of all graded work, textbooks, references, and any significant supplementary materials used for instruction. All requirements of 2015-2016 APPM section II.G.6.b.(2) will be satisfied.

B. Course syllabi
Appendix A contains complete syllabi for all courses employed in the BS Metallurgical Engineering Degree curriculum. Table 5-10 shows a listing of the Table of Contents for that Appendix A. It is a directory to the available course syllabi and is arranged by significant categories.

Table 5-8 Peers mentors (6/22/2015-6/21/2016)

Name	Title	Dept
Seivert, Robert	Peer Mentor	BS.MET,
Wagehoft, Baylor	Peer Mentor	BS.GEOE,
Asel, Michael	ME Peer Mentor	BS.ME,
Bane, William	MET Peer Mentor	BS.MET,
Benedix, Hannah	ME Peer Mentor	BS.ME,
Clark, Rebecca	ABS Peer Mentor	BS.ABS,SPECG.SPEC,
Costello, Harrison Chance	GGE Peer Mentor	BS.GEOE,
Crandall, Zachery	CHEM Peer Mentor	BS.CHEM,
Crecco, Daniel	MET Peer Mentor	BS.MET,
Earney, Tait	GGE Peer Mentor	BS.GEOL,
Hirschey, Travis	CEE Peer Mentor	BS.CEE,
Jewell, Paul	MIN Peer Mentor	BS.MINE,
Karatekeli, Kayhan	CSC Peer Mentor	BS.CSC,
Keene, Lauren	CSC Peer Mentor	BS.CSC,
Kreuzer, Jena	ME Peer Mentor	BS.ME,
Leonard, Rashyll	MATH Peer Mentor	BS.ACMA,
Monk, Chandler	ME Peer Mentor	MS.ENMG,
Schwab, Roye	ME Peer Mentor	BS.ME,
Seidel, Matthew	ME Peer Mentor	BS.ME,
Stelter, Andrew	CSC Peer Mentor	BS.CSC,
Taylor, Christina	ME Peer Mentor	BS.ME,
Thune, Jonah	ME Peer Mentor	BS.ME,
Trapp, Cassidy	AES Peer Mentor	BS.CEE,
Vincent, Hunter	CEE Peer Mentor	BS.CEE,MS.CENE,SPECG.SPEC,
Lee, Sunghee	Math Supp Instructor	BS.CENG,BS.MINE,
Brubaker, Noah	Math Supp Instructor	BS.APCMATH,BS.CSC,
Ryther, Tyler	CHEM Supp Instructor	BS.CHEM,
Braasch-Turi, Margaret	CHEM Supp Instructor	CHEM Supp Instructor
Huntington, Samuel	Math Supp Instructor	BS.ME,BS.APCMATH,
Angelo, Michael	Internatl Peer Mentor	BS.IEEM,
Dulal, Rohit	Internatl Peer Mentor	BS.ME,MS.MES,
Singh, Akshay	Internatl Peer Mentor	BS.CSC,

Table 5-9 Plan for Organizing and Presenting Course and Student Work Materials

BS Metallurgical Engineering Degree Program
(ABET Accreditation Policy and Procedure Manual (APPM) §II. E.3.c.(10))

Resource Room Course, Assessment, and Evaluation Documents

By Course
Course materials for all SDSM&T Met Eng courses used to meet graduation requirements for the degree BS in Metallurgical Engineering will be arranged by course on tables in the resource room. These materials will consist of the following:

- Syllabus
- Text
- Graded representative samples of exams
- Graded representative samples of graded homework
- Graded representative samples of lab reports
- A compilation of handouts and supplementary materials

By Outcome

- A directory of all outcomes and the material assessed will be posted above these documents.
- Materials used to assess outcomes will be arranged by year followed by outcome on a table in the resource room.

By Objective

- A directory of all objectives and the material assessed will be posted above these documents.
- Materials used to evaluate objectives will be arranged by assessment vehicle (Alumni Survey, Advisory Board Report, etc.) on a table in the resource room.

Table 5-10 Table of Contents for Appendix A: Course Syllabi

[†] After 2010 MET 443 was replaced by the 2-credit hour Advances in Processing and Nanoengineering of Polymers (MES 475) and the 1-credit hour Composites Manufacturing (MET 489)

[*] Beginning in 2015-16, MET 491 was renumbered as Security Printing Technology (MET 444/544)

[‡] New course Spring 2016

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CRITERION 6 - FACULTY

This criterion contains information on the program faculty qualifications, workload, size, professional development, authority and responsibility, and curriculum development and review policy.

A. Faculty qualifications

A summary of faculty and expertise areas for members in the Department of Materials and Metallurgical Engineering is shown below.

- Dr Crawford, Arizona State University (mechanical metallurgy, physical metallurgy)
- Dr. Cross, University of Utah (aqueous extraction, surface chemistry)
- Dr. Howard, Colorado School of Mines (high temperature metallurgy, thermodynamics)
- Dr Jasthi, SDSM&T (physical metallurgy, corrosion engineering)
- Dr. Kellar, University of Utah (mineral processing)
- Dr. Safarzadeh, University of Utah (aqueous extraction, electrochemistry)
- Dr. Salem, University of Manchester, U.K. (polymers, polymer synthesis, composites)
- Dr. West, University of Tennessee, Knoxville (physical metallurgy, materials joining)
- Dr. Widener, Wichita State University (mechanical behavior, advanced processing)

Table 6-1 shows the program faculty qualifications. All program faculty members hold PhD degrees in metallurgical or materials engineering or a closely-related supportive field and graduated from quality institutions. All faculty members are active in the campus research effort. The program teaching faculty have developed a strong research portfolio with nearly $1.7M in FY 15 expenditures. This number does not include funding associated with the two research labs managed by Dr. Salem (CAPE Lab) and Dr. Widener (AMP Lab) which amounts to nearly $2.5M in external support. Major active resesearch highlights include three State of South Dakota centers in the areas of advanced metal alloy repair, advanced polymers, and security printing as well as DoD grants related to strategic metals as shown below. Faculty have leveraged this research funding to acquire new equipment that directly benefits students in the program. An excellent example is acquisition of the new 3-D X-ray MicroCT system.

- G. Crawford (PI), D. Anagnos, L. Groven, R. McTaggart, “Fundamental Research Towards a Printable Spacecraft”, SD NASA EPSCoR, **funded,** $50,000, 2014-2015.
- Hoppe (PI), S. Smith, D. Engebretson, G. Crawford et. al. “Biochemical Spatiotemporal NeTwork Resource (BioSNTR), SD EPSCoR, **funded,** $10,000,000, 2013-2018.
- W. Cross (PI), J. Kellar, D. Boyles, G. Crawford, “Novel Separation Technologies For Recovering Manganese From Process Streams”, Office of Naval Research, **funded**, $398,834, 3/12-4/15.
- W. Cross (PI), J. Kellar, S. Safarzadeh, D. Boyles, M. West, “Extraction and Recovery of Rare Earth Metals II”, Army Research Laboratory, **funded**, $325,000, 9/14-9/15.
- H. Hong (PI), “Next Generation of Nanocoolants, Nanogreases and Nano-lubricants”, Army Research Lab, **funded,** $197,000, 07/29/10 – 08/31/15.

- J. Kellar (PI), P.S. May, G. Crawford and B. Logue, “Center for Security Printing and Anti-Counterfeiting Technology,” SD Board of Regents, $900,000, **funded**, 12/13-6/16.
- J. Kellar (PI), W. Cross, S. Safarzadeh and M. West, “Strategic Minerals Extraction,” Army Research Laboratory, $999,998, **funded**, 11/13-5/15.
- D. Salem (PI), M. Robinson, W. Cross et. al, “Composite and Nanocomposite Advanced Manufacturing Center (CNAM), **funded** $2,000,000, State of South Dakota, 6/2013 **–** 5/2018,
- M. West (PI), W. Cross, “REU Site Back to the Future II”, NSF, **funded**, $300,000 3/2012-3/2015.
- Widener (PI), B. Jasthi (Co-PI)- Governor’s Research Center - Advanced Manufacturing Process Technology Transition and Training Center (AMPTEC), State of South Dakota, **funded**, $2,500,000**,** 07/01/13-06/30/18.
- Widener (PI), G. Crawford , M. West, B. Jasthi , M. Carter , T. Curtis, “Development of Advanced Materials Processing, Cold Spray, and Additive Manufacturing for DOD Applications”, Army Research Laboratory, **funded,** $300,000

It should also be highlighted that faculty have been successful to develop pedagogical grants in the last period that have directly benefited undergraduate student outcomes in the program. These include two ongoing NSF REU programs as well as an NSF S-STEM award.

- M. West (PI), J.Kellar, “REU Site Back to the Future”, NSF, **funded**, $300,000 3/2010-3/2012.
- M. West (PI), W. Cross, “REU Site Back to the Future II”, NSF, **funded**, $330,000 3/2012-3/2015.
- G. Crawford (PI), J. Kellar, “REU Site: Security Printing and Anti-Counterfeiting Technology”, NSF, **funded,** $453,000, 3/2012-3/2016.
- J. Kellar (PI), J. Karlin, S. Kellogg and D. Medlin, NSF, “S-STEM: Culture and Attitude---Innovative Partnerships for Success,” **funded**, $600,000, 9/09-8/15.

All faculty members are interested in student achievement and success and have two formal processes for monitoring the quality of their instruction: use of the IDEA end-of-course survey and monitoring of the benchmarks for instructional effectiveness, academic advising, and concern for the individual that are generated by use of the Student Satisfaction Survey (SSI) with all seniors. As a matter of regental policy, all courses are evaluated by students with the IDEA end-of-semester survey. Additional information on the use and features of this instrument is available at http://www.theideacenter.org.) Student evaluations are returned to the department head who reviews the evaluations and follows up with each faculty member. The results of all course surveys are stored digitally in the Office of the Provost. While the provost has free access to all faculty member files, the department head and the faculty member are the primary audience for end-of-course student evaluations. The monitoring and improvement of teaching quality is the purview and primary responsibility of the faculty members in the program in collaboration with the department head. Faculty members also have course management software available to them and access to Web Advisor and Colleague, which gives them access to student information needed for quality advisement. Academic departments are responsible for monitoring the holding and posting of office hours, ensuring that instructors are readily available for student inquiries, and monitoring the quality of academic advising within the program(s).

Table 6-1 Faculty qualifications: BS Metallurgical Engineering

Faculty Name	PhD Earned Field and Year	Rank [1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[3]	Years of Experience: Govt./Ind. Practice	Years of Experience: Teaching	Years of Experience: This Institution	Professional Registration/ Certification[4]	Level of Activity[5] H, M, or L: Professional Organizations	Level of Activity H, M, or L: Professional Development	Level of Activity H, M, or L: Consulting/summer work in industry
Crawford, Grant A.	Materials Science and Eng, 2008	AST	TT	FT	3.5	4.5	4.5		M	M	M
Cross, William M.	Metallurgical Eng, 1999	ASC	T	FT	0	9	23		M	M	L
Howard, Stanley M.	Metallurgical Eng, 1971	EM & I	NTT	PT	2	45	45	PE	H	H	L
Jasthi, Bharat K.	Materials Eng and Sci, 2009	AST	TT	FT	2	3	7		M	M	L
Kellar, Jon J.	Metallurgical Eng, 1991	P	T	FT	0	26	26		H	L	L
Safarzadeh, M. Sadegh	Metallurgical Eng, 2013	AST	TT	FT	4.5	3	3		M	M	L
Salem, David R.	Polymer and Fiber Physics, 1983	P	T	FT	32	9	6	CPhys	M	M	L
West, Michael K.	Materials Science and Eng, 2006	ASC	T	FT	0	9	9		M	M	L
Widener, Christian	Mechanical Eng, 2005	ASC	T	FT	6	6	5		L	M	H

Instructions: Complete table for each member of the faculty in the program. Add additional rows or use additional sheets if necessary. Updated information is to be provided at the time of the visit.

1. Code: P = Professor, ASC = Associate Professor, AST = Assistant Professor, EM = Emeritus Professor, I = Instructor, A = Adjunct, O = Other
2. Code: TT = Tenure Track, T = Tenured, NTT = Non Tenure Track
3. At the institution
4. Code: PE = Professional Engineer, CPhys = Chartered Physicist
5. The level of activity, high, medium or low, should reflect an average over the year prior to the visit plus the two previous years.

Data shown in Table 1-8 generated by the use of the Student Satisfaction Survey (SSI) with all seniors is segmented by academic program and incorporated into the institutional-level performance metrics aligned with the strategic plan and tracked by the Executive Council. Levels of engagement and satisfaction with instruction at the sophomore level are monitored through use of the Second Year Student Assessment (SYSA) presented in Table 1-9.

B. Faculty workload

Table 6-2 summarizes the faculty workload and describes this information in terms of workload expectations for both 2014-15 and 2015-16. Workload expectations are set by the department head and agreed upon during the annual review cycle. Workload expectations are made to support the mission of the department and the university. The teaching faculty members in the department are expected to maintain a fairly equal balance between teaching and research and average approximately six credit hours a semester. New faculty members have been given a reduced teaching workload when possible during the review period to stimulate development of externally funded research programs.

C. Faculty size

As shown in Table 6-1, the program has six full-time, tenure-track faculty (Michael West, Jon Kellar, William Cross, Grant Crawford, Bharat Jasthi, and Sadegh Safarzadeh), two shared appointment professors (Christian Widener of the Arbegast Advanced Materials Processing Center (AAMPC) and David Salem of the Composites and Polymer Engineering Laboratory (CAPE), and one senior lecture and professor emeritus (Stanley Howard). Additionally, Dr. Timothy M Brenza from the Department of Chemical and Biological Engineering teaches the program's dual listed MET 433/CBE 433 Process Control course. The teaching faculty to student ratio for the program in Fall 2015 was 1/25.

The program faculty members are on first name basis with essentially all of our students by the time they reach their junior year. The department is known for its close and supportive relationship with its students. Students are welcomed into faculty offices to seek assistance with homework problems, curricular planning, scholarship applications, employment and interview procedures, or financial and personal problems. Students who are hospitalized are visited by a faculty to assess needs and provide assurance and support. Faculty offer special help sessions as needed for exam preparation and either post available office hours or have an open door policy. Friday Hammer In blacksmithing activity is often accompanied by grilled food, which draws faculty and students to this social event. The department annually holds several banquets and/or picnics sponsored by the local Materials Advantage Chapter. Through these activities and the constructive attitude of the faculty, the department continues its successful building of a close-knit student cohort supported by a caring, competent, professional faculty.

The program is managed by the program faculty in periodic curriculum planning sessions using input from the Advisory Board, reviews of other programs across the USA, and their experiences from implementing the prevailing program. Each program faculty member has adequate opportunity for making input and every change is discussed before submission to the University Curriculum Committee.

Dr. Cross is the program's representative to the curriculum committee and also serves on the Faculty Senate. In recent years he has served as the Curriculum Committee's representative to the Faculty Senate so presents all proposed curricular changes to the senate. This means that the BS Metallurgical Engineering Program has continuous and excellent communication with the process for making curricular changes. No change can be made without consent of the Faculty Senate and subsequent approval by the SD Board of Regents. Curricular changes are categorized in four levels with the first being minor modifications increasing to the most significant: new degree programs.

The administration has a long history of appreciating that the faculty has dominion over the curriculum within the broad boundaries established by legal, financial, facilities, and publically-expected norms (such as total credit hours for a degree). The faculty, administration, and the Regents have enjoyed a very constructive relationship for several decades. The Regents hold regular on-campus open forums for faculty and student input.

The Faculty Senate is comprised of a representative from each degree program or academic department. The senate has opted to impose no additional curricular requirements on engineering programs holding that the Regental General Education Requirements and those set by ABET are adequate minimums. The Provost is an ex-officio member of the senate and is always welcome to attend the senate meetings. The senate convenes General Faculty Meetings each semester at which time faculty are invited to discuss any topics of interest/concern. Without faculty senate approval no degree candidate may receive a degree from SDSM&T.

Table 6-2 Faculty workload summary: BS Metallurgical Engineering (2014-2015)

Faculty Member	PT or FT[1]	Term and Year[2] - Classes Taught (Course No./Credit Hrs.)	Program Activity Distribution[3]			% of Time Devoted to the Program[4]
			Teaching	Research or Scholarship	Other	
Crawford, Grant A.	FT	14F – BME 601/(3), BME 790/(1), MET 464 (2) 15S – MET 450/550(3), BME 790/(1), MET 352/(2), MET 465/(2)	40	40	20	100
Cross, William M.	FT	14F - MES 601/(4), MES 712/(3), Design Advisor 15S - MES 716/(3), MES 678L/(1), Design Advisor	35	45	20	100
Howard, Stanley M.	PT	14F - MET 320/(4), MATH 373/(3), MES 898/(2), Design Advisor 15S - MATH 373/(3), MES 898/(1&9), Design Advisor	60	20	20	75
Jasthi, Bharat K.	FT	14F - MET 231/(2), MET 430 & MET 430L/(3), Design Advisor 15S - MET 231/(2), MET 426/526/(3), Design Advisor	60	20	20	100
Kellar, Jon J.	FT	14F - MET 351/(2), MET 232/(3), Design Advisor 15S - MET 220/(3), MET 220L/(1), Design Advisor	40	40	20	100
Safarzadeh, M. Sadegh	FT	14F-MET 422/(4), MES 790/890(1), Design Advisor 15S-MET321/(4), Design Advisor	40	40	20	100
Salem, David R.	FT	14F – MET/CBE 489/589/(1)	10	30	60	10
West, Michael K.	FT	14F - MET 110/(1), MET 231/(3), Design Advisor 15S - MET 231/(3), MET 232/(3), Design Advisor	30	20	50	100
Widener, Christian A.	FT	14F - Design Advisor 15S - Design Advisor	10	70	20	10

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the Self-Study Report is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Out of the total time employed at the institution.

Design Advisor – advised one of eight design groups in MET 351(2), MET 352(1), MET 464(2), MET 465(1)

Table 6-2 Faculty workload summary: BS Metallurgical Engineering (2015-2016)

Faculty Member	PT or FT[1]	Term and Year[2] Classes Taught (Course No./Credit Hrs.)	Program Activity Distribution[3]			% of Time Devoted to the Program[4]
			Teaching	Research or Scholarship	Other	
Crawford, Grant A.	FT	F15 - MET 330/(3), MET 330L/(1), MET 464/(2) S16 - MET 440/550/(3), MET 465/(1), MET 352/(1)	40	40	20	100
Cross, William M.	FT	F15 - MET 491/(3), MES 601/(4), MES 691/(3), Design Advisor S16 - MET 310/(3), MES 712/(3), Design Advisor	40	40	20	100
Howard, Stanley M.	PT	15F - Design Advisor 16S - Design Advisor	75	15	10	30
Jasthi, Bharat K.	FT	F15 - MET 231/(3), MET 445/545/(3) , Design Advisor S16 - MET 440L/(2), MET 432/532/(3), Design Advisor	55	30	15	100
Kellar, Jon J.	FT	F15 - MES 790/890/(1), MET 351/(2), MET 232/(3), Design Adv S16 - MET 220/(3), MET 220L/(1), Design Advisor	40	30	30	100
Safarzadeh, M. Sadegh	FT	F15-MET 320/(3), MES 728/(3), Design Advisor S16-MET 310L/(1), MES 742/(3), Design Advisor	40	40	20	100
Salem, David R.	FT	F15 - MET/CBE 489/589/(1), Design Advisor S16 – MET/CBE/NANO 475/575/(2), Design Advisor	10	30	60	10
West, Michael K.	FT	F15 - MET 110/(1), MET 231/(2), MET 332/(3), Design Advisor S16 - MET 231/(6), MET 232/(3), Design Advisor	30	20	50	100
Widener, Christian A.	FT	15F - Design Advisor 16S - Design Advisor	10	70	20	5

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the Self-Study Report is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Out of the total time employed at the institution.

Design Advisor – advised one of eight design groups in fall: MET 351(2), MET 464(2); spring: MET 352(1), MET 465(1)
MS and PhD candidates are advised through course registration but are not listed here.

D. Professional development

To encourage and monitor the ongoing professional and career development, all tenure-track faculty members are required (under the Collective Bargaining Agreement, Section 12.2) to create and update an individualized Professional Development Plan. The department head reviews each faculty member's Professional Development Plan and negotiates the terms of the plan with each faculty member before it is sent to the provost for final review and approval. In addition, the department head and senior faculty routinely mentor junior faculty in all areas of teaching, research, and service. As an example, Dr. Kellar recently facilitated a formal monthly grant-writing workshop for the new faculty in the department. This workshop has also been attended by members of several other programs on campus. A detailed summary of faculty development activities is given below.

Dr. Crawford has remained active in The Minerals, Metals, and Materials Society (TMS) where he has attended all TMS annual meetings during this evaluation period. In this activity, he has acted as Co-Organizer/Co-Chair of the 2015 and 2016 Advanced Materials and Dental and Orthopedic Applications Symposium at the TMS annual meeting. Crawford has an active research program where he has advised 14 graduate students (6 PhD, 8 MS) and has served as PI on several research projects funded by both state and federal agencies (including NSF) during this evaluation period. Dr. Crawford is also active in university service where he is the Co-Director of the Biomedical Engineering Graduate program and has also served on several faculty search committees and other university committees.

Dr. Cross has attended a large variety of conferences and meetings during this reporting period, including multiple instances of the SME Annual Meeting, Materials Research Society Spring Meeting, Latin American High Security Printing Meeting, Optical Document Security meetings. In addition, he has served as an external reviewer for proposals submitted to the Department of Energy and the Environmental Protection Agency. During this reporting period Dr. Cross has been PI or co-PI on research awards from the National Science Foundation, the Office of Naval Research, National Aeronautics and Space Administration, and Army Research Laboratories that include fundamental research, obtaining research equipment, as well as engineering education/pedagogy. In addition, Dr. Cross has served the SDSM&T campus through his membership on various search committees, and as Secretary of the Faculty Senate and Chair of the Senate's Academic Affairs Committee, and as Metallurgical Engineering and Faculty Senate Representative to the Campus Curriculum committee.

Dr. Howard has maintained an active research program in ultra-purity Ge and Cu for the Stanford Underground Research Facility and publishes in that area. During the last several years he has directed two PhD students: one in the ultra-purity materials area and one in the modelling of friction stir welding. He is currently serving as the President of TMS and also serves on the TMS Foundation Board of Trustees. In the last year he has attended many TMS events including the COM 2015 Annual Meeting of Met Soc in Toronto, CA; MS&T 2016 in Columbus, OH, the American Society of Association Executives (ASAE)-Executive Officer Training Symposium in St Petersburg, FL; the 2016 NAE-AAES Convocation of the Professional Engineering Societies in Washington, DC, the Second Diversity Summit in Evanston, IL, the 2016 AIME Annual Board Meeting in Santa Fe, NM; the 95th National Council of Examiners for Engineering and

Surveying (NCEES) Annual Meeting in Indianapolis, IN; and the Founders Society Presidents Meeting in New York. He has served on the Professional Registration Committee of TMS where he participated in writing the PE Exam for materials engineering and served on the cut score panel for setting passing score on the exam. Of particular interest to Dr. Howard are seminars on modelling across scale and the Granta software development. He presented a technical talk at the 2016 Annual TMS Meeting in Nashville on three dimensional Kellogg diagrams and an invited talk at the University of Cambridge at the 9th International Materials Education Symposium in April 2016.

Dr. Jasthi has been active in research programs related to surface engineering. He has collaborated with industries and participated in several Small Business Innovative Research (SBIR) programs. Currently he is directing two PhD and 2 MS students in the areas of advanced materials and processing. He also developed and taught a new graduate/Senior level course on Advanced Materials and Processes at SDSMT. Dr. Jasthi has been serving as the Education Committee Member for The Minerals, Metals, and Materials Society and ASM International Materials Information Society (ASM). In addition, he is currently serving as the chair of the TMS Bladesmithing Committee. Dr. Jasthi is also a member of several SDSM&T service committees such as the Faculty Development Committee, Environmental Health Safety and Risk (EHS&R) Committee and many other faculty search committees.

Dr. Kellar has attended all SME annual meetings during this reporting period. In addition, he has served on numerous SME committees, and was recognized in 2014 with the AIME Mineral Industry Education Award and in 2015 as an SME Distinguished member. During this reporting period Dr. Kellar has been PI on several National Science Foundation proposals that include both fundamental research as well as engineering education/pedagogy. In addition, Dr. Kellar has served the SDSM&T campus through his membership on numerous search committees, and specifically as a member of the tenure and promotion and campus beautification committee.

Dr. Safarzadeh earned his PhD in Metallurgical Engineering from the University of Utah and started his academic career at SDSM&T as an Assistant Professor in 2013. His expertise is extractive metallurgy with a focus on hydrometallurgy. He has published more than 40 papers and chapters in peer-reviewed journals and books and is currently serving as an Associate Editor of the Elsevier journal *Hydrometallurgy* and also as a Key Reader for the Springer journal *Metallurgical and Materials Transactions B.* Dr. Safarzadeh is an active member of the professional societies Society for Mining, Metallurgy, and Exploration (SME) and TMS, currently serves on Arthur F. Taggart Award Committee for SME, and is a reviewer for several reputable journals in extractive metallurgical engineering. Dr. Safarzadeh teaches thermodynamics, heterogeneous kinetics, transport phenomena, and high temperature extraction and has developed a new graduate-level course on applied electrochemistry. He has received some prestigious awards including SME's Rong Yu Wan PhD Dissertation Award and the International Precious Metals Institute (IPMI) Metalor Technologies Award.

Dr. Salem directs research activities to support the Composite and Polymer Engineering (CAPE) Laboratory and, for the past three years, he has also directed the Composite and Nanocomposite Advanced Manufacturing (CNAM) Center. He is active in several professional societies, including the Society for the Advancement of Materials and Process Engineering (SAMPE), the

American Composites Manufacturing Association (ACMA), and the Fiber Society. These activities have included making presentations at SAMPE conferences, Fiber Society International Symposia and the Composite and Advanced Materials Expo (CAMX), and chairing the Ballistic Composites session at the SAMPE Tech 2014 conference. At SAMPE, ACMA and CAMX events, Dr. Salem has also organized exhibition booths to provide information to attendees on CAPE Lab and CNAM Center activities. While Dr. Salem's main focus in the last few years is support of undergraduate and graduate research at SDSM&T. He developed two new courses in composites manufacturing (MET 489/589) and Polymer/Composite Processing (MES 475/575). He has served as faculty advisor to the SAMPE student chapter for the past three years, and has served on many thesis and dissertation committees, the SDSM&T University Research committee, and the Nanoscience and Nanoengineering Graduate Program Advisory committee. He has also refereed scientific articles for academic journals.

Dr. West continues to support research activities to support the SDSM&T Advanced Materials Processing and Joining Laboratory. He is active in several professional societies. These activities include making invited presentations at several Minerals, Metals, and Materials Society (TMS) Symposia most notably Friction Stir Welding and Processing and Communicating Research to a broader audience, serving as the faculty advisor for the Black Hills Chapter of the American Welding Society (AWS), and serving on the ASM International Handbook Committee. Dr. West's main focus in the last few years is support of undergraduate research in South Dakota. For the past seven years he has directed a National Science Foundation Research Experience for Undergraduates (REU) site focused on metallurgical engineering and recently helped establish a state-wide undergraduate research symposium. Dr. West was also involved in paper review and proposal for National Science Foundation, NASA EPSCoR, Department of Energy, and Nuclear Engineering University Programs.

Dr. Widener continues to direct research activities to support the Arbegast Advanced Materials Processing and Joining Laboratory. He participates in several professional societies. These activities include making invited presentations at several conferences including The Minerals, Metals, and Materials Society (TMS) 1st Integrated Materials & Manufacturing Symposium, serving as a guest editor for the International Thermal Spray Conference, and the Cold Spray Action Team Meeting sponsored by the Army Research Laboratory. Dr. Widener's main focus in the last few years is support of undergraduate and graduate research at SDSM&T. For the past 6 years he has directed two South Dakota-funded research centers, the Repair, Refurbish, and Return-to-Service (R3S) Center, and the Advanced Manufacturing Process Technology Transition and Training Center (AMPTECH). Dr. Widener was also involved in paper reviews for several academic journals, and served on numerous thesis and dissertation committees, as well as serving as an active member of the SDSM&T University Research committee

E. Authority and responsibility of faculty

The department head in collaboration with program faculty members has the responsibility for program development and the design of new programs, program evaluation and quality, and initiation of program modifications and changes. Individual faculty members may make content modifications to their course so long as the changes do not fall outside the approved course description. The SD Regents have established a staged level approval system for changes beyond minor content changes made by faculty.

The process for creating and modifying curriculum within an academic program starts with a faculty member or an intra-program faculty group submitting a curriculum request to the department head who disseminates it to the department faculty. The curriculum request is discussed by all department faculty members at a department meeting. Suggestions are considered by the author(s) of the curriculum request and resubmitted for a vote by the faculty at a subsequent departmental meeting. Evaluation of the curriculum and course for currency, relevancy, consistency and quality is primarily achieved through established assessment processes described earlier.

Program curriculum modification begins at the program level with discussions led by Dr. West among the program faculty. If it is agreed upon, that said curricular modification is needed, a program faculty member is assigned the task of preparing the draft request for the University Curriculum Committee. Standard system curriculum forms are used. Once the draft is prepared, it is reviewed, and if necessary modified, by the program faculty before Dr. West submits the request to the University Curriculum Committee on behalf of the program.

Such agreed on new course creation and modifications are submitted to the University Curriculum Committee. Upon review and approval by the University Curriculum Committee the requested modifications are forwarded to the Faculty Senate for consideration. Modifications approved by the Faculty Senate are sent to the provost who reviews them and forwards completed and vetted requests to the regents. Once the regents have approved (or rejected) the proposed modifications, formal notice of the regental action is sent to the Provost who forwards it to the Registration and Academic Services for formal recording, promulgation, and publication.

Because of the integrated and interdependent way institutions in the Board of Regents system are managed (e.g., common course numbering and a shared student information system), substantive curricular changes and modifications need Board of Regents notification or approval. In these instances, curricular changes pass from the University Curriculum Committee to the provost for review before being taken to the Academic Advisory Council (AAC). The AAC is comprised of the vice president or provost for academic affairs at all institutions in the state system. The AAC forwards most recommendations on curricular matters to the Council of Presidents (COPS) which makes recommendations for final approval to the Board of Regents.

The faculty members define the objectives and outcomes of the program and the courses that comprise the curriculum. The academic program faculty members have complete control of and responsibility for creating the structures and processes to ensure all students in the program have ample opportunity to attain academic program objectives and outcomes. The assessment and evaluation of student learning is the purview of the program faculty. As a STEM-only institution, SDSM&T does not exert centralized control over program-level assessment processes since the rigorous standards set by ABET and the close collaboration of academic departments achieved through the Academic Leadership Council is deemed sufficient. The culture of ABET permeates this STEM-only campus, and the undergraduate programs share a focus on math, science, teaming, design, and other fundamentals of encompasses in the Criterion 3 (a) through (k) outcomes. The few programs not governed directly by the standards of ABET (i.e., math, interdisciplinary sciences, physics, geology, chemistry, and applied biological sciences) are subject to program reviews that require the creation of a self-study and review by an external evaluator.

A listing of curricular control issues and processes for each can be found at the following link: http://www.sdbor.edu/administration/academics/aac/guidelines.htm
This page includes links describing the following procedures:

- Deletion/Inactivation of Courses
- Authority to Offer an Existing Common Course Request
- Experimental Course Requests
- Minor Course Modifications
- New Unique Course Requests
- Revised Common Course Requests
- Revised Unique Course Requests
- Guidelines for Shared Courses
- Guidelines for Cross-Listed Courses
- New Prefix Request
- Common Course Guidelines

Course consistency is ensured at the system level by a common course numbering system (e.g. CHEM 112 at SDSMT compared to same course at another regental institution). Because the Metallurgical Engineering program is unique to the SD system the common course number system does not apply to program courses. Rather, course consistency applies at the program level to those courses where different instructors may teach the same course in different semesters. For example, MET 232 Properties of Materials is routinely taught in the fall semester by different instructors in the spring semester and fall semesters. In such cases the same textbook is used by both instructors and they coordinate the instruction so that the same content is covered each semester. Section 6F summarizes the curriculum control policy for SDSM&T.

As a matter of Regents policy, all courses are evaluated by students with the IDEA end-of-semester student opinion survey (SOS). (http://www.theideacenter.org for more information on this instrument.) Student evaluations of each course taught in the program are returned to the department head who reviews the evaluations and follows up with an individual consultation with each faculty member in the program. The results of all course surveys are placed in the faculty member's permanent file which resides in the Office of the Provost. While the provost has free access to all faculty member files, the department head and the faculty member are the primary audience for end-of-course student evaluations. The monitoring and improvement of teaching quality is the purview and primary responsibility of the department head in collaboration with the faculty members in the program. If the SOSs indicate a lack of quality instruction the department head works with the faculty member to help improve course quality. This support includes one-on-one discussion of course delivery as well as university support via programs offered by the Faculty Development Committee, as described in section

The department head is the administrator responsible for all hiring, once authorization is granted, of faculty members and other personnel in the program, annual evaluation for program personnel and faculty members, input to the provost of faculty annual evaluations, and petitions for promotion and tenure. The University Faculty Collective Bargaining Agreement governs terms of employment for faculty members in the Regents system. Each campus has its own Statement of Institutional Priorities for Faculty Performance and those for SDSM&T was approved in 2006 and is available to all faculty members at https://www.sdbor.edu/policies/Documents/SDSMTWorkloadPolicy.pdf.

F. **Curriculum development and review policy**

The SDSM&T is governed by enacted policies contained in the Policy Manual. Section II-1-1 shown below governs the curriculum review process.

SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY

Policy Manual

SUBJECT: Curriculum Development and Review Process

NUMBER: Policy II-1-1 (formerly, Policy II-A-3)

The curriculum shall be managed through shared oversight by faculty and administration. Faculty members shall develop the curriculum, approve all curricular offerings and evaluate the effectiveness and currency of the curriculum. The administration shall develop processes to assist faculty in the oversight of the curriculum and develop the resources for academic offerings.

1. Origination

Curricular developments shall be originated by a faculty member or members. Each curricular development shall be detailed on the appropriate form initiated by the faculty member, which shall include the faculty member's signature. Forms are available from the Office of the Provost/Vice President for Academic Affairs. Proposed developments shall be reviewed and appropriately endorsed by the department with responsibility for the curriculum.

2. Departmental Reviews

Curricular developments shall be reviewed by the Departmental Curriculum Committee which shall consist of the department head or program coordinator as committee chairperson and at least two faculty members.

A. In departments with ABET or other professionally accredited programs, the Departmental Curriculum Committee will include designated representation of the professionally accredited program.
B. The Department Curriculum Committee shall review all proposed curricular changes and make a recommendation to the departmental faculty; prepare self-study materials for all program reviews; review the results of the university assessment system and recommend appropriate action relative to the curriculum assigned to the department; review the syllabus for all courses and recommend appropriate action to revise, maintain or delete courses from the curriculum.
C. The recommendation of the Departmental Curriculum Committee shall be reported to the departmental faculty for appropriate endorsement action. The department head shall report the recommendations of the Departmental Curriculum Committee and the actions of the faculty endorsing such recommendation to the University Curriculum Committee.
D. Curriculum developments involving interdisciplinary degree programs shall initiate in and be approved by the Steering Committee for the degree. In the case of interdisciplinary graduate degree programs, the chairperson of the Steering Committee shall forward approved curricula proposals to the executive administrator(s) of and Curriculum Development and Review Process II-A-3 Page 2 of 2 committee(s) with oversight responsibility for graduate education and/or research, as appropriate.

3. University Faculty Review and Approval

Curricula developments approved by the departmental Curriculum Committee shall be submitted to the University Curriculum Committee for review and appropriate endorsement for action by the university faculty.

A. The University Curriculum Committee shall consist of ten faculty representatives appointed by the Faculty Senate in consultation with the Provost/Vice President for Academic Affairs. An individual faculty member may serve as chairperson of the University Curriculum Committee for no longer than three years.
B. The chairperson of the University Curriculum Committee shall report the results of the review including proposed endorsement actions if any, to the university faculty at a regularly scheduled meeting of the university faculty for a vote of approval or disapproval by the faculty. The chairperson of the Faculty Senate shall report the results of the university faculty vote to the Provost/Vice President for Academic Affairs. The chairperson of the University Curriculum Committee shall forward all curricula proposals considered by the committee to the Provost/Vice President for Academic Affairs.

4. University Administrative Review and Approval

A. The Provost/Vice President for Academic Affairs shall review all curricula approved actions of the university faculty and make a determination of the adequacy of resources available to support the proposed curricula actions,
B. If the Provost/Vice President for Academic Affairs determines that the resources available are inadequate, the Provost/Vice President for Academic Affairs shall document the evaluation and return the curricula request to the originator for possible further action with copies to the chairperson of the University Curriculum committee and chairperson the Faculty Senate.

C. If the Provost/Vice President for Academic Affairs deems that adequate resources are available to appropriately implement the endorsed curricula changes, the Provost/Vice President for Academic Affairs shall forward the proposed curricula in the form required by the Board of Regents to the appropriate persons at the Board of Regents Office.

SOURCE: Office of the Vice President, Mar. 1994; Office of the Vice President, Nov. 1995; Office of the Provost, Dec. 2009 BOR Reference: Policy 1:10, Policy 2:7, Policy 2:8, Policy 2:23, Policy 2:29. Policy 4:12, University Faculty Collective Bargaining Agreement, sects 2.3 and 5.1

The program faculty constitute the Department Curriculum Committee in the BS Metallurgical Engineering program.

The forms for programs to request course modifications are titled as follows:

- Authority to Offer an Existing Common Course Form
- Experimental Course Notification Form
- Existing Courses Minor Course Modifications Form
- New Course Request Form
- Revised Existing Course Form – Common Course
- Revised Existing Course Form – Unique Course

Tables 6-3 through Table 6-8 show the forms used by the program faculty to initiate approval of program curricular changes. These forms and their instructions are available to faculty at https://sdbor.edu/administrative-offices/academics/academic-affairs-guidelines/Pages/2-Programs-and-Curriculum.aspx.

Table 6-3 Authority to Offer an Existing Common Course Form

SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

Authority to Offer an Existing Course

Institution **Division/Department**

Institutional Approval Signature **Date**

1. Is this a request to offer an existing common course or an existing unique course (approval will change course status from unique to common)? ***Place an "X" in the appropriate box.***

Common Course ☐
Unique Course ☐

2. Provide the complete description as it appears in the system database including pre-requisites and co-requisites.

Prefix & No.	Course Title	Credits

Course Description

Pre-requisites or Co-requisites (add lines as needed)

Prefix & No.	Course Title	Pre-req *"X" if yes*	Co-req *"X" if yes*

3. Universities currently offering this course (*place an "X" in the appropriate boxes*):

______ BHSU _____ DSU _____ NSU _____ SDSMT _____ SDSU _____ USD

4. Does Offering the Course Create FTE Implications?

______ **No**. Replacement of ________________________ (deletion form attached)
(prefix, number, name of course, credits)
Effective Date of Deletion: ________________________

______ **No**. Schedule Management, explain: ________________________

Curriculum Forms, Authority to Offer an Existing Course (last revised 01/2016)

Page 1 of 2

Table 6-3 Authority to Offer an Existing Common Course Form (cont'd)

______

______ **Yes**. Specify: ______________________________

5. Existing program(s) in which course will be offered: ______________________________

6. CIP Code for the course: ______________________________

7. Proposed instructional method by this university: ______________________________

8. Proposed delivery method by this university: ______________________________

9. University Dept. Code: ______________________________

10. Authority to offer effective beginning in what term? ______________________________

11. Section Restriction: ______________________________

Curriculum Forms, Authority to Offer an Existing Course (last revised 01/2016)

Page 2 of 2

Table 6-4 Experimental Course Notification Form

SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

YOUR FUTURE IS HERE South Dakota Board of Regents Public Universities & Special Schools

Experimental Course Notification

Use this form to notify the System Chief Academic Officer and the Academic Affairs Council (AAC) of a university's experimental course. Consult the system database through Colleague or the Course Inventory Report for information about existing courses before submitting this form.

Institution	Division/Department	Originator	Date
Department Chair	School/College Dean	Institutional Approval Signature	Date

Section 1. Course Title and Description

Provide a complete course description for each experimental course using a prefix approved for your university. Experimental course numbering is limited to 199, 299, 399, 499, 599, or 699. A university is limited to offering an experimental course during a maximum of two (2) semesters over the course of two (2) academic years (an academic year is defined as a Fall semester and a Spring semester). Any additional offerings require submission and approval of a New Course Request.

Prefix & No.	Course Title	Credits

Course Description

Note: Course descriptions are short, concise summaries that typically do not exceed 75 words. DO: Address the content of the course and write descriptions using active verbs (e.g., explore, learn, develop, etc.). DO NOT: Repeat the title of the course, layout the syllabus, use pronouns such as "we" and "you," or rely on specialized jargon, vague phrases, or clichés.

Pre-requisites or Co-requisites (add lines as needed)

Prefix & No.	Course Title	Pre-Req/Co-Req?

Registration Restrictions

Curriculum Forms, Experimental Course Notification (last revised 12/2015)

Page 1 of 2

Table 6-4 Experimental Course Notification Form (cont'd)

Section 2. Other Course Information

2.1. Proposed Instructional Method: ______________________________

2.2. Proposed Delivery Method: ______________________________

NOTE: *If the university offers the experimental course by distance delivery, the university must complete the Distance Delivery Quality Assurance Process and list the course with the Electronic University Consortium (EUC).*

2.3. Initial Term Offered: ____________ / ____________

semester *year*

2.4. Date of Termination: ____________ / ____________

semester *year*

NOTE: No later than two academic years after the initial term offered

2.5. Is grading for this course limited to S/U (pass/fail)? ☐ Yes ☐ No

Place an "X" in the appropriate box.

2.6. Will section enrollments be capped)? ☐ Yes ☐ No

Place an "X" in the appropriate box.

If yes, what is the maximum enrollment per section? ____________

Section 3. Department and Course Codes (Completed by University Academic Affairs)

☐ **University Department Code** ______________________________

☐ **Proposed CIP Code** ______________________________

Is this a new CIP code for the university? ☐ Yes ☐ No

Curriculum Forms, Experimental Course Notification (last revised 12/2015)

Page 2 of 2

Table 6-5 Existing Courses Minor Course Modifications Form

SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

Existing Courses Minor Modification

Use this form to request minor modifications of existing unique and common courses. Consult the system database through Colleague or the Course Inventory Report for information about existing courses before submitting this form. If the course revision is for an approved General Education course, please see the Revision to General Education Requirements Form.

Institution	**Division/Department**	**Originator**	**Date**
Department Chair	**School/College Dean**	**Institutional Approval Signature**	**Date**

Section 1. Existing Course Title and Description

Prefix & No.	Course Title	Credits

Effective Date: ____________________

This course is a:
☐ **Unique Course (see section 2)** ☐ **Common Course (see section 3)**

Place an "X" in the appropriate box.

Section 2. Unique Courses: Requested Minor Modifications

Place an "X" in the appropriate boxes.

	Current		New
☐ **Prefix change**	________	to	________
☐ **Course Number change**	________	to	________

NOTE: You may only change a unique course number to a number not currently used in "active" status at another university. Consult the system database in Colleague or the Course Inventory Report.

	Current		New
☐ **Credit hours**	________	to	________
☐ **Course pre-requisites**	________	to	________
☐ **Course co-requisites**	________	to	________

Curriculum Forms, Existing Courses Minor Modifications (last revised 01/2016)

Page 1 of 3

Table 6-5 Existing Courses Minor Course Modifications Form (cont'd)

☐ **Registration restriction** ______ to ______

☐ **Enrollment limitation** ______ to ______

☐ **Repeatable for additional credit** ______ to ______

☐ **Grading option** ______ to ______

☐ **Course title change** ______

☐ **Cross-listing and equating with** ______

☐ **Dual-listing at 400/500 level**

☐ **Course description (that does not change course content). Complete table below:**

Existing description:

New description:

Note: Course descriptions are short, concise summaries that typically do not exceed 75 words. DO: Address the content of the course and write descriptions using active verbs (e.g., explore, learn, develop, etc.). DO NOT: Repeat the title of the course, layout the syllabus, use pronouns such as "we" and "you," or rely on specialized jargon, vague phrases, or clichés.

☐ **Add course in x9x series**

CIP Code: ______

New to this university? ☐ Yes ☐ No

Will this university's sections of the course be limited to S/U (pass/fail)?

☐ Yes ☐ No

☐ **Delete Course (effective date):** ______

Justification for changes indicated in Section 2:

Curriculum Forms, Existing Courses Minor Modifications (last revised 01/2016)

Page 2 of 3

Table 6-5 Existing Courses Minor Course Modifications Form (cont'd)

Section 3. Common Courses: Requested Minor Modifications

Place an "X" in the appropriate boxes.

	Current		New
☐ **Credit hours (within variable limits)**	______	to	______
☐ **University specific co-requisites**	______	to	______
☐ **Cross-listing and equating with**	______		
☐ **Dual-listing at 400/500 level**			
☐ **Add course in x9x series**			
CIP Code:	______		
New to this university?	☐ Yes		☐ No
Will this university's sections of the course be limited to S/U (pass/fail)?	☐ Yes		☐ No
☐ **x9x grading method**	______	to	______

Justification for changes indicated in Section 3:

Section 4. Department and Course Codes (Completed by University Academic Affairs)

4.1. University department code: ______

4.2. Change university department code to: ______

Curriculum Forms, Existing Courses Minor Modifications (last revised 01/2016)

Page 3 of 3

Table 6-6 New Courses Request Form

SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

New Course Request

Institution **Division/Department**

Institutional Approval Signature **Date**

Section 1. Course Title and Description

If the course contains a lecture and laboratory component, identify both the lecture and laboratory numbers (xxx and xxxL) and credit hours associated with each. Provide the complete description as you wish it to appear in the system database in Colleague and the Course Inventory Report including pre-requisites, co-requisites, and registration restrictions.

Prefix & No.	Course Title	Credits

Course Description
Note: Course descriptions are short, concise summaries that typically do not exceed 75 words. DO: Address the content of the course and write descriptions using active verbs (e.g., explore, learn, develop, etc.). DO NOT: Repeat the title of the course, layout the syllabus, use pronouns such as "we" and "you," or rely on specialized jargon, vague phrases, or clichés.

Pre-requisites or Co-requisites (add lines as needed)

Prefix & No.	Course Title	Pre-Req/Co-Req?

Registration Restrictions

Section 2. Review of Course

2.1. Was the course first offered as an experimental course (if yes, provide the course information)?

Curriculum Forms, New Course Request (last revised 01/2016)

Page 1 of 4

Table 6-6 New Courses Request Form (cont'd)

2.2. Will this be a common or unique course (*place an "X" in the appropriate box*)?

Unique Course ☐

If the request is for a unique course, verify that you have reviewed the common course catalog via Colleague and the system Course Inventory Report to determine if a comparable common course already exists. List the two closest course matches in the common course catalog and provide a brief narrative explaining why the proposed course differs from those listed. If a search of the common course catalog determines an existing common course exists, complete the Authority to Offer an Existing Course Form.

Prefix & No.	Course Title	Credits

Provide explanation of differences between proposed course and existing system catalog courses below

Common Course ☐

Indicate universities that are proposing this common course:

_____ BHSU _____ DSU _____ NSU _____ SDSMT _____ SDSU _____ USD

Section 3. Other Course Information

3.1. Are there instructional staffing impacts?

_______ **No**. Replacement of ______________________ (deletion form attached)
(prefix, number, name of course, credits)

Effective date of deletion: ______________________

_______ **No**. Schedule Management, explain: ______________________

_______ **Yes**. Specify: ______________________

3.2. Existing program(s) in which course will be offered ______________________

3.3. Proposed instructional method by university: ______________________

3.4. Proposed delivery method by university: ______________________

3.5. Term change will be effective: ______________________

3.6. Can students repeat the course for additional credit?

☐ Yes, total credit limit: ____________ ☐ No

Curriculum Forms, New Course Request (last revised 01/2016)

Page 2 of 4

Table 6-6 New Courses Request Form (cont'd)

3.7. Will grade for this course be limited to S/U (pass/fail)? ☐ Yes ☐ No

3.8. Will section enrollment be capped?
☐ Yes, max per section: ____________ ☐ No

3.9. Will this course equate (i.e., be considered the same course for degree completion) with any other unique or common courses in the common course system database in Colleague and the Course Inventory Report?
☐ Yes ☐ No

If yes, indicate the course(s) to which the course will equate (add lines as needed):

Prefix & No.	Course Title

3.10. Is this prefix approved for your university? ☐ Yes ☐ No
If no, provide a brief justification below:

Section 4. Department and Course Codes (Completed by University Academic Affairs)

4.1. University Department Code: ____________________

4.2. Proposed CIP Code: ____________________
Is this a new CIP code the university?
☐ Yes ☐ No

Curriculum Forms, New Course Request (last revised 01/2016)

Page 3 of 4

Table 6-6 New Courses Request Form (cont'd)

NEW COURSE REQUEST
Supporting Justification for On-Campus Review

Request Originator	Signature	Date
Department Chair	Signature	Date
School/College Dean	Signature	Date

1. Provide specific reasons for the proposal of this course and explain how the changes enhance the curriculum.

2. Note whether this course is: ________ Required ________ Elective

3. In addition to the major/program in which this course is offered, what other majors/programs will be affected by this course?

4. If this will be a dual listed course, indicate how the distinction between the two levels will be made.

5. Desired section size ____________________

6. Provide qualifications of faculty who will teach this course. List name(s), rank(s), and degree(s).

7. Note whether adequate facilities are available and list any special equipment that will be needed for the course.

8. Note whether adequate library and media support are available for the course.

9. Will the new course duplicate courses currently being offered on this campus?
________ Yes ________ No

If yes, provide justification.

10. If this course may be offered for variable credit, explain how the amount of credit at each offering is to be determined.

11. Add any additional comments that will aid in the evaluation of this request.

Curriculum Forms, New Course Request (last revised 01/2016)

Page 4 of 4

Table 6-7 Revised Existing Course Form - Common Course

SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

Revised Course Request: Common Course
(Substantive Modifications)

Use this form to request a substantive change to an existing common course. Representatives from all institutions offering the common course must participate in developing the proposed revisions to a common course. Signatures from all institutions offering the common course must be included on the final form submitted to the Academic Affairs Council (AAC). Consult the system database in Colleague and the Course Inventory Report for information about existing courses. If the course revision is for an approved General Education course, please see the Revision to General Education Requirements Form.

Institution	**Form Initiator**	**Dean's Approval Signature**	**Date**
Institution	**Division/Department**	**Institutional Approval Signature**	**Date**
Institution	**Division/Department**	**Institutional Approval Signature**	**Date**

(add additional lines as needed)

Indicate universities that currently offer the common course:

_____ BHSU _____ DSU _____ NSU _____ SDSMT _____ SDSU _____ USD

Section 1. Existing Course Title and Description

If changing from a course that previously had only a lecture or laboratory component to a composite course, identify both the course and laboratory numbers (xxx and xxxL) and credit hours associated with each. Provide the complete description as it appears in the system database in Colleague and the Course Inventory Report including pre-requisites, co-requisites, and registration restrictions.

Prefix & No.	**Course Title**	**Credits**

Course Description

Pre-requisites or Co-requisites ***(add lines as needed)***

Prefix & No.	**Course Title**	**Pre-Req/Co-Req?**

Curriculum Forms, Revised Course Request: Common Course (last revised 01/2016)

Page 1 of 3

Table 6-7 Revised Existing Course Form - Common Course (cont'd)

Registration Restrictions

Section 2. Modification(s) Requested

Check all revisions that apply and provide detailed information in the Current and New fields below. If changing a course that previously had only a lecture or laboratory component to a composite course, identify both the course and laboratory numbers (xxx and xxxL) and credit hours associated with each.

2.1. This modification will include (*place an "X" in the box for all that apply*):

	Current		New
☐ **Prefix change from**	________	to	________

Indicate any university for which this must be added as new prefix:

_____ BHSU _____ DSU _____ NSU _____ SDSMT _____ SDSU _____ USD

	Current		New
☐ **Course Number change from**	________	to	________
☐ **Course Title change from**	________	to	________
☐ **Credit Hours change from**	________	to	________
☐ **Pre-Requisites**	________	to	________

Note: University specific pre-requisites are inconsistent with the system common course guidelines and receive approval only in rare circumstances.

	Current		New
☐ **Co-Requisites**	________	to	________
☐ **Registration Restriction**	________	to	________

☐ **Addition/deletion of a lab/lecture component**

If the addition of a lab/lecture component requires a change in pre-requisites or co-requisites, indicate below (add lines as needed)

Prefix & No.	Course Title	Pre-Req/Co-Req?

☐ **Course Content/Description change (write proposed new content/description below)**

Note: Course descriptions are short, concise summaries that typically do not exceed 75 words. DO: Address the content of the course and write descriptions using active verbs (e.g., explore, learn, develop, etc.). DO NOT: Repeat the title of the course, layout the syllabus, use pronouns such as "we" and "you,"

Curriculum Forms, Revised Course Request: Common Course (last revised 01/2016)

Page 2 of 3

Table 6-7 Revised Existing Course Form - Common Course (cont'd)

or rely on specialized jargon, vague phrases, or clichés.

☐ **Course Deletion**

Indicate the universities deleting the course:

_____ BHSU _____ DSU _____ NSU _____ SDSMT _____ SDSU _____ USD

2.2. Add justification for all changes noted above:

Section 3. Other Course Information

Will this course equate (i.e., be considered the same course for degree completion) with any other unique or common courses in the common course database (Course Inventory Report)?

☐ Yes ☐ No

If yes, indicate the course(s) to which the course will equate (add lines as needed):

Prefix & No.	Course Title

Section 4. Department and Course Codes (Completed by University Academic Affairs)

	Current		New
☐ **Change in University Department Code**	________	to	________
☐ **Change in CIP Code**	________	to	________

Curriculum Forms, Revised Course Request: Common Course (last revised 01/2016)

Page 3 of 3

Table 6-8 Revised Existing Course Form - Unique Course

SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

Revised Course Request: Unique Course
(Substantive Modification)

Use this form to request a substantive change to an existing unique course. Consult the system database in Colleague and the Course Inventory Report for information about existing courses. If the course revision is for an approved General Education course, please see the Revision to General Education Requirements Form. Signatures are required on the final form submitted to the Academic Affairs Council (AAC).

Institution	**Form Initiator**	**Dean's Approval Signature**	**Date**
Institution	**Division/Department**	**Institutional Approval Signature**	**Date**

Section 1. Existing Course Title and Description

If changing from a course that previously had only a lecture or laboratory component to a composite course, identify both the course and laboratory numbers (xxx and xxxL) and credit hours associated with each. Provide the complete course description as it appears in the system Course Inventory Report including pre-requisites, co-requisites, and registration restrictions.

Prefix & No.	Course Title	Credits

Course Description

Pre-requisites or Co-requisites (add lines as needed)

Prefix & No.	Course Title	Pre-Req/Co-Req?

Registration Restrictions

Curriculum Forms, Revised Course Request: Unique Course (last revised 01/2016)

Page 1 of 3

Table 6-8 Revised Existing Course Form - Unique Course (cont'd)

Section 2. Modification(s) Requested

2.1. This modification will include (*place an "X" in the box for all that apply*):

☐ **A change in description/subject matter content (enter revised description below).**

Note: Course descriptions are short, concise summaries that typically do not exceed 75 words. DO: Address the content of the course and write descriptions using active verbs (e.g., explore, learn, develop, etc.). DO NOT: Repeat the title of the course, layout the syllabus, use pronouns such as "we" and "you," or rely on specialized jargon, vague phrases, or clichés.

	Current		**New**
☐ **Change in instructional method**	____________	to	____________

☐ **Addition/deletion of a lab/lecture component (*explain below*)**

If the addition of a lab/lecture component requires a change in pre-requisites or co-requisites, indicate below (add lines as needed)

Prefix & No.	Course Title	Pre-Req/Co-Req?

☐ **Change to existing common course:**

Prefix & No.	Course Title	Credits

NOTE: Use the Authority to Offer an Existing Course Form to request authorization to offer an existing common or unique course.

Indicate universities offering the common course:

_____ BHSU _____ DSU _____ NSU _____ SDSMT _____ SDSU _____ USD

Effective term of the change: ____________________

☐ **Explain any additional minor changes proposed at this time below (if needed):**

Curriculum Forms, Revised Course Request: Unique Course (last revised 01/2016)

Page 2 of 3

Table 6-8 Revised Existing Course Form - Unique Course (cont'd)

2. Add justification for all changes noted above:

Section 3. Other Course Information

1. Will this course equate (i.e., be considered the same course for degree completion) with any other unique or common courses in the common course database (Colleague and the Course Inventory Report)?

☐ Yes ☐ No

If yes, indicate the course(s) to which the course will equate (add lines as needed):

Prefix & No.	Course Title

Section 4. Department and Course Codes (Completed by University Academic Affairs)

	Current		New
☐ **Change in University Department Code**	______	to	______
☐ **Change in CIP Code**	______	to	______

Curriculum Forms, Revised Course Request: Unique Course (last revised 01/2016)

Page 3 of 3

CRITERION 7 - FACILITIES

Below is a summary of the campus facilities available to faculty, staff, and students.

A. Offices, classrooms and laboratories

Campus space allocated to the Department of Materials and Metallurgical Engineering Department is shown in Table 7-1. The department has 3,178 ft^2 of office space, 825 ft^2 of student lounge/study space, 6,406 ft^2 of lab space used primarily for the BS Metallurgical Engineering degree program with the balance of the 13,127 ft^2 allocated for research associated mostly with graduate research although undergraduate students do have access to such laboratories as needed. The above space includes 2,663 ft^2 in the well-appointed steel building termed the *foundry* that houses specialized manufacturing-related and blacksmithing equipment available for use by undergraduate students. Additionally, the BS Metallurgical Engineering students also have access are often closely involved with the 2,300 ft^2 Arbegast Advanced Manufacturing Center in the Civil-Mechanical Building which houses friction stir welding, ultrasonic welding, laser additive manufacturing equipment, and related mechanical testing equipment. Dr. Widener is the director of that facility, which also has several thousand square feet of additional space housing cold spray equipment in the Black Hills Business Development Center on campus. BS Metallurgical Engineering students often are employed in the center and all students are able to access such equipment if needed. The program faculty share classrooms across campus but do have three classrooms totaling 2,559 ft^2 in the Mineral Industries Building. As the campus student population grows, moves to larger classrooms or multiple course sections are being employed. Currently, there is adequate classroom space available; although, there is fairly high demand in the mid-morning periods. The fist M denotes SDSM&T in the state system; MI is the Mineral Industries Building, MF is the Met Foundry.

The university's Capital Equipment List cites 980 individual capital equipment items. Major equipment under the Materials and Metallurgical Engineering Department is shown in detail in Appendix C – Equipment. The entire list is not included in this report for brevity but is available on request.

The campus offers multimedia teaching classrooms, each with computer projection equipment that consists of a minimum of a 2.6 to 3.4 GHz quad-core processer with 4 to 8 GB desktop system and a ceiling-mounted projector. Each projector is capable of accepting signals from multiple devices via the input selection, which enables faculty members to take their tablet PCs directly to the classroom. Each classroom has wireless capabilities for student tablet PCs. All instructional buildings offer 1 Gigabit-per-second local area network access. The campus has 54 Megabit-per-second wireless service. This equipment is adequate to meet the needs of the department. There are also four distance-delivery classrooms that offer the same assets as the multimedia classroom but have integrated video conferencing and recording capabilities. Recorded classes are available via our website for distance classes. All classroom instructional computers run Windows 7. The software on or available to students is listed in Tables 7-2 and 7-32. All software is available to students even though it is often assigned to a department for management purposes as is the case with the software listed in Table 7-3.

Table 7-1 Space Allocation for Metallurgical Engineering

Building	Room #	Area, ft^2	Capacity	Primary Use
MMI	128C	196	5	Lab, 3D X-ray tomography
MMI	130A	412	4	Lab, Magnetic Separation
MMI	130	1,082	11	Lab, Mineral Processing
MMI	128B	362	8	Lab, Furnace
MMI	111	130	1	Lab, Grad Research
MMI	113	186	6	Lab, Surface Chemistry
MMI	121	530	3	Lab, Grad Research
MMI	127	330	5	Lab, Characterization
MMI	102A	212	3	Lab, Grad Research
MMI	103A	251	3	Lab, Corrosion
MMI	124C	115	2	Lab, Grad Research
MMI	127B	56	1	Utility
MF	104	1,853	20	Lab, Manufacturing
MF	102A	357	5	Lab, Manufacturing
MF	102C	453	5	Lab, Manufacturing
MMI	125	620	13	Lab, Mechanical Testing
MMI	126	1,140	12	Lab, Hydrometallurgy
MMI	124	940	24	Lab, Phys Met
MMI	124B	172	1	Lab, Optical Imaging
MMI	124D	110	2	Lab, Grad Research
MMI	105	415	15	Library & Conference
MMI	221	515	15	Lounge, MI Bldg Student
MMI	124A	84	1	Material Storage
MMI	101	143	1	Office, Dr. Jasthi
MMI	102	124	2	Office, Grad students
MMI	103	130	1	Office, Dr. Safarzadeh
MMI	104	130	1	Office, Dr. Hong, Res Sci
MMI	106	130	1	Office, Dr. Crawford
MMI	108	191	1	Office, Dr. West
MMI	110	130	1	Office, Dr. Cross
MMI	112	170	1	Office, Dr. Kellar
MMI	114	160	1	Office, Dr. Howard
MMI	115	258	1	Office, Department
MMI	123	387	6	Office, Grad students
MMI	127A	153	3	Office, Grad students
MMI	128A	475	10	Office, Grad students
MMI	127C	56	1	Utility

Undergraduate students taking more than 6 credit hours are required to be part of the Tablet PC Program on campus. Participating students receive a Tablet PC with full tablet functionality. Tablets are on a four-year replacement cycle, and tablets are repaired or replaced quickly and as needed through the help-desk center. This program has been in operation since 2006 and has proved very successful for SDSM&T.

B. Computing resources

SDSM&T uses multiple and redundant servers to handle various types of services, including email, web hosting, licensing, and personal file storage. Networked file storage is provided for students, faculty, departments, and other campus needs. Faculty/staff email is provided by a campus Exchange mail system, while student email is provided by Google mail. All services and data can be accessed both on and off campus through protected connections.

SDSM&T participates in the Microsoft MSDN Academic Alliance (MSDNAA) program through which students and faculty can download and use various Microsoft software products and online resources for academic and non-profit research purposes. Non-Microsoft software is also available depending on the student's major and classes. The software listed in Table 7-2 is the basic software package that is loaded on all classroom computers (i.e., those at the podium for the instructor to use as well as any machines for students), all computers in the Surbeck Center Lab, and computers in the Library. These programs are also common to faculty and student computers so they get classified as "Base Image" software.

Table 7-2 Base Image software

Department/Type	Software
Base Image	MS Office
PPT Addin	Insert New Slide
Base Image	MS System Center
Media Players	Quick Time Player
Media Players	Windows Media Player
Media Players	VLC Media Player
Media Players	Windows Expression Encoder
Media Players	DVD Player Codec/Program
Internet Browsers	Internet Explorer
Browser Addin	IE Flash Player
Internet Browsers	Chrome
Internet Browsers	Firefox
Browser Addin	FF Flash Player
Browser Addin	Adobe Shockwave Player
Browser Addin	Java
Browser Addin	Microsoft.net 4.0 Framework
MISC	Skype
MISC	Adobe Reader
MISC	7 Zip

The software listed in Table 7-2 is also loaded on all of the instructional classroom computers, the Surbeck Lab computers, and Library Lab computers. Creating software images for each building/department would be too time consuming for ITS, so all programs that might be needed are loaded on all general access computers.

Table 7-3 Specialized available software

Department/Type	Software
AES	Compass ESL
CBE	EES
CBE	Polymath
CBE	COMSOL
CBE	Aspen
CBE	Loop-Pro
CBE	MD Solid
CBE	Pipe flo
CBE	StatEase DX9
CABS	Logger Pro
CEE	Arc GIS
CEE	GeoStudio Slope
CEE	Rocscience
CEE	Mathcad
CEE	MatLab
ECE	IE3D
ECE	CST
ECE	ADS
ECE	SIMSCRIPT
ECE	MatLab
ECE	Pspice
GEOL	Arc GIS
IA (athletics)	Hudl Remote
LIB	EndNote
MCS	MAPLE
MCS	Visual Studio
MCS	Microsoft SQL Client
MCS	VIM
MCS	Mathcad
MCS	Xming
ME	Solidworks/VS 2005
ME	MatLab
ME	Mathcad
MET	Thermocalc+Dictra
MET	Mathcad
MET	ENVI/IDL

The following is a partial listing of applications available to Faculty/Students:

- Microsoft DreamSpark
  - Windows Operating Systems (7, 8.1, 10)
  - Access 2016
  - Project 2013, 2016
  - Visio 2013, 2016
  - Visual Studio 2015
  - SQL Server 2012, 2014
  - Windows Server 2012, 2012 R2
  - Expression Studio 4
  - XNA Game Studio 4
  - Exchange Server 2010
  - SharePoint Server 2010
- SolidWorks
- Maple (instructor tips from Maple)
- MATLAB
- Aspen
- MathCad
- StatEase
- Minitab 17

In addition to the above universally available software, Metallurgical Engineering undergraduate and MES graduate students have available the following program-specific software:

- ThermoCalc®, Thermochemical computations
- Dictra® Diffusion computations
- WinWulff®, Stereographic rendering
- STABCAL Thermochemical calculations
- Avizo Fire 3-D Visualization

SDSM&T provides several computing clusters for parallel work. The Department of Math and Computer Science (MCS) operates a Non-Uniform Memory Access (NUMA) system with 32 cores which is exclusively for use within the department. MCS faculty members also have access to computing hours at Golden Energy Computing Organization (GECO). The GECO system has 2144 cores on 268 nodes (256 Clovertown E5355 nodes and 12 Xeon 7140M nodes) with a 17 teraflop sustained performance. Moreover, the physics department maintains the largest cluster on campus with 256 cores on 51 nodes. There are also several smaller homogenous clusters (32-64 cores) housed in different departments on the campus.

The campus LAN consists of a 10 GB fiber backbone to every campus building. This resource is dispersed within the buildings to ensure 1 GB desktop connections. Wireless is available in all buildings on campus with student laptops, and faculty/staff machines have wireless access to the internal network servers. An open wireless infrastructure that sits outside our internal network exists for personal devices to provide direct access to the Internet.

As a member institution, SDSM&T is connected to the National Research & Education infrastructure through several high bandwidth networks:

- The Northern Tier Network Consortium (NTNC) connecting Chicago IL with Alaska through the northern tier of states (IL, WI, ND, SD, NE, IA, MT, ID, WA and AK). Internet2 supports NTNC by providing various types of organizational service and assistance. As an Internet2 participant, SDSM&T is connected with Committee on Institutional Cooperation (CIC OmniPoP), an Internet2 connector in Chicago, and is able to establish an appropriate high-speed connection to a national or international aggregation point through the NTNC shown in Figure 7-1.

- The Great Plains Network (GPN), a consortium of universities in the Midwest, connecting SD, NE, IA, KS, MO, AR, and OK connected as shown in Figure 7-2.

- The SD Research, Education and Economic Development Network (REED) connecting six public universities and two university centers in South Dakota with multiple 10 GB/s links. We are investigating the move to 100 GB for the REED backbone to be done over the next few years possibly connecting to the North Dakota network shown in Figure 7-3.

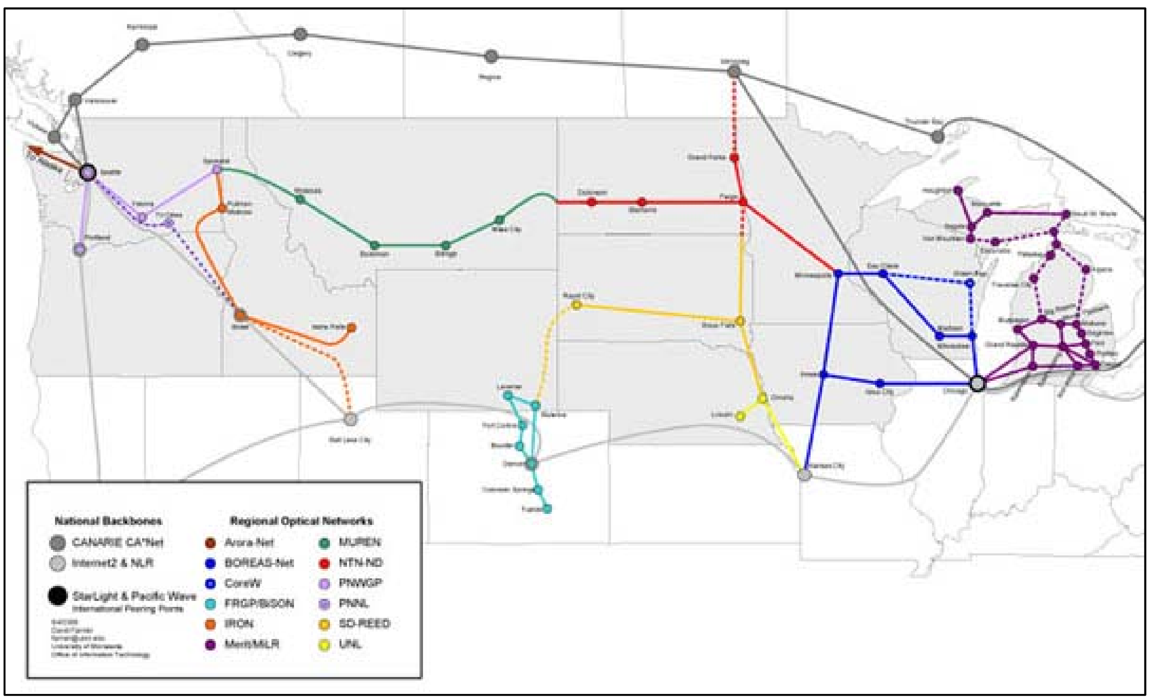

Figure 7-1 Northern Tier National backbone route across the northern U.S.

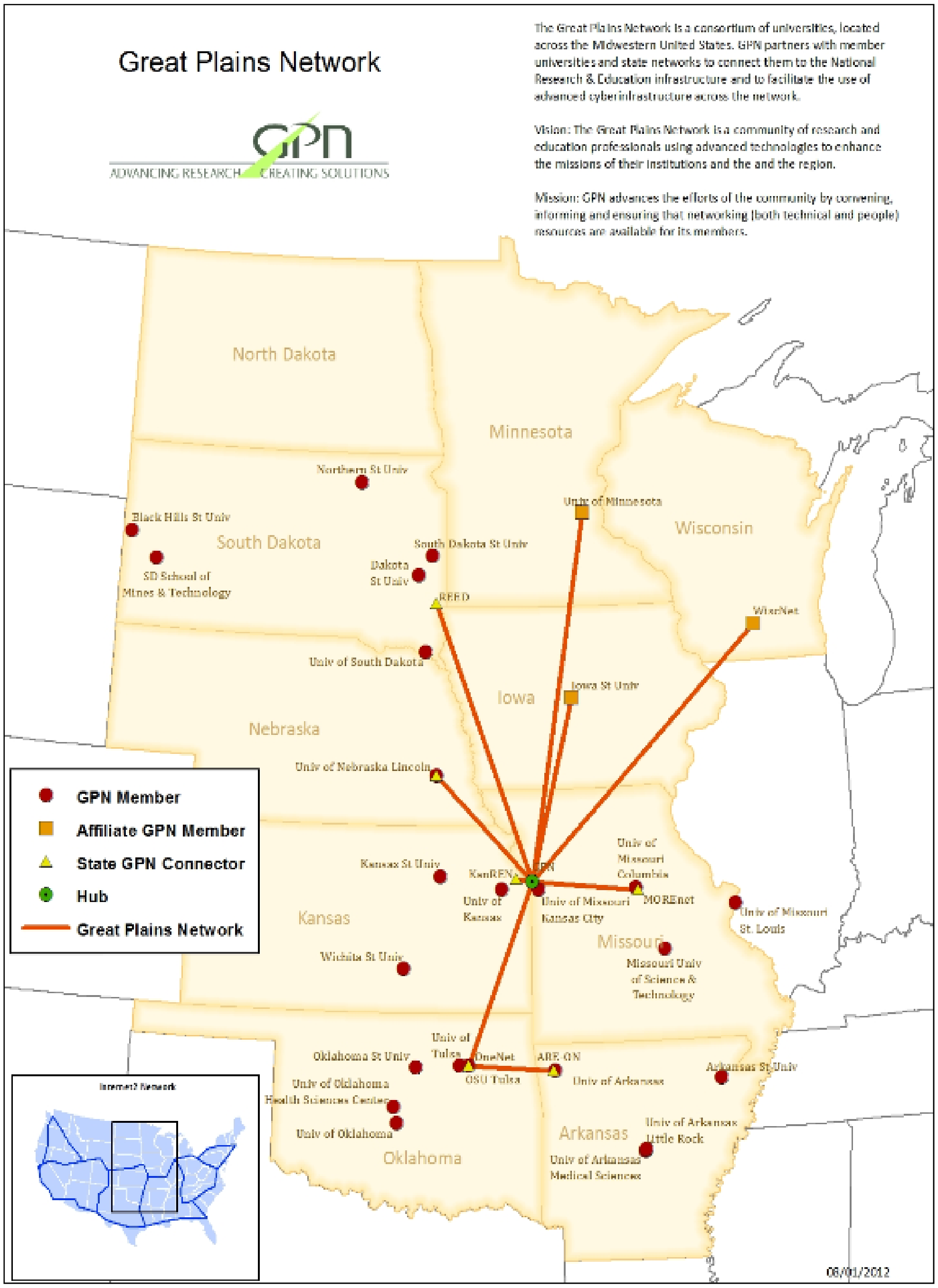

Figure 7-2 The Great Plains Network

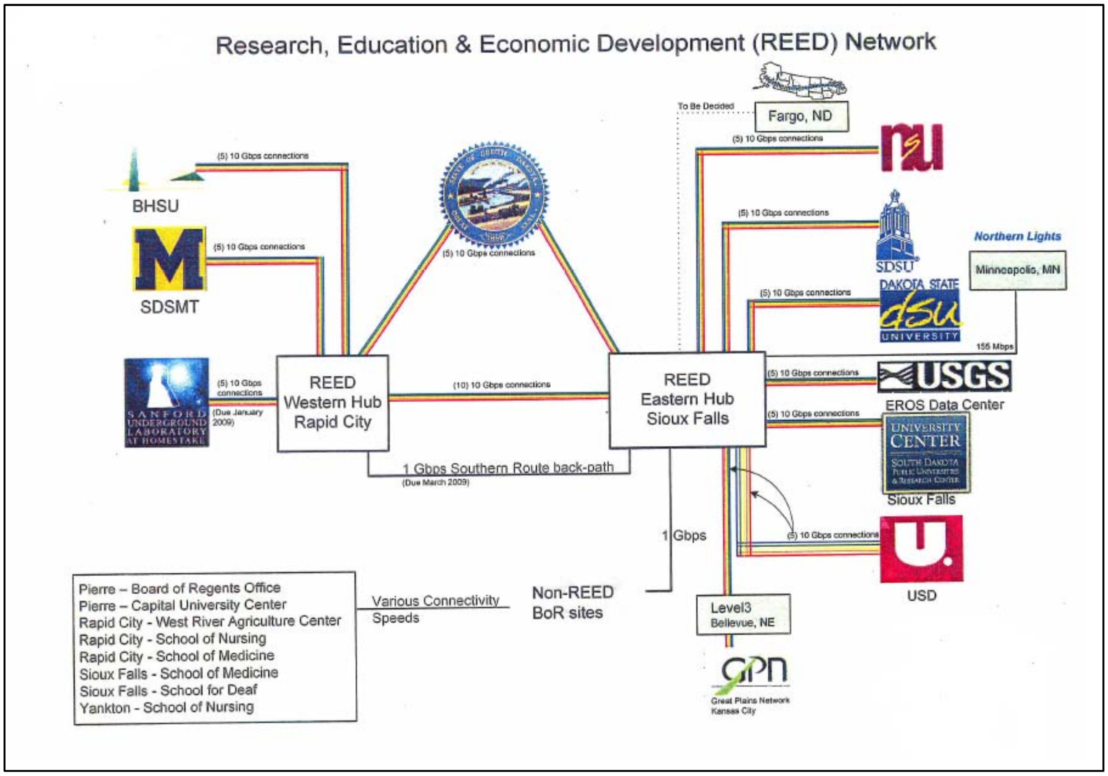

Figure 7-3 SD Research, Education and Economic Development Network

C. Guidance

Students are given a tablet PC orientation when they arrive on campus and have training sessions throughout their academic careers. The Help Desk is also available to students for software and hardware training during normal working hours with some outside hours being provided during the week. There are also many webpages devoted to "How-To" queries to help students, faculty and staff with the more common issues/procedures. Instructional material as well as the South Dakota Board of Regents Acceptable Use Policies can be found at: http://www.sdsmt.edu/its.

D. Maintenance and upgrading of facilities

The department of Materials and Metallurgical Engineering shares with Department of Mining Engineering a full time technician who primarily addresses computer-related issues. The department hires students with high mechanical aptitude to assist in maintaining equipment. Additionally, the department hires on an as-needed basis our former technician to make equipment repairs that are beyond the capability of student hires. Balances and hardness testing equipment is recalibrated on a recurring basis by certified off-campus agents. New equipment is typically covered by warrantees or service contracts. Older equipment is maintained by the responsible faculty or in unusual circumstances by hiring a service agent.

The department of Materials and Metallurgical Engineering has also made a concerted effort in the last period to renovate and improve safety in the labs through research funding and industry foundation support. Recent examples include a complete renovation of the Mineral Processing

Lab (MMI 130) and the Corrosion Lab (MMI 103A). The renovation of the Hydrometallurgy Lab (MMI 126) will begin in the spring of 2016.

All classroom instructional computers are replaced every three to four years. Student tablet PCs are replaced every four years. Incoming freshmen receive new tablets, and Windows 10. Software is maintained and upgraded regularly on tablet PCs. Should major operating system upgrades happen during the life of the machine, a new image is created with the new operating system, and students/faculty/staff can upgrade at their convenience.

SDSM&T offers certified service center so maintenance of computer/laptop hardware is done in-house. Turnaround times are greatly reduced with this method which creates a much more reliable Tablet Program on campus. A small percentage of machines are held in reserve so they can be immediately put into production in case a student or faculty/staff member has a catastrophic failure with a machine. Most of the time, even with a catastrophic failure, a student or faculty member can be out the door with a working machine in a matter of minutes as opposed to the weeks that replacement or repair would require were SDSM&T not a service center.

E. Library services

The Devereaux Library has nine full-time staff members, two librarians and seven support staff members. All are very responsive and provides excellent service. Additionally, approximately seven student workers are hired during the academic year to supplement the staffing of the library. This staff is adequate to serve the needs of the campus. Library Hours are as follows: Sunday 2:00 pm – 10:00 pm / Monday – Thursday 7:30 am – 10:00 pm / Friday 7:30 am – 5:00 pm / Saturday, closed. The physical presence and resources of the library are significantly supplemented by its online presences, access, and resources.

The library online (http://library.sdsmt.edu) is designed to guide students to search for information, find resources and keep in contact with the library. Most students start with the "Search for Resources Worldwide" search box (located next to the Devereaux Library banner) or the Subject Guides which sort the array of databases into departments/majors for ease of use. Each Subject Guide is divided into sections to assist in finding the right kind of information quickly. Alternatively, when an instructor has recommended or assigned a specific resource or database, a student can enter the information into "Search the Devereaux Library Website" and, thereby, locate the resource directly. The main page is designed to offer ready access to social media links; the library catalog; an individual student's library-related records; interlibrary loan; and an interface for submitting comments, questions, and suggestions.

Historical practice for the library has been to allocate yearly resources to each academic program and to rely on academic department library liaisons for new, one-time acquisitions. Budget cuts and lack of resources has led to the suspension of this practice since 2014. The library director continues to consult with the academic departments and seeks to ensure that collections, subscriptions, and services meet needs.

A summary of journal resources and databases (both digital / paper) is as follows:

- Journals:
  - Paper Titles, 101 (24 of which include online access)
  - Electronic Titles, 347
- Databases
  - Full-Text, 2 (Applied Science & Technology and ProQuest SciTech)
  - Index only, 2 (Engineering Village 2 Compendex and MLA (Modern Languages Association)
- Ebook collections, 2 (Knovel and ProQuest Academic Complete, i.e.,'Ebrary')
- Databases supported by the Board of Regents
  - Full-Text, 2 (Dissertations & Theses and IOP Science Journals)
  - Index only, 2 (Chemical Abstracts Service SciFinder Scholar and Thomson Reuters Web of Science)

The library has been moving aggressively toward an all-electronic model for journals over the last four years. Currently the titles retained in paper are popular reading (Time, Newsweek, Car and Driver, Rolling Stone, etc.), titles not available in electronic format, or titles prohibitively expensive to acquire in electronic format. Titles featured in the "downtime / popular reading" relaxation area are all maintained in paper.

Interlibrary Loan services are available to anyone with a valid campus ID. Faculty/Staff and Graduate Students are required to pay a minimal fee to off-set costs. Undergraduates are not charged. The Devereaux Library belongs to MINITEX, a network based at the University of Minnesota. MINITEX provides access to materials throughout the region (e.g., South Dakota, Minnesota, North Dakota, Wisconsin, etc.), Michigan's Federal Depository libraries, the University of Illinois, and the Copyright Clearance Center. Most interlibrary loan traffic goes through OCLC, which has expanded into a worldwide conglomerate of libraries. The Untied State Patent and Trademark Office website http://www.upsto.gov is relied on for access to patent and trademark information.

Library resources of particular value to the BS Metallurgical Engineering program are as follows:

- Standards, Annual book of ASTM standards. American Society for Testing and Materials Annual, Philadelphia, PA, USA, 2004.
- Burkin, A.R., Chemical hydrometallurgy: Theory and principles. Vol. 1. 2001: World Scientific.
- Chandler, H., Heat treater's guide: practices and procedures for irons and steels. 1994: ASM international.
- Chandler, H., Heat treater's guide: practices and procedures for nonferrous alloys. 1996: ASM international.
- Davis, J.R., ASM specialty handbook: stainless steels. 1994: ASM International.
- Davis, J.R. and J.R. Davis, Aluminum and aluminum alloys. 1993: ASM international.
- Foundation, A.S. and A.W. Cramb, The Making, Shaping and Treating of Steel: Casting Volume. 2003: AIST Steel Foundation.
- Fruehan, R.J., The Making, Shaping, and Treating of Steel: Ironmaking volume. Vol. 2. 1999: AIST Steel Foundation.

- Garrels, R.M. and C.L. Christ, Solutions. Minerals and Equilibria: Freeman, Cooper and Company, San Francisco, 1965.
- Handbook, A., Properties and selection: irons, steels, and high performance alloys. ASM international, 1990. 1: p. 140-194.
- Hansen, M., K. Anderko, and H. Salzberg, Constitution of binary alloys. Journal of the Electrochemical Society, 1958. 105(12): p. 260C-261C.
- Hansen, M., R.P. Elliott, and F.A. Shunk, Constitution of binary alloys. First-supplement. Vol. 2. 1965: McGraw-Hill.
- Hultgren et al., Selected values for the thermodynamic properties of the elements, ASM international, 1970.
- Hultgren et al., Selected values for the thermodynamic properties of binary alloys, ASM international, 1970.
- Francis A Shunk, Constitution of binary alloys. Second-supplement. Vol. 2. 1969: McGraw-Hill.
- Hultgren, R., et al., Selected values of the thermodynamic properties of binary alloys. 1973, DTIC Document.
- Kosmulski, M., Surface charging and points of zero charge. Vol. 145. 2009: CRC Press.
- Krauss, G., Steels: heat treatment and processing principles. ASM International, 1990, 1990: p. 497.
- Marsden, J. and I. House, The chemistry of gold extraction. 2006: SME.
- Osborn, E. and A. Muan, Phase diagrams for ceramists (All Volumes). The American Ceramic Society, Columbus, OH, USA, 1964. 219.
- Raymond, R., Out of the fiery furnace: the impact of metals on the history of mankind. 1986: Penn State Press.
- Scott, D.A., Metallography and Microstructure in Ancient and Historic Metals. 1992: Getty Publications.
- Scott, D.A., Ancient metals: microstructure and metallurgy. Vol. 1. 2011.
- Scott, D.A., Ancient Metals: Microstructure and Metallurgy: Iron and Steel. Vol. 4. 2011.
- Stout, R.D. and W.D.O. Doty, Weldability of steels. 1971: Welding Research Council.
- Stull, D.R. and H. Prophet, JANAF thermochemical tables. 1971, DTIC Document.
- Tylecote, R., A History of Metallurgy, Inst. Material, London, 1992.
- Vander Voort, G.F., Metallography, principles and practice. 1984: ASM International.
- Villars, P., A. Prince, and H. Okamoto, Handbook of ternary alloy phase diagrams. 1995: ASM Intl., (10 vol)
- Wakelin, D., The Making, Shaping and Treating of Steel, Iron Making. David H. Wakelin, Richard J. Fruehan//Latest technology, 1999. 2: p. 497-533.
- American Society of Metals: Hand Books (All Volumes)- ASM International.
- Welding Handbook Series; American Welding Society; vol 1-5, 8th edition, 1987,
- Elements of X-Ray Diffraction, B. D. Cullity and S. R. Stock; Prentice Hall; 3 edition, 2001.
- Welding Journal
- Heat Treating Progress (ASM)
- Metallurgical Transactions A & B
- Advanced Materials and Processes (ASM)
- Journal of Metals

- International Journal of Mineral Processing
- Hydrometallurgy Journal
- Minerals and Metallurgical Processing Handbook
- SME Mineral Processing Handbook, V. 1 and 2, 1986, N. Weiss, Editor, SME.

In addition to these resources, the department maintains a library of several hundred reference books in the department study /meeting room (MI 105) open to students when not in use for meetings. This resource includes a complete set of ASTM standards. The faculty also have extensive reference materials that are made available to students as needed.

F. Overall comments on facilities

The BS Metallurgical Engineering program works to maintain safe equipment and a safe working environment. The facilities, tools, and equipment that present hazards if used improperly are kept locked and made available to those who have the appropriate instruction for safe operation. Chemical supplies are periodically cataloged by the Chem Stores Office and reviewed for safety and need. A complete set of (Materials) Data Safety Sheets ((M)SDS) are available for all chemical or hazardous materials in the laboratories via an online database (MSDSonline) that can be accessed through the SDSM&T environmental health and safety webpage . The system automatically updates as new (M)SDS sheets become available. Laboratories using chemicals are equipped with eye wash stations and showers are available. All laboratories involving hot materials are equipped with googles, gloves, and gowns. Laboratories involving flying debris from crushing equipment or mechanical processing equipment are equipped with eye protection. Ear protection is provided for all blacksmithing and metalworking activity. Before every laboratory, the instructor reviews pertinent safety information with all students.

The program has made a concerted effort in the last period to renovate and improve safety in the labs through research funding and industry foundation support. Recent examples include a complete renovation of the Mineral Processing Lab (MMI 130) and the Corrosion Lab (MMI 103A). The renovation of the Hydrometallurgy Lab (MMI 126) will begin in the spring of 2016. In addition, the department has worked with the Mining and Geological Engineering programs and university foundation to begin raising funds to completely renovate the Mineral Industries building. These efforts have resulted in $1.5M in committed funds as of end of FY 15.

All mishaps, close calls, or potentially unsafe conditions are reported to the department head or the Campus Safety Officer (Jerilyn Roberts). The campus Safety Officer conducts regular audits of our laboratories and sends the department head and all faculty members in the department a list of findings. Conditions in need of attention are followed by the department head and the Campus Safety Officer until rectified. Table 7-6 shows the Feb 10, 2016 Environmental Health and Safety Audit for the Department of Materials and Metallurgical Engineering.

Table 7-6 Environmental Health and Safety Audit Feb 10, 2016

South Dakota School of Mines and Technology EHS Audit Report

Week of Audit: 10/5/2015

To: Materials and Metallurgical Engineering Department

From: Margaret Smallbrock

Building: Mineral Industry Building **Department:** Met

Introduction: The audit of the MET department labs was conducted the week of 10/05/2015. The report details the findings and observations. Your diligence in keeping your areas safe is appreciated.

Room: MI-102
Building: Mineral Industry Building
Supervisor/PI: Haiping Hong

Category	Requirement	Description of Observation	Picture or Support Document	Repeat Category
Other	Other	Samples and food sharing to close of a space. Samples should be relocated to the opposite side of the room. The dorm fridge also should be labed as for food only.	Fridge-Sample	☐

Room: MI-102A
Building: Mineral Industry Building
Supervisor/PI: Haiping Hong

Category	Requirement	Description of Observation	Picture or Support Document	Repeat Category
Housekeeping	Combustible material (boxes, chemical, etc.) is not allowed to be stored on top or inside of flammable cabinets.	Flammable material stored on top of the flammable cabinet. Cardboard and other materials are not to be stored on top of these cabinets. Please remove all items from the top of the flammable cabinet.	Flame Cabinet	☐

Room: MI-103A
Building: Mineral Industry Building
Supervisor/PI: Grant Crawford

Category	Requirement	Description of Observation	Picture or Support Document	Repeat Category
Chemical Storage	Chemicals are properly labeled including dates/owner.	A desicator was found on a shelf in the room with an orange material and an unlabled beaker with white powder. The material needs to be labeled. If the orange material is not a dessicant, it is suggested to clean up the material.	Desicator	☐

Room: MI-113
Building: Mineral Industry Building
Supervisor/PI: Jon Kellar

Category	Requirement	Description of Observation	Picture or Support Document	Repeat Category
Waste Management	Waste containers are stored in controlled areas other than general traffic areas or on floor.	Bottles were found on the floor with drain/supply lines to the instrument. Either being a waste or supply to the instrument, the containers need to be labeled with contents, covered and not in the walkway of the room.	Waste container	☐

Table 7-6 Environmental Health and Safety Audit Feb 10, 2016 (Cont'd)

Room:	**MI-121**			
Building:	Mineral Industry Building			
Supervisor/PI:	Haiping Hong/Stan Howard			
Category	**Requirement**	**Description of Observation**	**Picture or Support Document**	**Repeat Category**
Compressed Gases	Cylinders are properly secured.	Found an unsecured nitrogen and acetylene cylinder in the corner of the room. The nitrogen cylinder was noted during the State Risk Management walkthrough in May. The cylinders must be secured.	Un-Secured Cylinders	☐
Compressed Gases	Cylinders are properly secured.	Two cylinders were found to be improperly secured. With the strap at the lower end of the cylinder, this will not prevent a cylinder from being knocked over. This was noted previously during the State Risk Management walkthrough in May.	Improperly Secured Cylinders	☐
Electrical	Access to circuit breaker boxes is not blocked. (Maintain 36" access)	There are some long pipes on the floor in this room that are a trip hazard in front of the electrical cabinet. These should be moved to a different location to allow safe access to the cabinet.	Electrical Cabinet	☐
Electrical	Access to circuit breaker boxes is not blocked. (Maintain 36" access)	There are long pipes lying on the floor in front of the electrical panel in this room. This violates code in which 36" must be kept clear in front of all electrical panels. Please relocate this pipe.	Electrical Panel	☐
Other	Other	Respirator found hanging in the lab. The name on it, Peter Kim is not in our files for fit testing or PFT to ensure safe use of the respirator.	Respirator	☐
Room:	**MI-124**			
Building:	Mineral Industry Building			
Supervisor/PI:	Michael West			
Category	**Requirement**	**Description of Observation**	**Picture or Support Document**	**Repeat Category**
Chemical Storage	Chemicals are properly labeled including dates/owner.	Bottle of what is assumed to be acidic material has a corroded label that is not legible. This bottle needs to be relabeled for contents to be known.	Bottle Label	☐
Chemical Storage	Chemicals are properly labeled including dates/owner.	There are many unlabeled materials throughout the lab. There are items on a tray near the window, and other bottles scattered throughout the room. The attached picture is only an example of one.	Unlabeled bottles	☐
Housekeeping	Contaminated glassware should be cleaned daily.	There is a beaker in the fume hood that apears to have residue. Without a label there is a possibility that materials could interact with this unknown.	Dirty Beaker	☐
Room:	**MI-124B**			
Building:	Mineral Industry Building			
Supervisor/PI:	Michael West			
Category	**Requirement**	**Description of Observation**	**Picture or Support Document**	**Repeat Category**
Housekeeping	No food/drink in areas containing chemicals.	During the audit, I found trash that included food containers. There is not to be food or drink within the lab.	Food Debris	☐

Table 7-6 Environmental Health and Safety Audit Feb 10, 2016 (Cont'd)

Housekeeping	Counters and floors clean, clear of clutter.	General Housekeeping is needed in this area. It is recommended to orgaize and clear up the counters to allow better use of the space.	Countertops	☐

Room: MI-126				
Building: Mineral Industry Building				
Supervisor/PI: William Cross				
Category	**Requirement**	**Description of Observation**	**Picture or Support Document**	**Repeat Category**
Chemical Storage	Chemical storage containers are in good condition (not broken, cracked, dented).	The freezer in this room has frozen itself shut. It is possible that the material stored within can be damaged by excessive frost. Please carefully defrost the freezer and evaluate the contents.	Freezer	☐
Chemical Storage	Chemicals are properly labeled including dates/owner.	There are a handul of unlabed bottles in this room. Please identify and label this material.	Unknown Chemicals	☐
Chemical Storage	Chemicals are properly labeled including dates/owner.	There is a 2.5L bottle in the corrosive cabinet that has a misleading label. If a bottle is to be re-used, the label must be completely removed or covered by the new label. Please replace the label with a more detailed label.	Corrosive Bottle Label	☐
Chemical Storage	Chemicals are stored in compatible environments when not in use.	There is a flammable solid stored in general chemical storage. This material needs to be stored in a flammable cabinet.	Flammable Material	☐
Chemical Storage	Chemicals are properly labeled including dates/owner.	There are some unknown materials stored within the flammable cabinet in this room. These items need to be labeled to ensure proper storage.	Flammable Unknowns	☐

Room: MI-127				
Building: Mineral Industry Building				
Supervisor/PI: Jon Kellar				
Category	**Requirement**	**Description of Observation**	**Picture or Support Document**	**Repeat Category**
Other	Other	There is a speaker melted to a piece of equipment in this room. The amount of attachement and melt shows that consideable heat was generated to do this. Please separate the two and ensure the equipment is still in working order.	Melted Speaker	☑

Room: MI-128C				
Building: Mineral Industry Building				
Supervisor/PI: William Cross				
Category	**Requirement**	**Description of Observation**	**Picture or Support Document**	**Repeat Category**
Electrical	Access to circuit breaker boxes is not blocked. (Maintain 36" access)	There is slight blockage of the electrical cabinet in this room. Care needs to be taken to ensure that the electrical cabinet maintains 36" of clear space.	Blocked Electrical Cabinet	☐

Room: MI-MET General				
Building: Mineral Industry Building				
Supervisor/PI: Michael West				
Category	**Requirement**	**Description of Observation**	**Picture or Support Document**	**Repeat Category**

Table 7-6 Environmental Health and Safety Audit Feb 10, 2016 (Cont'd)

Chemical Storage	Chemicals are properly labeled including dates/owner.	I noticed many unlabeled wash bottles scattered throughout the lab spaces. Even water must be labeled. Please label all wash bottles with contents.	Wash bottle	☐

CRITERION 8 - INSTITUTIONAL SUPPORT

The institution provides support to the BS in Metallurgical Engineering in the form of leaders who interface with the people of the state of South Dakota via the SD executive branch, the SD Legislature, and the South Dakota Board of Regents (SDBOR) through which a large portion of the program's funding derives. This section of the report describes the leadership structure and the budgetary process at the university level. The staffing made possible by such funding is described as are the faculty hiring and development practices and procedures.

A. Leadership

SDSM&T no longer has colleges or deans; therefore, the administrative structure of the Academic Affairs division is notably flat. Department heads enjoy direct access to executive leaders and meet every two weeks with Dr. Demitris Kouris, Provost and Vice President for Academic Affairs in the Academic Leadership Council Meeting (ALC). The meeting minutes of this meeting are distributed campus wide. Periodically President Wilson, Vice President for Finance Stephen Malott, or Vice President of Research Affairs Dr. Jan Puszynski attend the ALC meetings. Additionally, each department head meets monthly on a one-on-one basis with the Provost and Vice President for Academic Affairs who is available for more frequent meeting as needed.

Faculty ownership of the curriculum and oversight of academic matters are assured by the structures and processes of the Faculty Senate, program curriculum committees, the University Curriculum Committee, the Promotion and Tenure Committee, and the Council on Graduate Education. Decision making by these entities is faculty controlled. The Faculty Senate President Dr. Rodney Rice meets with the president monthly.

Structures that help ensure the flow of communication across areas of research include the University Research Committee, which has representatives for all major areas of research and smaller focused groups that are organized around the key research areas of energy and the environment, materials and manufacturing, underground science and engineering, and STEM education.

To ensure the availability of information across units and academic department, a shared drive on the intranet serves as a common repository for policies, procedures, and agreements. Every month, the finance office distributes two types of budget reports:

- Overall institutional budget report to each executive council members that tracks revenue and expenses, profit and loss for all categories, such as salaries, benefits, supplies, etc.
- Up-to-date accounting to each academic program and unit administrators detailing the accounts over which they have budgetary authority.

Academic department heads hold 12-month positions with reduced teaching and/or research commitments. They are the administrators with primary responsibility for the academic programs residing within their department. These responsibilities include program enrollment management and the fostering of opportunities for external funding. The fiduciary responsibilities of department heads include managing the budget for the program, making salary recommendations, and overseeing operating expenses and student support budgets. Department heads provide an important oversight and coordinating step in the process of approving research proposals submitted by their faculty members. Department heads provide input to the provost on space utilization, program needs, and any additional information needed by the administration to ensure the effective management of institutional resources.

The six goals of the strategic plan are posted at (http://www.sdsmt.edu/About/Strategic-Plan/) and consist of the following:

- **Student Success -** Prepare more undergraduate students for leadership in engineering and science.
- **Research -** Increase research to prepare science and engineering experts, advance knowledge, and catalyze economic development.
- **Facilities -** Redevelop and expand needed living, learning, and research spaces.
- **People -** Recruit, develop, and retain excellent faculty and staff.
- **Administration -** Responsibly steward financial and physical resources.
- **Development -** Establish a robust culture of philanthropy to enable the university to sustain excellence.

B. Program budget and financial support

Several months before the new fiscal year, the Department of Finance and Administration develops the program budget and determines the level of financial support for the coming fiscal year. Input from the Department Head on this process is giving during a budget hearing conducted in November or December. The budget hearing often includes specific financial requests from the program (i.e. funding to hire new faculty or additional funding for teaching assistants) along with discussion and evidence of how current financial resources are being used to support the educational mission of the program and university. Each program's budget request must contain the following elements:

- Summary of program / unit results related to university strategic goals
- Review of previous fiscal year budget and actual expenditures
- Proposed operating budget initiatives for the budget year ahead to support the university's strategic objectives or preparation for accreditation (and estimated costs)
- Proposed cost reductions or shifts in university budgets to fully or partially fund priorities within limited resources
- Treatment of special topics

For the FY 2016 budget, the special topics were retention and the first-year experience, enrollment planning, and fundraising. Budget requests were required to include treatment of the program or unit's contributions to these special topic areas.

Financial support for the program is comprised of a number of institutional sources including:

- Tuition and fees (recurring)
- Overhead funds from research (recurring)
- Foundation/Development funds (temporary)

The cost for an undergraduate in the BS in Metallurgical Engineering is shown in Table 8-1. In addition to these costs, selected metallurgical engineering laboratories have a lab fee not exceeding $30 per credit for supplies. In the last period, the Engineering Service Fee (Lab Fees) has changed to a Special Disciplines Fee. A portion of fees generated from courses also goes into supporting laboratory maintenance and consumables.

Table 8-1 Estimated SDSM&T undergraduate cost for (2016-17)

Undergraduate	SD	Non-SD
Tuition and Fees*	$10,400	$14,560
Books and Supplies**	$2,000	$2,000
Room and Board	$7,720	$7,720
Estimated Annual Total	$20,120	$24,280

* Averages based on 30 credits per year
** Includes Tablet PC Program.

Overall program support for personnel, departmental operations, and operating expenses for the last three fiscal years is summarized in Table 8-2 below. Table 8-2 shows that financial support for faculty and staff has increased as new faculty have been hired. Funding support for teaching assistants has remained constant. Additional support for the two new faculty hired in 2013 has been provided by the office of the Provost in the form of one-time start-up funds of nearly $90,000.

Table 8-2 Program budget

Fiscal Yr	Faculty & Staff	TA's	Lab/Disc Fee	Univ Support
2013	$430,909	$8,043	$66,058	$13,491
2014	$747,026	$8,043	$93,275	$12,991
2015	$770,251	$8,043	$75,535	$10,292

Significant sources of support for the department also come from Foundation (private) accounts and returned overhead from research grants. A summary of starting budgets and expenditures from Foundation accounts is shown in Table 8-3. The most significant source of unrestricted program support continues to be from the Nucor endowment ($1M). Other significant sources of industry funding came from Goldcorp, John Deere, Cliffs Resources, and Newmont. These Foundation funds have predominately supported student program activities, faculty development, lab improvement, and small equipment acquisitions. The table also summarizes scholarship money available to support students through both endowed and one-time gifts. The program continues to conduct development work in cooperation with Foundation staff to ensure adequate funds are available to support the program as needed.

Table 8-3 Summary and expenditures from foundation accounts

Fiscal Yr	Program Starting	Travel	Equipment/ Lab Support	Scholarships
2013	$80,171	$15,116	$2,010	$65,500
2014	$84,533	$9,767	$9,290	$91,000
2015	$92,932	$8,920	$9,217	$84,500

Faculty have also been successful in competitive funding for research (as detailed in Criterion 6) from a variety of sources including the National Science Foundation, Department of Defense, and NASA. Table 8-4 shows a summary of returned overhead budget information available to support the department. Expenditures shown have primarily supported faculty travel and maintenance of major equipment.

Table 8-4 Summary of expenditures from overhead accounts

Fiscal Yr	Starting Balance	Indirect Revenue	Expenditures
2013	$38,745	$16,313	$25,807
2014	$24,169	$17,529	$25,001
2015	$23,537	$43,551	$26,965

In summary, the state support provides a critical base for program execution by providing the necessary faculty FTE's to deliver the necessary breadth of the program. The department continues to successfully leverage other resources in the form of private industry and research funding to ensure student outcomes are met.

C. Staffing

Faculty numbers have increased since the last ABET review in 2010 from approximately 130 to 150. Staff numbers have followed the same trend as shown in Table 8-5. Reliance on term-contract faculty is low at approximately 15 percent or less. A number of these part time faculty are emeritus faculty serving part time and so are among the most experienced faculty on campus. This is the case for BS. In Metallurgical Engineering program, which retained the part time services of Dr. Howard who had 43 years of experience at SDSM&T before his two years of part time service beginning in the fall of 2014. The overall campus student/faculty ratio has remained at good levels. The institution does not use graduate students as instructors.

Department heads are appointed as 12-month faculty members with significantly reduced teaching loads to accommodate the need for year-round program oversight and planning. The department of Materials and Metallurgical Engineering has approximately four TA's hired at 15 hours/week who are used in the instructional program for grading and for preparation of undergraduate laboratory experiments. If the TA is a graduate student nearing the completion of their MS or PhD program of study, they may assist undergraduate students by answering questions, but this not widely employed. Also, on rare occasions, an experienced TA may work problems in a class period when the instructor is unavailable (travel, illness, etc.). This is done only if an experienced faculty member is unavailable. The total time in the classroom for all such substitution is well under 10 hours per year for all metallurgical engineering courses combined.

Table 8-5 Annual Institutional Update Data submitted to the HLC on Employees and Student/Faculty Ratios

Employee Type	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Full-Time Faculty	126	130	130	142	153	148	149
Part-Time Faculty	17	17	23	18	16	26	26
Full-Time Annually contracted staff	123	143	134	149	128	140	149
Part-Time Annually contracted staff	4	8	18	33	43	40	28
Full-Time Civil Service Support staff	53	52	50	40	43	77	112
Part-Time Civil Service Support staff	13	18	14	13	13	27	21
Student-Faculty Ratio	N/A	14	14	14	14	14	15

Staffing for all areas of campus tends to run slightly behind demand. During recent years of tight budgets, requests for additional faculty and staff positions consistently outpaced available funding; therefore, the analysis of what positions need to be filled to meet needs in critical areas is conducted as part of the annual budget-building process. Working with budget projections, executive leaders in all areas must prioritize hiring requests and plan for restructuring or redistribution of duties to ensure adequate staffing.

Staffing levels in Student Development are based on enrollment and national best practices, such as the expectation that one psychological counselor be available to serve no more than 800 students.

Work is underway now to develop a faculty workload model promises to improve processes for allocating funding for positions. The purpose of such a model would be to generate data that would quantify both productivity and demand and support equitable distribution of resources between and among academic departments, but it is difficult to equitably quantify faculty activity.

The Human Resources Office contributes to processes for ensuring adequate staffing by monitoring and forecasting employee turnover. Turnover is anticipated by tracking the following:

- Retirement eligibility
- Planned and unplanned resignations
- Dismissal or reduction in force
- Identification of succession planning for emergency unplanned absences
- Classification changes and promotions

Once a position becomes vacant, it is reviewed for the following:

- Essential duties and responsibilities
- Institutional needs and funding
- The possibility of collapsing or eliminating functions, or the need for additional functions
- Organizational/reporting structure
- Cross-training opportunities

The SDBOR institutions have unified HR polices and processes for employee position-description creation, recruitment, classification, and compensation. All institutions in the Regents system use a shared Online Employment System (OES) for recruitment and application-processing. In order to create a position description and to initiate a search, users of the OES must answer a fairly extensive array of questions ranging from the skills and attributes required of candidates to budget sources for the position.

Career Service Act (CSA) employees are subject to the Affirmative Action Plan, South Dakota Codified Law, the Administrative Rules of South Dakota, and the Recruitment and Selection Guidelines of the Bureau of Personnel. State law requires that CSA employees be appointed, promoted, compensated, or terminated according to Civil Service Act criteria. Rights and responsibilities of faculty eligible for collective bargaining are defined by the Council of Higher Education (COHE) agreement. BOR policy defines the duties and responsibilities of faculty not in the collective bargaining unit, in a manner nearly identical to the COHE agreement. Non-faculty Exempt (NFE) employees in professional or research roles have annual contracts. ARAMARK Corporation manages dining services and handles its own human resource functions. Student health services are also provided by a private contractor.

The hiring of students is handled internally, and the process for hiring involves the Personnel Action Request (PAR), which was greatly simplified in 2015 into an electronic EPAR that is trackable and paperless.

Human Resources staff visits with all new hires to discuss benefits and responsibilities on their first day of employment. Anti-harassment and drug and alcohol policies are described and detailed in handouts. In 2016, an online training system is being implemented to cover anti-harassment and discrimination training. This training also covers Title IX. Three times a year, an orientation is held to introduce CSA, NFE, and Faculty employees to each other, to have senior management introduce their divisions and/or areas of responsibility, to watch a video of the history of the SDSM&T, and to tour the campus. The president hosts an annual new employee reception and periodic receptions for all faculty.

To ensure employees remain current in skills and development, free or low-cost professional development training offerings are publicized by the state Bureau of Personnel (BOP) through email and a comprehensive calendar of all training opportunities. To accommodate singular requests, Human Resources (HR) automatically approves all requests for online training. Faculty training is handled within the department and needs identified through each faculty member's annual evaluation and/or Professional Development Plan. Specialized professional development for staff members in key areas, such as Admissions, Registration and Student Services, Student Development, etc., is funded out of unit budgets, and training needs are typically identified in one of two ways: 1) the supervisor or employee will include a training request in their annual performance review materials, or 2) the supervisor will ensure that their direct reports remain connected with and active in relevant professional societies and/or user groups within the SDBOR system. For example, system schools are engaged in an Oracle migration, expanding use of the EMAS recruitment management platform, and improving degree-audit processes. Training occurs at and is coordinated by all system schools through the SDBOR.

D. Faculty hiring and retention

All institutions in the Regents system use a shared Online Employment System (OES) for recruitment and application-processing. An online workbook, "Hiring Procedures and Online Employment System Processing" guides the Hiring Manager. All members of search and screen committees and employees granted hiring authority must attend a "Best Hiring Practices" workshop. A Hiring Manager uses online forms to document all steps in the hiring process, including detailed information about the nature, scope, and requirements of the position as well as the knowledge, skills, and abilities required. Set questions in the online forms solicit information on the organizational culture, values, and work environment for the position, and this information shared with the search committee and applicants. Background checks are outsourced to HireRight®.

Search committees are composed to ensure a diversity of perspectives and a comprehensive evaluation of candidates. The regional labor pool and demographics of STEM PhDs result in minorities and women being underrepresented. To counter this, Human Resources targets advertising; promotes the institutional commitment to recruiting a diverse workforce; and presents workshops on proper behavior, diversity and hiring.

The Department of Materials and Metallurgical Engineering has a direct link to the Diversity in Minerals, Metals, and Materials Profession Summit and related activities through Dr. Howard who serves as the president of TMS, which is a sponsoring society of the Diversity Summit.

Over the last decade, SDSM&T made a concerted effort to improving gender and racial diversity for faculty in STEM disciplines as shown in Table 8-6. During the spring semester 2016, women comprise 25 percent of the SDSM&T faculty.

Table 8-6 SDSM&T hiring data from 2005 to 2015

Year	All Hires			Faculty Hires		
	All	Female	Minority	All	Female	Minority
2005	27	11	5	9	2	1
2006	41	18	9	12	1	4
2007	31	17	6	7	0	2
2008	36	18	7	7	0	2
2009	52	17	10	11	0	3
2010	44	19	7	10	2	0
2011	11	5	3	3	0	1
2012	26	11	4	17	9	5
2013	20	8	7	13	5	4
2014	21	5	7	9	1	4
2015	20	9	4	8	1	2

Faculty members are evaluated according to the terms set SDBOR system-wide COHE collective bargaining agreement. Expectations for percentage of time allocations for teaching, research, and service are set each year in the annual review. Every year, all faculty members prepare a summary of all teaching, scholarship, and service activities and a description of performance objectives for the coming year for review with and approval by the department head. Both the head and the faculty member sign off on a performance evaluation write up. Guiding these evaluations are a campus-wide Statement of Institutional Priorities for Faculty Performance. Discipline-specific criteria for levels of performance (i.e., meets, does not meet, and exceeds expectations) are set at the program level. In addition, each faculty member in the SDBOR system creates a Professional Development Plan (PDP) according to a SDBOR template that aligns the faculty member's plan with institutional goals and solicits information on resources and professional development needed to remain productive. Plans are signed off on by the department head and the provost and go into a faculty member's file for use in annual review.

The Department of Human Resources leads activities that promote faculty and staff retention and engagement. These activities are summarized in Tables 8-7 and 8-8 below.

Table 8-7 Processes and activities to foster employee engagement and satisfaction

Employee retention efforts are varied and include the following:

- Advertising the "Rule of 85" opportunity which allows an employee whose age plus years of service equal 85 to retire with full benefits
- Securing salary competitiveness funding from the legislature based on benchmarking of salaries and benefits against peer institutions
- Offering longevity pay for NFE and CSA employees beginning their seventh year of employment. The annual rate begins at $100 per year and continues to accumulate to $2205 for 49 years of service
- Holding an annual employee recognition award event (including ARAMARK employees) to congratulate and thank employees for their years of service. Employment anniversaries are recognized on five-year increments, by state pins, gift certificates, and commemorative timepieces
- Offering generous benefits packages negotiated for employees with vendors by the State of South Dakota's Bureau of Personnel. Leave accrual increases at 15 years from 10 hours to 13.34 hours; maximum vacation hours to accrue jumps from 240 to 320 hours.
- Providing feedback on performance and soliciting input and requests through annual Accountability and Competency Evaluation (ACE) performance review processes for all NFE and CSA employees and their supervisors
- Sending birthday cards with gift coupons to every employee every year
- Welcoming new employees with a card containing bookstore discount and free meal coupons
- Inviting all employees to a monthly "Payday Coffee and Cookies" social hosted by the President

A fully equipped Wellness Center is available with flexible hours for faculty and staff use. Preventive health care, including health screenings, wellness fairs, and inoculations, are strongly promoted by the State Bureau of Personnel. Employees with chronic illnesses, such as diabetes, heart disease, chronic back pain, and asthma, are counseled and tracked through the Latitude program. And employees are informed about all services and health-related deadlines and notifications through the Benefits Briefings sent by Human Resources.

E. Support of faculty professional development

Faculty training is funded within the department and needs are identified through each faculty member's annual evaluation and/or Professional Development Plan. Campus-wide professional development for instructors is handled by a development expert in Human Resources who convenes a Faculty Development Committee comprised of one faculty member from each department on campus to select at least two pedagogy workshops per year and to design book groups, in-house seminars, new-faculty cohort groups, and other training sessions that make the best use of the $25,000 yearly budget. Review of professional development and training needs is conducted yearly as part of the annual evaluation.

Department of Materials and Metallurgical Engineering attend at least one national level profession society meeting each year. All departmental faculty members are actively engaged in research and publication and professional service as described in Criterion 6. Campus seminars and webinars are offered frequently on a wide range of topics.

Table 8-8 Processes and activities to foster engagement and satisfaction are detailed below.

Process or activity	How designed	Contribution to employee engagement and satisfaction
All campus convocations, and breakfasts with the president	Since 2008, annual convocations and bi-annual, mid-semester all-campus "breakfasts" with the president are held.	All campus is invited and fed at convocations and planning sessions. Planning documents and reports are shared, and an annual report is published online.
Weekly executive council meetings	The president meets with the provost, vice presidents, and directors of athletics, the Foundation and the Alumni Association	Minutes are kept, and any employee can forward an issue for discussion through his or her supervisor.
Monthly Cabinet meetings	Cabinet is comprised of the Executive Council members and representatives from the Student Association, Faculty Senate, athletics, facilities, and NFE and CSA employee councils.	Minutes are published and observers may attend as desired. Cabinet represents all campus constituents and is an important venue for policy discussions.
Academic Leadership Council	The provost meets twice monthly with the department heads; minutes are kept and widely distributed.	Having one layer of reporting between faculty members and the provost fosters transparency and empowerment.
Campus Committee structure	Institutional culture is to have as few committees as needed, to publish clear charges and a list of all members, and to retire inactive groups.	Members are elected or volunteers solicited. The campus size means that nearly all employees serve.
NFE and CSA meetings	Meetings are held monthly, typically with a socially interactive element, such lunch or presentations	All NFE and CSA employees are members, so all have representation
Online news	University Relations posts current and archived news releases on the website and refreshes almost daily a rollover display of headlines with illustrations on the home page of the web presence.	The "News and Events" tab on the web presence consolidates all news items, press releases, and events announcements in one area.
Newsletter for K-12 community	The Office of the President publishes Monthly@Mines	SDSM&T touts the accomplishments of faculty and remind the educational community of the resources they offer.
Employee appreciations	Annual employee recognition award event for all employees.	Event features retrospective slideshows, trivia contests, and door prizes
President's Picnic	Picnic on the quad held at the beginning of fall semester yearly	All faculty, staff, and students are served a picnic on the green
M-Week	Picnic and climb up M Hill held at Founder's Park	All faculty, staff, and students are included
Sponsored events	Free admission for faculty, staff and their families for all campus-sponsored events	

PROGRAM CRITERIA

The BS in Metallurgical program satisfies the program criterion for Metallurgical Engineering as described in Criterion 5 and described here in greater detail.

A. Curriculum

The curriculum requires students to have completed basic courses in chemistry and physics and engineering principles before they embark on upper division required metallurgical engineering courses. For example, students must complete one half of their required eight credit hours of college level chemistry (CHEM 112, 112L, 114, 114L) and six credits of college level physics (PHYS 211, 213) before enrolling in the junior-level Metallurgical Thermodynamics course (MET 320). They are also required to complete Statics (EM 214) and either Mechanics of Materials (EM 321) or Introduction to Solid Mechanics (ME 216) before enrolling in Mechanical Metallurgy (MET 440). MET 422 (Transport Phenomena in Metallurgical Engineering) and MET 433 (Process Control) both require completion of the two college-level Calculus I and Calculus II (MATH 123 and MATH 125) and Differential Equations (MATH 321). The advanced chemistry, physics, and engineering principles derived from these courses are applied to the production, shaping, forming, treating, and performance of metals. Every capstone senior design projects involve only the production or processing of metals.

The four major elements of the field are the focus of the curriculum. The development of these criteria originated in the early 1990’s from efforts led by Dr. Gerald Liedl serving as chair of the TMS Accreditation and Education and Professional Affaires committees. TMS is the lead society for Materials and Metallurgical Engineering. The difficulty of describing an educational criteria for both the extractive and physical branches of metallurgical engineering was resolved by applying the seemingly physical metallurgical terms of structure, properties, processing and performance to extractive processes as well. As Dr. Liedl described it, “an iron blast furnace has both *structural* and *properties* critical to its *processing* and *performance* that every extractive metallurgical engineer should know.” The same applies to every chemical process employed by extractive metallurgists from the mineral processor, to chemical metallurgist as well as to physical metallurgists for which the terms are familiar. Each metallurgical engineer relies on these four elements of the field to solve materials selection and design problems.

Table 9-1 shows a quality deployment matrix for how each required and elective MET engineering course. The importance of each course in satisfying the metallurgical engineering criteria is indicated with a rating of 9 if it is highly important; a 3 if it is moderately important; and 1 if it is of low importance. The specific curricular details for each course are available in the course syllabi, but the *highly important* items (score of 9) are summarized for convenience below for each of the four elements: structure, properties, processing, and performance.

Table 9-1 Quality Function Deployment Matrix for meeting the program criteria

Course	Description	Structure	Properties	Processing	Performance
Required					
MET 220	Min Proc & Resource Rec	9	3	9	1
MET 220L	Min Proc & Resource Rec Lab	1	3	9	3
MET 231	Structures & Prop of Mat Lab	3	9	3	9
MET 232	Prop of Materials	9	9	3	1
MET 310	Aqueous Extract/Conc/Rec	3	3	9	9
MET 310L	Aq. Extract/Conc/Rec Lab	1	3	9	9
MET 320	Metallurgical Thermodynamics	1	9	3	1
MET 321	High Temp Extract/Conc/Rec	9	3	9	3
MET 330	Physics of Metals	9	3	9	3
MET 330L	Physics of Metals Lab	9	9	3	3
MET 332	Thermomechanical Processing.	3	3	9	9
MET 422	Transport Phenomena	1	3	9	9
MET 433	Process Control	3	3	3	9
MET 440	Mechanical Metallurgy	9	9	9	9
MET 440L	Mechanical Metallurgy Lab	3	9	3	9
MET 351	Engineering Design I	1	9	3	9
MET 352	Engineering Design II	1	9	3	9
MET 464	Engineering Design III	1	9	3	9
MET 465	Engineering Design IV	1	9	3	9
		75	111	111	123
Electives					
MET 426	Steelmaking	9	3	9	3
MET 430	Weld Eng & Design, Structures	3	9	9	3
MET 443	Composite Materials*	9	9	3	3
MET 450	Forensic Engineering	9	3	9	3
MET 445	Oxidation and Corr. of Metals	1	9	3	9
MET 491	Security Printing Technology	3	9	3	3
		26	34	34	30

* Replaced after 2010 by the 2 credit hour Advances in Processing and Nanoengineering of Polymers (MES 475) and the one credit hour Composites Manufacturing MET 489)

Structure
The fundamental scientific and engineering principles associated with the microstructure of metallurgical elements and alloys are taught the following requires undergraduate lecture and laboratory courses.

Required

- MET 220 (Mineral Processing)
  Students examine the crystallography and stoichiometry related to minerals used for metal content and/or industrial mineral value. Students also examine how mineral crystallography influences comminution behavior.
- MET 232 (Properties of Materials)
  Students examine microstructure and bonding and its relationship to polymer, ceramic, and metal properties.
- MET 321 (High Temperature Extractive, Concentration, and Recycling)
  Students learn the structure of a number of selected metal production process equipment such as the iron blast furnace and how such structures work to produce metals from 1) metal-based compounds and 2) the recycling of materials.
- MET 330 (Physics of Metals)
  Students study in detail the crystal structure of metals. Students also study important defect structure that influence behavior of metals including grain structure, solidification structure, and dislocation structure.
- MET 330L (Physics of Metals Laboratory)
  Students make extensive use of metallography to examine the physical structure of metals including grain structure, phase structure, and precipitate structure.
- MET 440 (Mechanical Metallurgy)
  Students learn the influence of metal structure (e.g. crystal structure, dislocations, grain boundaries, precipitates) on elastic deformation, plastic deformation, and fracture

Electives

- MET 426 (Steelmaking)
  This course covers the unit operations in integrated steel mills, mini-mills, and direct reduction processes. The structure of these unit operations provides the basis for the thermochemical and thermomechanical process analysis.
- MET 443 (Composite Materials)[†]
  This course prepares students in the basics of materials, design, and selection of materials for critical applications such as defense, crash protection and aerospace.
- MET 450 (Forensic Engineering)
  Students in detail the structure related to fracture surfaces and metal failures. Students also use various advanced characterization techniques that are common to looking at the structure of materials including optical and electron microscopy.

† Replaced after 2010 by the 2 credit hour Advances in Processing and Nanoengineering of Polymers (MES 475) and the one credit hour Composites Manufacturing (MET 489)

Properties
The fundamental principles associated with material properties and their application to solving engineering problems and material selection is taught in the following required courses.

Required

- MET 231 (Structure and Properties of Materials Laboratory)
  Students learn the to measure material properties including hardness, strength, and toughness. Students also learn about relative standards for testing properties.
- MET 232 (Properties of Materials)
  Students learn the fundamentals of accurately defining and describing material properties including hardness, strength, toughness, fracture toughness, and fatigue. Students are introduced to performance properties including hardness, tensile strength, toughness, fatigue limits, brittle-ductile transition temperature, fracture toughness, and ductility.
- MET 320 (Metallurgical Thermodynamics)
  Students learn the rigorous definition of thermochemical terms such as heat capacity, Enthalpy, Gibb's energy, etc. They learn the fundamentals needed to perform heat balances and determine conditions for chemical equilibrium and the propensity for chemical reaction and phase change. Students gain a fundamental understanding and learn to compute chemical and phase stability using Gibb's energy and perform simple heat balances for physical and chemical processes.
- MET 330L (Physics of Metals Laboratory)
  Students perform detailed hardness, microhardness, and other mechanical property tests on metal alloys in a variety of conditions.
- MET 440 (Mechanical Metallurgy)
  Students learn the rigorous definition of mechanical properties of metals (e.g. yield strength, tensile strength, fatigue strength, fracture toughness) and how these properties are controlled by the processing and structure of metals.
- MET 440L (Mechanical Metallurgy Laboratory)
  Students conduct advanced mechanical property tests to measure tensile, fatigue and fracture properties. Emphasis is placed on understanding relevant testing standards.

Design

- MET 351 (Engineering Design I)
- MET 352 (Engineering Design I)
- MET 464 (Engineering Design I)
- MET 465 (Engineering Design I)
  Students are enrolled in the design sequence during their junior and senior years. They spend considerable time selecting materials or their design projects. Students typically select materials for their projects using a trade table in which material properties are a major consideration. This is true whether the project is a physical metallurgy project or an extractive processing project. Both have unique material selection requirements.

Electives

- MET 430 (Weld Eng & Design, Structures)
  Students study in detail the effect of different welding techniques on the physical and mechanical properties of metals. Emphasis is placed on consideration of weld design with respect to change in mechanical properties.
- MET 443 (Composite Materials)†
  This course prepares students in the basics of materials, design, and selection of materials for critical applications such as defense, crash protection and aerospace.
- MET 445 (Oxidation and Corrosion)
  Students learn about the corrosion properties and relative galvanic response of metal alloys. Students also perform corrosion testing to measure the corrosion properties of metals in different media.
- MET 491 (Security Printing Technology)
  The students learn how to relate fundamental concepts of interfacial chemistry to understand ink manufacture for specific printing applications, and to combine inks, printing and substrates to make security end products for a variety of overt, covert, and forensic applications

† Replaced after 2010 by the 2 credit hour Advances in Processing and Nanoengineering of Polymers (MES 475) and the one credit hour Composites Manufacturing MET 489)

Processing

The fundamental principles and application to engineering problems of metallurgical processing is taught in the following required courses.

Required

- MET 220 (Mineral Processing)
  Students learn the fundamentals of minerals processing including comminution; separations by gravity, electrostatic, magnetic, flotation, size fractionation and heavy media; dewatering processing including thickeners and filtration; and environmental considerations.
- MET 220L (Mineral Processing)
  The student applies the fundamentals learned in MET 220 to conduct mineral concentration by gravity, electrostatic, magnetic, and flotation. This laboratory culminates in an experiential learning project where students apply these processing techniques to a real world industrial mineral separation.
- MET 310 (Aqueous Extraction, Concentration, and Recycling)
  The students learn the fundamentals of liberation analysis and to understand and solve complex problems related to the concentration, solution purification, and recovery of metals from minerals in aqueous solution.
- MET 310L (Aqueous Extraction, Concentration, and Recycling)
  The student will able to design a set of leaching process experiments, to understand important parameters affecting the leaching of metals, and to understand the principles of solvent extraction, cementation, ion exchange and solution precipitation.

- MET 321 (High Temperature Extractive, Concentration, and Recycling)
  Students learn the operating characteristics and methods for analyzing extractive metallurgical unit operations including oxidations, reduction, and refining processes ranging from carbothermic to electrochemical processes. They perform heat and mass balances on metal production processes.
- MET 330 (Physics of Metals)
  Students learn the fundamental effects of heat on recovery, recrystallization and grain growth in metals. They also study the effect of solidification rates on the substructure of metals along with the effect of heating and cooling rates on phase transformations.
- MET 332 (Thermomechanical Processing)
  Students learn fundamental heat treatment methods and mechanical processes used in the production of many metal alloys. These include annealing, quenching, and precipitation treatments. Students also learn the fundamentals of surface hardening through carburization and other treatments.
- MET 422 (Transport Phenomena)
  Students learn the fundamentals of heat and mass transfer and how they influence heat treating processes and control the composition of metals during surface modification processes.
- MET 440 (Mechanical Metallurgy)
  Students learn how the theory of elasticity and theory of plasticity are used in mechanical processing of metals.

<u>Electives</u>

- MET 426 (Steelmaking)
  This course covers the unit operations in integrated steel mills, mini-mills, and direct reduction processes. The structure of these unit operations provides the basis for the thermochemical and thermomechanical process analysis.
- MET 430 (Weld Eng & Design, Structures)
  Students learn about the difference in heat input and energy density for many welding techniques. Students also learn the fundamental strategies of choosing a particular joining process for an application.
- MET 450 (Forensic Engineering)
  The students learn the influence of materials processing (e.g. heat treatment, casting, forging) on failure of metals and how to use this information to conduct failure analysis.

Performance

Understanding the application of microstructure, properties and processing to the performance of a material in an engineering design is a critical component in the undergraduate curriculum and is inherent in the courses listed above.

<u>Required</u>

- MET 231(Structure and Properties of Materials Laboratory)
  Students gain laboratory experience in performance properties including hardness, tensile strength, toughness, brittle-ductile transition temperature, and ductility.

- MET 310 (Aqueous Extraction, Concentration, and Recycling Laboratory)
  Students study the performance of unit operations including concentration, leaching, and recovery from solution.
- MET 310L (Aqueous Extraction, Concentration, and Recycling)
  The students apply statistical design and analysis of experiments to optimize a process.
- MET 332 (Thermomechanical Processing)
  Students learn the strategy behind alloy development for steels and non-ferrous alloys. Students also focus on the selection of alloys and heat treatments for long term performance.
- MET 422 (Transport Phenomena)
  Students learn how to compute the performance of a system undergoing thermal and mass diffusion processes. This is useful to determine heat and mass transfer controlled process rates, heating (and quenching) rates used for chemical processing or heat treatment, and for determining the affected depth of surface treatments.
- MET 433 (Process Control)
  Students model the dynamic behavior of physical processes and automatic control systems using algebraic and differential equations; using block diagrams and transfer functions to represent the Laplace transforms of those equations; tune feedback controllers and automatic controllers to illustrate control techniques and response modes
- MET 440 (Mechanical Metallurgy)
  The students learn how to calculate yield and failure stresses. Students also study mechanisms, criteria, and prediction for long-term fatigue and creep performance. Students are also introduced to methodologies of failure analysis of metallic components.
- MET 440L (Mechanical Metallurgy Laboratory)
  Students perform mechanical testing related to materials lifetime under different loading conditions.

<u>Design</u>

- MET 351 (Engineering Design I)
- MET 352 (Engineering Design I)
- MET 464 (Engineering Design I)
- MET 465 (Engineering Design I)
  All student projects are focused on a result; consequently, the performance of the materials selected for their projects become paramount as the project nears completion and evaluation.

<u>Electives</u>

- MET 445 (Oxidation and Corrosion)
  Students study the effects of corrosion and oxidation of metals in different aqueous and high temperature environments. Students also learn about passivation and corrosion control techniques used to enhance metal performance.

Applying and Integrating these four fundamental concepts are reinforced by student capstone design projects; applied homework assignments that specifically concentrate on using the principles of microstructure, properties, and/or processing to solve engineering problems specifically applied to metallurgical engineering; and in the required directed met electives courses.

Experimental, statistical, and computational methods are used widely in the metallurgical engineering program in a way consistent with the program educational objectives.

Experimental Experience
The BS metallurgical engineering program requires students complete a robust suite of experimental laboratories that prepare them well for a career in metallurgical engineering. Table 9-2 lists the laboratory courses required in the degree program. The laboratory experience includes the basics of chemistry, materials science, and the specialized and practical aspects needed for entering career in metallurgical engineering.

Computation Experience
Students learn computation methods in MATH 373 (Applied Numerical Analysis). The current computational platform employed in the course is MatLab. MatLab has been the standard for the last three years. Before that MathCad was used extensively. Microsoft Excel is also used extensively. All of this software is available to all students via the laptop computer program. Metallurgical engineering students also use digital resources such as the Metal Handbook now available on-line via the Deveraux Library and perform thermodynamic computations using ThermoCalc® or STABCAL® computational software. This software is used in MET 320

Table 9-2 Program laboratory courses (1 credit hour each)

CHEM 112L	General Chemistry I
CHEM 114L	General Chemistry II
MET 220L	Mineral Processing and Resource Recovery
MET 231	Structure & Properties of Materials
MET 310L	Aqueous Extraction, Concentration, and Recycle
MET 321	High Temperature Extraction, Concentration, and Recycle*
MET 330L	Physics of Metals
MET 440L	Mechanical Metallurgy **

*Computational laboratory is 50 percent /High temperature experimental laboratory is 50 percent
**Contains a segment that includes in-class workshops on statistical instruction

(Metallurgical Thermodynamics) to perform equilibrium calculations in reacting systems and produce tables of thermodynamic data, MET 310L (Aqueous Extraction, Concentration, and Recycle) to create eH-pH diagrams, and MET 321 (High Temp Extraction, Concentration, and Recycle) to compute equilibrium diagrams. Phase diagram are constructed via thermodynamic computations in MET 330 (Physics of Metals). Computational methods used in MET 310 are primarily focused around using Excel and its computational abilities. Specific methods used involved using the add-in Solver to determine equilibrium metal ion concentration values of multi-mineral pulps by solving multiple solubility product equations and using Goal Seek to solve cubic and higher order equations to determine metal ions concentrations from the solubility product and activity coefficient. Essentially all metallurgical engineering courses rely heavily on Microsoft Excel® as a computational platform.

In the coming year a new two-credit course in computation is planned as part of the required curriculum. The credits will be made available by dropping the one-credit of required physical education and another to-be-determined one-credit hour reduction in the curriculum. The content of the new course will replace computational content previously offered by Dr. Howard on programming with VBA's throughout the curriculum (e.g. MET 320, MET 321, MET 422 and MATH 373). The new course also will include instruction on programmable instruments.

Statistical Analysis Experience
Aspects of statistics and statistical data analysis are covered in several courses within the program curriculum. These begin with MET 231 (Properties of Materials Laboratory), usually the first laboratory course MET program students take. Upper division courses with significant statistics and statistical data analysis content are MET 310L (Aqueous Extraction, Purification and Recycling Laboratory) and MET 440L (Mechanical Metallurgy Laboratory). Generally, these are designed so that the experiences in MET 310L (Mineral Processing and Resource Recovery) and MET 440L (Mechanical Metallurgy Laboratory) build upon and extend the materials covered during MET 231 (Properties of Materials Laboratory). At the end of this series, the students are expected to be able to calculate basic statistical measures, such as mean and standard deviation, perform hypothesis testing and determine confidence intervals, and design experiments, including randomization, repeatability and reproducibility, to determine if data sets from experimental procedures are from the same population.

The first laboratory assignment in MET 231 (Properties of Materials Laboratory) involves an introduction to basic statistics calculations, including mean, standard deviation, variance and significance. In addition, later laboratory reports require least squares data fits and the determination and use of means and standard deviation data to properly interpret data. In the MET 310L (Aqueous Extraction, Purification and Recycling Laboratory) course, the background from MET 231 ((Properties of Materials Laboratory) is expanded through inclusion of design and analysis of experiments concepts. This includes factorial design, analysis of variance (ANOVA) and procedures for linking experimentation with analysis. All student group performed laboratories involving designing a set of experiments to test a hypothesis and analyzing the experimental results through proper procedures such as ANOVA or Yates method. In the MET 440L (Mechanical Metallurgy Laboratory) course, the background from MET 231 (Properties of Materials Laboratory) is used and expanded on through three laboratory assignments on the Hardness Reproducibility and Repeatability, Fatigue Analysis, and Statistical Process Control. In addition to using means, standard deviations and confidence intervals, the students learn and use non-parametric statistics and learn six sigma procedures for process control.

Specific topics can be reviewed in the course syllabi contained in Appendix A and in the examples of course examinations and design problems on display during the accreditation visit.

B. Faculty expertise

The metallurgical engineering program faculty all hold PhD degrees in metallurgical engineering or a closely related field of study from recognized accredited USA or UK universities. They maintain active membership in professional mineral, metal, and materials societies ranging including, TMS, SME ASM, AIST, ACeRS, and NACE and publish the results of their research regularly in recognized metallurgical/materials engineering journals, and serve in leadership positions in the professional community. The program faculty members have a combined instructional experience surpassing 100 years and engage in continuous feedback and improvement and continuing personal education opportunities. Faculty hold professional engineering licensure and several are working to gain status as licensed professional engineers. The program faculty members are a cohesive group who interact very well and who put their students' interests first. The faculty members know the undergraduate and graduate students by their first name and value maintaining a close working relationship with the students because it enhances the students' likelihood of success.

Appendix A – Course Syllabi

MET Required Courses

- MET 220
- MET 220L
- MET 231
- MET 232
- MET 310
- MET 310L
- MET 320
- MET 321/L
- MET 330
- MET 330L
- MET 332
- MET 351
- MET 352
- MET 422
- MET 433
- MET 440
- MET 440L
- MET 464
- MET 465

MET Electives

- MET 110
- MET 426
- MET 430/L
- MET 432‡
- MET 443†
- MET 445
- MET 450
- MES 475
- MET 489
- MET 491*

Other Required Engineering

- EE 301/L
- EM 214
- ME 216
- EM 321
- IENG 301

Support Courses

- CHEM 112
- CHEM 112L
- CHEM 114
- CHEM 114L
- ENGL 101
- ENGL 279
- ENGL 289
- MATH 123
- MATH 125
- MATH 225
- MATH 321
- MATH 373
- PHYS 211
- PHYS 213

† After 2010 MET 443 was replaced by the 2-credit hour Advances in Processing and Nanoengineering of Polymers (MES 475) and the 1-credit hour Composites Manufacturing (MET 489)

* Beginning in 2015-16, MET 491 was renumbered as Security Printing Technology (MET 444/544)

‡ New course Spring 2016

MET 220 – MINERAL PROCESSING AND RESOURCE RECOVERY: (3-0)/3

INSTRUCTOR

Dr. J. J. Kellar, MI 112, Ph. (605) 394-2343, jon.kellar@sdsmt.edu

TEXTBOOK

Mineral Processing and Resource Recovery (online text), Ken Han and Jon Kellar, 2008

COURSE INFORMATION

Catalog Description: An introductory course in mineral processing highlighting unit operations involving comminution, sizing, froth flotation, gravity separation, electrostatic separation, magnetic separation and flocculation. Other topics discussed include remediation of contaminant effluents and the unit operations associated with recycling of post-consumer materials using mineral processing techniques.
Prerequisites: MATH 123, CHEM 112
Co-requisites: none
Required Course: B.S. Metallurgical Engineering ("C" or better), B.S. Mining Engineering
Selected Elective: none

COURSE GOALS

Specific Outcomes

- Given system mass flows, grades and recoveries the student will be able to complete a system mass balance.
- The student will be able to calculate a material's specific surface area given particle size and density information.
- Given sieve data the student will be able to construct a Gaudin-Schumann plot and determine size and distribution moduli.
- Given particle size and density the student will be able to determine whether the particle settles according to Stokesian conditions, and the particle settling velocity regardless of particle diameter (Han approach)
- For a given particle type the student will be able to determine the optimal surface treatment and solution conditions to cause desired particle wettability.
- Given particle size and density the student will be able to utilize gravity-based methods to cause particle separation and concentration.
- The student will be able to predict particle separation based upon the magnetic and electrostatic properties for a given particle mixture.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (c), (e), (k)

TOPICS

Abundance of the elements, and resources (1 class); Mass balances, grade, recovery (3 classes); Particle characterization, particle diameter, specific surface area, density, particle sizing (4 classes); Comminution: crushing, grinding, general crushing and grinding flowsheets, Bond Theory, critical speed, Gaudin-Schuhmann Distribution, Tyler sieve series, circulating load (4 classes); Movement of solids in fluids, Stokesian settling, Newtonian settling, free and hindered settling (5 classes); Classification devices, mechanical classifiers, elutriators, hydrocyclones (4 classes); Froth flotation, contact angle, flowsheets, surface charge, electrical double layer, hydrophobicity/hydrophilicity, adsorption-physisorption, chemisorption, frothers, oxide, sulfide, coal flotation de-inking of paper (5 classes); Gravity concentration concentration criterion sluice-particle stratification jig-consolidation trickling cones, spirals, shaking table (5 classes); Heavy media separation (2 classes); partition coefficient, Tromp curve; Magnetic separation (2 classes); magnetic susceptibility, MSW separation and recovery-USBM process , Electrostatic separation (2 classes); automobile recycling Thickening (2 classes); flocculants Shultz-Hardy Rule

PREPARED BY

J.J. Kellar, March 12, 2016

MET 220L – MINERAL PROCESSING AND RESOURCE RECOVERY LABORATORY: (0-1)/1

INSTRUCTOR Dr. J. J. Kellar, MI 112, Ph. (605) 394-2343, jon.kellar@sdsmt.edu

TEXTBOOK Mineral Processing and Resource Recovery (online text), Ken Han and Jon Kellar, 2008

COURSE INFORMATION

CATALOG DESCRIPTION: An introductory laboratory course in mineral processing highlighting relevant unit operations.
Prerequisite: none
Pre- or **Co-requisites:** MET 220
Required Elective: B.S. Metallurgical Engineering
Selected Elective: none

COURSE GOALS

The objective of this course is to provide students with the working knowledge of a variety of mineral processing equipment, formulas and concepts. Students will be able to better understand the chemical and physical processes on particle liberation, separation and concentration. Upon completion of the course the students will be able to apply this knowledge in design and in subsequent upper-level courses.

Specific Outcomes

- The student will be able to perform a simple mass balance, and calculate grade and recovery for basic mineral processing unit operations.
- The student will be able to comminute mineral samples and generate sieve data for a Gaudin-Schuhmann size distribution plot. From the Gaudin-Schuhmann diagram the student will be able to determine the size and distribution modulus for the system.
- The student will be able to correctly sample ore samples of various sizes and composition.
- The student will be able to determine particle shape and show how shape effects surface area and mineral processing unit operations.
- The student will be able to compare particle size measurements from a variety of measurement techniques and statistically examine this comparison.
- The student will understand the trade-offs associated with maximizing grade and recovery while minimizing costs.
- The student will be able to perform bench-scale flotation tests and understand the connection between comminution, adsorption, hydrophobic character and flotation response.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (d), (g), (k)

TOPICS

- History of mineral processing and metallurgy
- Mass balances
- Comminution
- Sampling

- Particle characterization
- Movement of solids in fluids
- Froth flotation
- Gravity concentration
- Magnetic separation
- Basic statistics

PREPARED BY

J.J. Kellar, March 12, 2016

MET 231 - STUCTURE AND PROPERTIES OF MATERIALS LABORATORY: (0-1)/1

INSTRUCTOR
Dr. Michael West, MI 108, (605) 394-1283, Michael.West@sdsmt.edu

TEXT BOOK
No textbook required.

COURSE INFORMATION
Catalog Description: A laboratory involving quantitative metallography, heat treating practice, mechanical property measurements and metallurgical design of the thermal mechanical treatment of metals
Prerequisite: none
Pre- or Co-requisite: MET 232
Required Elective: B.S. Metallurgical Engineering, B.S. Mechanical Engineering
Selected Elective: none

COURSE GOALS
The objective of this laboratory program is to relate the properties of engineering materials to the materials microstructure developed during thermal and mechanical processing. Students will become familiar with mechanical testing and metallurgical evaluation of materials according to ASTM standards. Students will gain an understanding of the variability of material properties. Finally, students will also practice writing technical reports that detail experimental findings. The laboratory exercises in MET 231 are timed to follow or coincide with lecture content in MET 232.

Specific Outcomes

- Students will be able to use ASTM standard index and look up appropriate standards for materials testing.
- Given a metallographic specimen, students will be able to measure grain size using ASTM methods.
- Students will be able to conduct a Rockwell hardness test on a metal sample using appropriate scales.
- Students will understand the effects of carburizing and decarburizing on the microhardness of steel.
- Students will be able to take tensile test data and generate an appropriate stress-strain curve.
- Students will be able to interpret important mechanical properties from a stress strain curve for a metal.
- Students will be able to conduct a Charpy impact test and use the data to determine the ductile to brittle transition temperature for a metal.
- Given a metallographic specimen of steel, students will be able to estimate the carbon content.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (d), (g), (k)

TOPICS

- Statistics
- ASTM Standards
- Hardness Testing
- Microhardness Testing
- Charpy Impact Testing
- Tensile Testing
- Strain Gages
- Optical Metallography
- Scanning Electron Microscopy
- Thermomechanical (Jominy) Testing
- Laboratory report writing

PREPARED BY

Michael West, March 27, 2016

MET 232 - PROPERTIES OF MATERIALS: (3-0)/3

INSTRUCTOR

Dr. Michael. West, MI 108, Ph. (605) 394-1283, michael.west@sdsmt.edu

TEXTBOOK: Materials Science and Engineering: An Introduction, 8th Ed, W. D. Callister, Jr., and D. G. Rethwisch, 2010

COURSE INFORMATION

CATALOG DESCRIPTION: A course in engineering materials and their applications. The different technological uses of metals, ceramics, plastics, and composite materials are discussed and explained in terms of their basic atomic structure, and mechanical, thermal, optical, electrical, and magnetic properties. Material selection in engineering design is emphasized.

Prerequisites: MATH 123 and CHEM 112

Co-requisites: none

Required Elective: B.S. Metallurgical Engineering, B.S. Mechanical Engineering

Selected Elective: B.S. Chemical Engineering

COURSE GOALS

Specific Outcomes

- Given electronegativity data the student will understand the basics of atomic bonding and the resulting structure of crystalline solids.
- Given a specific type of defect the student will know and be able to identify the role the imperfection imparts in the development of mechanical and physical properties of materials.
- Given systems time, temperature data students will be able to perform using mass transport in solids as it pertains to design of alloys and the carburization of steels.
- Given basic input data such as stress and strain students will be able to determine the mechanical properties of materials, and apply these material properties in the design system components.
- Given an image of a fractured specimen the student will be able to identify ductile, brittle, fatigue and high strain rate fractures.
- Given binary phase information the student will be able to predict equilibrium and non-equilibrium structures.
- Given hardenability data for steel and a specified heat treatment schedule, the student will be able to predict if the material meets minimum strength requirements.

STUDENT OUTCOMES ADDRESSED: Major: (a), (b), (c), (e), (g), (h), (i), (j) (k)

TOPICS

- Metal Structures
- Imperfections in Solids
- Solid State Diffusion
- Mechanical Behavior of Metals
- Strengthening Mechanisms
- Phase diagrams
- Kinetics of Phase Transformations
- Iron Carbon Alloys
- Properties/Microstructure
- Nonferrous metals Alloys
- Properties/Microstructure

PREPARED BY
Michael West, March 27, 2016

MET 310 – AQUEOUS EXTRACTION, CONCENTRATION AND RECYCLING: (3-0)/3

INSTRUCTOR
Dr. William M. Cross, MI 110, (605) 394-2485, William.Cross@sdsmt.edu

TEXT BOOK
Fundamentals of Aqueous Metallurgy, K. N. Han, SME, p. 212, 2002

COURSE INFORMATION
Catalog Description: Scientific and engineering principles involved in the winning of metals from ores and scrap. Areas covered include the unit operations of comminution, sizing, solid/liquid separations, leaching, ion exchange, solvent extraction, and surface phenomena as related to flocculation, froth floatation, and electrostatic separation.

Prerequisites: MET 320 or CBE 321, or CHEM 342
Co-requisites: none
Required Course: B.S. Metallurgical Engineering
Selected Elective: B.S. Chemical Engineering

COURSE GOALS
Specific Outcomes

- The student will be able to understand the meaning of surface tension and apply this concept to various practical processes.
- The student will be able to understand how solids obtain the surface charges and understand the significance of the surface potential, potential determining ion, Stern potential and zeta-potential in relation to practical applications.
- The student will be able to estimate the adsorption density from the adsorption isotherm and comprehend the role of the surface charge and other adsorption driving forces on the adsorption density and be able to apply in practices.
- The student will be able to distinguish the major differences between sulfide and oxide froth flotation.
- The student will be able to correctly balance half-cell reactions.
- The student will be able to calculate the equilibrium activities of products for hydrometallurgical systems.
- The student will be able to make and utilize Pourbaix diagrams to understand equilibrium leaching and environmental phenomena.
- The student will be able to formulate and suggest tests to confirm the rate expression for given concentrations of reactants and products as a function of time.
- The student will able to understand and apply the effect of temperature on the rate of reaction.
- The student will be able to understand the solvent extraction/ion exchange mechanisms and the selectivity relationship between the elements to be separated.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (e), (f), (g), (h), (i), (j), (k)

TOPICS
- Mineral Particle Size, Shape and Size Distributions
- Liberation of Valuable Mineral, Liberation Models, Measuring Liberation

- Hydrometallurgy; Activity Coefficients, Solubility Calculations, Metal Complexation, Effect of Temp and Pressure on Equilibrium, Pourbaix Diagrams, Leachants, Leaching Techniques
- Leaching Kinetics: Kinetic Expression, Data Analysis, Temperature Effect on Leaching Kinetics.
- Removal of Metal Ions from Leach Liquor: Solvent Extraction, Electrowinning, Ion Exchange
- Interfacial Phenomena: Surface Tension, Wetting Phenomena, Spreading, Theoretical Aspects of Adsorption, Gibbs Adsorption Equation.
- Origin of Charges, Electrical Double Layer, Gouy Model, Stern and Grahame Approach, Electrokinetics: Zeta and Streaming Potentials, Electrokinetics, Flotation of Oxides and Sulfides.

PREPARED BY
William M. Cross, February 24, 2016

MET 310L - AQUEOUS EXTRACTION, CONCENTRATION AND RECYCLING LABORATORY (0-1)/1

INSTRUCTOR

Dr. M.S. Safarzadeh, MI 103, ph. (605) 394-1284, sadegh.safarzadeh@sdsmt.edu

TEXTBOOK

Hydrometallurgy: Fundamentals and Applications, 1st Ed., Michael Free

COURSE INFORMATION

Catalog Description: Laboratory experiments in design of processing equipment and cost estimation, zeta potential, surface tension, leaching kinetics, electrowinning, and solvent extraction.
Prerequisite: none
Pre- or Co-requisite: MET 310
Required Course: B.S. Metallurgical Engineering
Selected Elective: B.S. Chemical Engineering

COURSE GOALS

Specific Outcomes

- The student will be able to apply statistical design and analysis of experiments to optimize a process.
- The student will able to design a set of leaching process experiments which can be analyzed statistically to optimize the process response surface.
- The student will be able to measure surface tension of liquids contact angle of water with and without surfactants to identify a set of experimental parameters to optimize grade, recovery or their combination for a flotation system.
- The student will be able to calculate the Gibbs free energy of adsorption of metal ions on solid surface and examine the effect of charge of solids on the adsorption density of these ions.
- The student will be able to understand important parameters affecting the leaching of metals and calculate the activation energy.
- The student will be able to understand the principles of solvent extraction, cementation, ion exchange and solution precipitation.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (c), (d), (g), (k)

TOPICS

Experimental Design, Process Design, Leach Kinetics, Leaching Equilibrium, Recovery of Metal Ions from Solution, Adsorption and Precipitation of Metal Ions, Contact Angle Measurements, Surface Tension Measurements, Cementation, STABCAL solution chemistry software, Atomic Absorption Spectroscopy, Electrowinning, Solvent Extraction

PREPARED BY

M.S. Safarzadeh, March 23, 2016

MET 320 - METALLURGICAL THERMODYNAMICS: (4-0)/4

INSTRUCTOR
Dr. M.S. Safarzadeh, MI 103, ph. (605) 394-1284, sadegh.safarzadeh@sdsmt.edu

TEXTBOOK
Introduction to the Thermodynamics of Materials, 5th Ed., David Gaskell

COURSE INFORMATION
Catalog Description: The principles of chemical thermodynamics and their application to metallurgical engineering processes. Topics covered include the zeroth, first and second laws of thermodynamics, the fundamental equations of state for open and closed systems, criterion of equilibrium, heat capacities, reaction equilibrium constants and their dependence upon temperature and pressure, chemical potential, standard and reference states, stability diagrams, and solution thermodynamics.
Prerequisites: PHYS 211, CHEM 112, MATH 125
Co-requisites: none
Required Course: B.S. Metallurgical Engineering, B.S. Geological Engineering
Selected Elective: none

COURSE GOALS
Specific Outcomes
- Given the initial state (i.e. two of the following: T, P, V), the final state (i.e. one of the following: T, P, V), and the path followed (isothermal, isochoric, isobaric, adiabatic, reversible, free expansion) by an ideal gas, the student will be able to calculate ΔU, ΔH, ΔS, q, and w.
- The student will be able to calculate ΔS_{total} when a body of given mass, heat capacity, and initial temperature equilibrates with a heat sink of specified temperature.
- The student will be able to calculate ΔS^{Mixing} when two or more pure components at the same temperature, pressure, and state form an ideal solution.
- Given a chemical reaction where the temperatures and amounts of reactants, the final temperature and amounts of the products, and corresponding enthalpies of formation at 298 K and the heat capacities are specified, the student will determine the heat added to or removed from the system.
- The student will be able to integrate the Clausius and the Clausius-Claperyon Equations and given all but one of the variables in the equation solve for the remaining variable using the equation. The student must recognize that melting or boiling point information constitutes a (T, P) set.
- The student will be able to calculate ΔG for a condensed-phase reaction at constant temperature as a function of pressure given the molecular weights and densities of the reactants and products and the ΔG at a specified pressure.
- The student will be able to determine the equilibrium constant for a reaction from $\Delta G°$ of formation data for the reaction and to correctly describe the standard state for each component involved in the reaction.

- The student will calculate the equilibrium state (partial pressures, moles) for a reaction involving known initial amounts of gases and pure condensed phases occurring at a given temperature and pressure. The student will be provided either the $\Delta G°$ or K_{Equil} for the reaction.
- The student will determine activities and activity coefficients for component i from the integral molar Gibbs energy of mixing and from the partial molar Gibb's energy of mixing for component i.
- The student will derive the Fundamental equations for an open system, the Maxwell Relations, the "Other" Thermodynamic relationships, the criterion of equilibrium for systems at constant temperature and pressure.
- The student will calculate the cell potential for electrolytic cells involving dissolved components in non-aqueous systems.
- The student will determine using the Ellingham Diagram relative oxide stabilities, equilibrium oxygen pressures, equilibrium H_2/H_2O and CO/CO_2 ratios for any reaction on the Ellingham Diagram.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (c), (e), (k)

TOPICS

First Law of Thermodynamics (9 classes), Forms of Energy, Heat and Work, Joules Experiments, Conservation of Energy, Concept of Maximum Work, Isothermal Expansion, Reversible, Adiabatic Expansion, Constant Pressure Processes, Constant Volume Processes, Enthalpy, Second Law of Thermodynamics (9 classes), 2nd Law Statement, Carnot Cycle, 4 Propositions, Statistical Entropy (2 classes), Physical Meaning of Entropy, Boltzman Equation, Mixing Entropy, Stirling's Approximation, Auxiliary Functions (3 classes), Fundamental Equations of State, Maxwell Relationships, Other Thermodynamic Relations, Chemical Potential, Gibbs-Helmholtz Equation, Criteria of Equilibria, Heat Capacity and Entropy Changes (5 classes), Sensible Heats, Transformation Heats, Reaction Heats, Adiabatic Flame Temperatures, Heat Balances, JANAF Thermochemical Tables, Phase Equilibria in One Component Systems (6 classes), Clausius-Claperyon Equation, Heats of Vaporization From Vapor Pressure Data, Shift in Transformation Temperature with Pressure, The Behavior of Gases (3 classes), Compressibility Factor, Law of Corresponding States, Equations of State, Fugacity, Reactions Equilibria (13 classes), Equilibria in Gaseous Systems, The Equilibrium Constant, Reaction Extent Problems, Equilibria in Systems Containing Condensed Phases, Ellingham Diagram, Activities, Solution Thermodynamics (9 classes), Absolute and Partial and Integral Molar Quantities, Relative and Partial Integral Molar Quantities, Ideal Solutions, Excess Quantities, Gibb's Duhem Equation, Tangent Intercept Method, a=f(T), Change in Reference State, 1 wt % Reference State Interaction Parameters, Phase Equilibria and Electrochemistry (as time permits), Tests (5 classes)

PREPARED BY

M.S. Safarzadeh, March 23, 2016

MET 321 - HIGH TEMPERATURE EXTRACTION, CONCENTRATION, AND RECYCLING (3-1)/4

INSTRUCTOR: Dr. M.S. Safarzadeh, MI 103, ph. (605) 394-1284, sadegh.safarzadeh@sdsmt.edu

TEXTBOOK: Principles of Extractive Metallurgy, 2nd Ed., Terkel Rosenqvist

COURSE INFORMATION

CATALOG DESCRIPTION: Thermodynamic principles involved in the winning of metals. Areas covered include calcination, oxidation, reduction processes, smelting, high - temperature refining, electrorefining, slags, and slag-metal interactions.
Prerequisites: MET 320
Corequsistes: none
Required: B.S. Metallurgical Engineering
Selected Elective: none

COURSE GOALS

Specific Outcomes

- Given sufficient but minimal mass flow information on an open process, the student shall calculate all unstated mass flows.
- Given sufficient but minimal heat and mass flow information on an open process, the student shall calculate all unstated heat and mass flows.
- Given isothermal activity data as a function of composition for a standard state, the student will be able to calculate ΔG° for a new standard state and the corresponding variation of activity coefficients in the new standard with respect to the new composition variable.
- Given liquidus temperature and composition data for a phase diagram in which a pure component A is in equilibrium with the liquid, the student will be able to derive the equation for finding the activity of the liquid component A in the solution relative to the pure, liquid A.
- Given the Fe-O-C phase diagram in which percent O_2 vs T is plotted, the student will be provided the underlying equations and cite the required data for calculating any equilibrium line on the diagram.
- The student will be able to calculate the cell potential for required for the reduction of any metal by molten salt electrolysis given ΔG^0 of formation for the salt. This includes combined reactions and reduction from molten salt solutions such as encountered in the Hall Cell.
- The student will be able to describe the fundamental problem of producing Zn from ZnO by carbothermic reduction and recommend at least two methods of effecting the recovery of metallic Zn.
- The student will sketch the silica slag network, show the effect of basic component additions on the network, and describe the effect such additions have on slag viscosity and conductivity. The student must be able to cite at least five basic slag components.
- Given a ternary phase diagram and the rules of interpretation, the student will determine the temperature and order of solidification from the liquid state at any specified bulk

composition and will describe all phases present and their relative amounts at any given temperature.

- Given activity coefficient data for a component in a metal phase, the corresponding data for the component in the oxidized state in a slag in equilibrium with the metal, the standard Gibbs energy for the oxidation, and the chemical potential of the oxidation agent, the student will determine the slag-metal distribution ratio of the component.
- Given an Ellingham diagram, the student will provide the order of oxidation in a specified matte smelting process.
- The student will describe in detail all of the steps to performing a gold assay and the purpose of each step.
- The student will describe the differences in process in a mini steel mill and an integrated steel mill.
- The student will be able to determine the rate of free evaporation of liquid metals alloy components in vacuum using the Langmuir equation. The student will be given the solution composition, activity coefficient data for each component, their molecular weights, and the temperature.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (c), (k)

TOPICS

Cost, conservation, and concentration of mineral resources (2 classes), Sampling, Process Outline, Library & Internet Resources, Thermo Review (I class), Phase Rule, Ternary Phase Diagrams (4 classes), Roasting (10 classes), Stability Diagrams (M-O-S, M-X-Y), Roaster Diagrams, STABCAL software for the construction of stability diagrams (1 class), Zn Roasting, Sintering and Calcination (1 class), Solution Thermodynamics (7 classes), Temperature Dependence of Activity, Alternative Standard States, Activities From the Phase Diagram, Gibbs-Duhem Integration using the Alpha Function, Derivation and Application of the Gibb's Phase Rule, Processes by elemental group, Oxidation - reduction reactions (8 classes), Smelting and converting reactions (6 classes), Refining processes (3 classes), Refractories and slags (2 classes), Fused salt electrolysis (4 classes), Tests (3 or 4 classes)

PREPARED BY

M.S. Safarzadeh, March 23, 2016

MET 330 - PHYSICS OF METALS: (3-0)/3

INSTRUCTOR
Dr. G.A. Crawford, MI 104, (605) 394-5133, grant.crawford@sdsmt.edu

TEXTBOOK
Physical Metallurgy Principles, 4th Edition, Reed-Hill & Abbaschian, 2009

COURSE INFORMATION
Catalog Description: The fundamental principles of physical metallurgy with an emphasis on the mathematical description of mechanisms that control the structure of materials. Topics covered are the structure of metals, x-ray diffraction, elemental theory of metals, dislocation theory, slip phenomena, grain boundaries, vacancies, annealing, and solid solutions.
Prerequisites: MET 232 with a grade of "C" or better
Co-requisites: none
Required Course: B.S. Metallurgical Engineering
Selected Elective: none

COURSE GOALS
Specific Outcomes
- Given unit cell and crystal structure information, students will be able to determine volumetric, planar and linear density within a crystal lattice.
- Given atomic and structure information for metals, students will be able to predict the degree of solubility of solid solutions.
- Given an x-ray powder diffraction intensity scan, students will be able to determine the crystal structure and lattice parameter for a metal.
- Students will be able to calculate the resolved shear stress to cause slip in a metal.
- Students will understand atomic bonding in materials and how bonding influences physical properties and elastic constants.
- Students will understand how to use a stereographic projection, pole figures, and inverse pole figures for crystallographic analysis and texture analysis of metals.
- Students will understand the fundamentals of dislocation structure, movement, and generation in metal crystal systems and the importance of dislocations in plastic deformation and strengthening of metals.
- Students will understand basic metal characterization methods including electron microscopy, optical microscopy, and bulk and surface chemical analysis methods.
- Given activation energy for vacancy formation, students will be able to calculate the equilibrium number of vacancies for a metal at high temperature.
- Given diffusivity data for solid state diffusion, students will be able to estimate the concentration profile of a diffusing species in a metal using Fick's 2nd law.
- Given a distribution coefficient based on the phase diagram, students will be able to estimate the concentration gradient in a directionally solidified ingot.
- Students will understand the nature of the energy barrier associated with homogeneous nucleation. Given degree of subcooling, students will be able to estimate the critical nucleus size for a metal.

- Students will be able to describe the effects of grain size reduction, alloying and dislocation density on strength and recrystallization temperature.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (e), (k)

TOPICS

- Crystal Structure
- Structure Determination
- Characterization of metals
- Grain Boundaries
- Dislocations
- Vacancies
- Diffusion
- Solidification
- Nucleation and Growth
- Solid Solutions
- Phase Diagrams
- Recovery and Recrystallization
- Phase Transformations
- Precipitation
- Twinning/Martensitic Transformations

PREPARED BY

G.A. Crawford, April 12, 2016

MET 330L PHYSICS OF METALS: (0-1)/1

INSTRUCTOR

Dr. G.A. Crawford, MI 104, (605) 394-5133, grant.crawford@sdsmt.edu

TEXTBOOK

Physical Metallurgy Principles, 4th Edition, Reed-Hill & Abbaschian, 2009

COURSE INFORMATION

Catalog Description: Practical laboratory exercises that involve (1) x-ray diffraction methods, (2) transmission electron microscopy as it applies to dislocations in materials, (3) recovery, recrystallization and grain growth as it applies to annealing of materials, (4) optional and scanning electron microscopy as it applies to the microstructure of materials, and (5) thermomechanical processing of metals with limited regions of solid solubility.
Prerequisites: MET 231
Pre- or Co-requisites: MET 330
Required Course: B.S. Metallurgical Engineering
Selected Elective: none

COURSE GOALS

Specific Outcomes

- Students will continue development of technical writing skills through the preparation of engineering reports.
- Students will be able to perform metallographic sample preparation, optical metallography, and microhardness testing.
- Students will develop experimental skills in heat treating of steels, aluminum alloys, and copper alloys.
- Given a tensile testing specimen, students will be able to perform uniaxial tensile testing.
- Students will be able to use phase diagrams, hardenability data, TTT curves, IT curves and other information to develop specific microstructures in steels.
- Students will be able to identify microstructures in various steels alloys, cast irons, aluminum alloys, and copper alloys.
- Students will understand the iron-carbon system, aluminum alloy systems, and copper alloy systems.
- The student will get an understanding of x-ray diffraction laboratory techniques and obtain experience determining the crystal structure, lattice parameter and composition of an unknown pure sample using x-ray diffraction. Students will also perform quantitative phase analysis of known and unknown materials.
- The students will obtain an understanding of point and line defects in crystalline solids and will understand the motion of edge dislocations through construction of a “bubble raft” model.
- Students will gain an understanding of heat treatment steels including austenizing, quenching, and tempering. Students will understand the impact of alloy composition on heat treatment and resulting microstructure and mechanical behavior of the material.
- Students will learn the effect of dislocation pinning by interstitial atmospheres on stress-strain curve in low carbon steels.

- The students will gain a mechanistic understanding of recovery, recrystallization and grain growth. Students will gain hands-on experience with rolling mill operation.
- Students will understand precipitation hardening of metal alloys. Given a phase diagram, students can discuss the possibility of precipitate formation by a three step (1) solution heat treatment, (2) quench and (3) aging process. Students will develop a practical and mechanistic understanding of the relationship between precipitate growth and mechanical behavior in precipitate strengthened alloys.
- Students will gain a practical and theoretical understanding of diffusion of carbon in steel. Students will gain an understanding of the relationship between carbon concentration and microstructure and hardness of steel. Given a steel specimen students will be able to perform carburizing and decarburizing operations, analyze the thickness of the carburized/decarburized layer and compare results to analytic calculations using Fick's 2nd law.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (d), (e), (g), (k)

TOPICS

- Laboratory experiments supporting MET 330 lecture content.
    - Metallography principles
    - Fundamentals of x-ray diffraction
    - Dislocation motion via the "bubble raft" model
    - Sharp yield point and dislocation atmospheres
    - Diffusion in steel
- Laboratory experiments supporting MET 332 lecture content.
    - Tempered martensite in steel and steel alloys
    - Recovery, recrystallization and grain growth in copper alloys
    - Precipitation hardening of aluminum alloys
    - Metallurgy of cast irons

PREPARED BY

G.A. Crawford, April 12, 2016

MET 332 THERMOMECHANICAL PROCESSING: (3-0)/3

INSTRUCTOR
Dr. Michael West, MI 108, (605) 394-1283, Michael.West@sdsmt.edu

TEXT BOOK
Steels: Processing, Structure, and Performance, George Krauss, ASM International, 2005.

COURSE INFORMATION
Catalog Description: The relationship between the structure and properties of materials. Topics covered are the iron-carbon system, hardenability of iron base alloys, stainless steels, cast irons, aluminum, copper and magnesium, rubber and copper polymers. Concepts of heat treatment, age hardening, dispersion hardening, and hot and cold working correlated with modification of the structure and physical properties of materials.
Prerequisites: MET 232 with a grade of "C" or better
Pre or Corequisites: MET 330 and MET 320 or ME 211
Required Course: B.S. Metallurgical Engineering
Selected Elective: none

COURSE GOALS
The objective of this course is to develop a professional understanding of the relationship between microstructure and mechanical and physical properties of metals and alloys. Students that successfully complete the course requirements will understand and be able to predict the structure of metals based on alloy composition, heat treatment, and mechanical processing. Students will also understand selection of alloys based on the resulting mechanical properties.

Specific Outcomes
- Given any binary phase diagram with any invariant reaction, the student can discuss the initial and final microstructure through drawings and words formed during solidification and/or solid-state invariant reactions. In addition students can compute the fraction of phases present at any specified temperature and alloy composition.
- Students will understand the relationship between processing, microstructures, properties and performance of carbon steels, alloy steels, cast irons, aluminum alloys copper alloys, stainless steels, tool steels, titanium alloys, and nickel alloys.
- Students will understand the steel making process, ingot and continuous solidification processes, microstructures, heat treatments, mechanical processing, national and international alloy designations, and surface hardening processes.
- Students will understand basic technical terminology to specific alloy groups such as annealing, stress relief, normalizing, tempering, martempering, austempering, quenching, solution annealing, precipitation hardening, over aging, sensitization, work hardening, cold rolling, carburizing, nitriding, etc.
- Students will understand diffusion topics such as homogenization and carburization. Several solutions to Fick's second law are developed in class and used to solve engineering problems.

- Students will understand alloy steels and the effects of alloy composition on performance. In addition, students will understand how to use TTT curves, IT curves, hardenability data to design specific alloy thermo-mechanical processes.
- Students will understand the aluminum alloy designation system, aluminum refining processes, casting methods, work hardening operations, solution and aging treatments, and the effect of alloying on specific properties and processing.
- Students will know the stainless steel designation systems, types of stainless steels, thermo-mechanical processing methods, corrosion resistance issues, limitations, and processing cautions.
- Students will understand the above topics for cast irons, tool steels, copper alloys, titanium alloys and nickel based alloys.
- Students will be able to design and select alloys for specific engineering applications.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (c), (e), (k)

TOPICS

- Phase diagrams
- Ferrous Alloys – Steels, Cast Irons, Stainless Steels
- Non-ferrous Alloys – Aluminum, Copper, Nickel
- Development of superalloys
- Heat treatment
- Precipitation hardening
- Surface treatments
- Metalworking fundamentals
- Alloy selection

PREPARED BY

Michael West, March 27, 2016

MET 351 METALLURGICAL ENGINEERING DESIGN I: (2-0)/2

INSTRUCTOR Dr. G.A. Crawford, MI 104, (605) 394-5133, grant.crawford@sdsmt.edu

TEXTBOOK

Optional: Engineering Design, a Materials and Processing Approach, George E. Dieter, McGraw-Hill Company, Third Edition, 2000.

COURSE INFORMATION

Catalog Description: Introduction to engineering design. Compare the scientific method with the engineering design method. Define the concept of need as it pertains to the design process. Develop skills associated with the use of modern and classic sources of information. In addition, material selection processes, interaction of materials, and materials processing topics are presented. Focus on the design process, and the design method. The development of interdisciplinary teams is a high priority.

Pre- or Co-requisites: MET 320

Co-requisites: none

Required Course: B.S. Metallurgical Engineering

Selected Elective: none

COURSE GOALS

Specific Outcomes

The objectives of this course are to provide hands on practical experience on metallurgical engineering design. Students develop their projects by working teams under the direction and supervision of one or more faculty mentors. During the semester students will demonstrate the ability to:

- Define the problem and establish the project requirements and constraints.
- Gather information and establish the state of the art on the design science and technology.
- Conceptualize various concept solutions to the design problem.
- Use decision matrices for the selection of the candidate solution.
- Establish the candidate design and the tasks needed to achieve this design.
- Establish a project schedule.
- Work effectively in a team environment.
- Write progress and final design reports.
- Make effective oral presentations.
- Integrate knowledge, vertically and horizontally, and apply analytical tools from a variety of metallurgical engineering courses.
- Manage the project effectively by using a project schedule and other management tools.
- Develop and implement appropriate and detailed manufacturing plans.
- Write progress and final design reports, incorporating ethical, environmental and societal issues pertinent to the specific design project.
- Test and evaluate prototype performance.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (c), (d), (e), (f), (g), (h), (k)

TOPICS

- Interdisciplinary junior capstone design projects.
- Design process
- Project management
- Effective teamwork
- Engineering statistics and the design process
- Trade studies and decision matrices
- Global, societal and environmental context
- Intellectual property and ethical considerations

PREPARED BY

G.A. Crawford, April 14, 2016

MET 352 METALLURGICAL ENGINEERING DESIGN II: (1-0)/1

INSTRUCTOR Dr. G.A. Crawford, MI 104, (605) 394-5133, grant.crawford@sdsmt.edu

TEXTBOOK

Optional: Engineering Design, a Materials and Processing Approach, George E. Dieter, McGraw-Hill Company, Third Edition, 2000.

COURSE INFORMATION

Catalog Description: A continuation of the design sequence.
Prerequisites: MET 351
Co-requisites: none
Required Course: B.S. Metallurgical Engineering
Selected Elective: none

COURSE GOALS

Specific Outcomes

The objectives of this course are to provide hands on practical experience on metallurgical engineering design. Students develop their projects by working teams under the direction and supervision of one or more faculty mentors. During the semester students will demonstrate the ability to:

- Define the problem and establish the project requirements and constraints.
- Gather information and establish the state of the art on the design science and technology.
- Conceptualize various concept solutions to the design problem.
- Use decision matrices for the selection of the candidate solution.
- Establish the candidate design and the tasks needed to achieve this design.
- Establish a project schedule.
- Work effectively in a team environment.
- Write progress and final design reports.
- Make effective oral presentations.
- Integrate knowledge, vertically and horizontally, and apply analytical tools from a variety of metallurgical engineering courses.
- Manage the project effectively by using a project schedule and other management tools.
- Develop and implement appropriate and detailed manufacturing plans.
- Write progress and final design reports, incorporating ethical, environmental and societal issues pertinent to the specific design project.
- Test and evaluate prototype performance.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (c), (d), (e), (f), (g), (h), (k)

TOPICS

- Interdisciplinary junior capstone design projects.

PREPARED BY

G.A. Crawford, April 14, 2016

MET 422 - TRANSPORT PHENOMENA: (4-0)/4

INSTRUCTOR

Dr. M.S. Safarzadeh, MI 103, ph. (605) 394-1284, sadegh.safarzadeh@sdsmt.edu

TEXTBOOK

Transport Phenomena in Metallurgy, G. H. Geiger and D. R. Poirier

COURSE INFORMATION

Catalog Description: The principles of momentum, heat and mass transfer and their application to metallurgical engineering. Topics covered include thermal conductivity, mass diffusion, mechanisms of transport, Fourier's and Fick's Laws, shell balance, boundary conditions, equations of change, unsteady-state transport, mass and heat distributions in turbulent flow, and interphase transport.
Prerequisites: MATH 321
Pre or Co-requisites: MET 320
Required Course: B.S. Metallurgical Engineering
Selected Elective: none

COURSE GOALS

Specific Outcomes

- Students are expected to write Newton's Law, Fourier's Law, and Fick's Law and describe the analogies among them.
- Students will perform shell balances for momentum, heat, and mass transfer and obtain the differential equation describing the velocity, temperature, and concentration gradient.
- Students are expected to understand the difference between Newtonian and non-Newtonian flows.
- Students will be able to reduce the Equations of Continuity and Change for rectangular, cylindrical and spherical coordinates to the terms applicable for a specified condition.
- Students will be able to derive from linear, steady-state flow distributions in laminar flow volumetric and average flow equations.
- Students provided a set of independent variables upon which a dependent variable depends will reduce the set to a dimensionless set using Buckingham Pi Theory.
- Students will be able to design packed and fluidized beds for given system for uniform particles given their density, shape, and size and the fluid's rheological properties.
- Students must determine the modes of heat transfer (conduction, convection, and radiation) and describe the governing equations for each mode.
- Students are expected to calculate the heat transfer rate for convective heat transfer given heat transfer correlation and its pertinent parameters.
- Students will determine heat loss from radiative systems using Kirchhoff Loop electric analog solution method.
- Students will solve 1D USS and 2D SS heat transfer and mass transfer problems using spreadsheets.
- Students will determine the concentration dependency of diffusivity.
- Students will be able to derive differential equations describing diffusion through a stagnant gas film, a moving gas stream, and a falling liquid film.

- Students will describe the mathematical similarities between turbulent convective heat transfer and turbulent diffusion including the correspondence between dimensionless groups.

  STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (c), (e), (k)

TOPICS

Introduction to momentum, energy and mass transfer analogies between Newton's, Fourier's, and Fick's Laws (1), Theoretical and semi-empirical equations for viscosity of gases, liquids, and molten slags (3), Newtonian and non-Newtonian fluids (1), Laminar flow and momentum balances: flow of a falling film; flow through a circular tube (3), Equations of continuity: rectangular volume, arbitrary shape using vectors (3), Substantial time derivative; total and partial time derivatives (2), General equations of momentum transfer: Naiver-Stokes, Euler equations (2), Applications of the general equation of motion: flow through a long vertical cylindrical duct, Couette-Hatschek viscometer, creeping flow around a sphere; flow near the leading edge of a flat plate, Dimensional analysis: Re, Fr numbers (1), Turbulent flow: time-smoothed quantities Interphase transport: friction factor (2), Flow through packed and fluidized beds (4), Theoretical and semi-empirical equations for thermal conductivity of fluid and solids (1), Heat conduction flat plates, cylinders through composite walls with generation (4), Heat transfer with forced and natural convection (4), Transient systems (4), Solidification heat transfer (2), Dimensional analysis: Nu, Gr numbers (1), Molar and mass flux Theoretical and semi empirical equations for diffusivity of gases, liquids and ionic species (3), Diffusion in solids of gas through thin film, concentration dependent diffusivity transient diffusion (3), Mass transfer in fluid systems diffusion through a stagnant gas film, diffusion in a moving gas stream, diffusion into a falling liquid film, forced convection (4), Dimensional analysis: Sh, Sc numbers (1)

PREPARED BY

M.S. Safarzadeh, March 16, 2016

CBE 433/MET 433 - Process Control (3-0)/3

INSTRUCTOR: Dr. Timothy M Brenza (Chemical Engineering), MI 210 (temporary), ph. (605) 394-1766, Timothy.Brenza@sdsmt.edu

TEXTBOOK

Principles and Practice of Automatic Process Control, by C. A. Smith and A. B. Corripio, 3rd ed., John Wiley & Sons, New York, (2006).

COURSE INFORMATION

Catalog Description: (3-0) 3 credits. Analysis and design of process control systems for industrial processes, including controller tuning and design of multivariable control schemes. This course is cross-listed with MET 433.
Prerequisites: MATH 321 and senior standing
Co-requisites: none
Required Course: B.S. Metallurgical Engineering, B.S. Chemical Engineering
Selected Elective: none

COURSE GOALS

Specific Outcomes

After completion of this course the average student is expected to be able to:

- Model the dynamic behavior of physical processes and automatic control systems using algebraic and differential equations, and by using block diagrams and transfer functions representing the Laplace transforms of those equations.
- Tune feedback controllers to produce a desired mode of response.
- Identify and sketch graphs illustrating overdamped, critically damped, underdamped, undamped and unstable systems, and predict which response will occur based on the transfer functions describing a system.
- Model complex process behavior using empirical first-order-plus-dead-time models, and tune automatic controllers based on those process models.
- Illustrate control techniques and response modes using simulation software.
- Explain advanced control techniques of feed-forward and cascade control using block diagrams, process and instrumentation diagrams, and time-domain graphs.
- Explain and use basic concepts of statistical process control, including statistics of central tendency and variability, and control charts.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (k)

TOPICS

- Feedback control
- Control algorithms
- P & IDs
- Laplace transforms
- 1st order processes
- 2nd order processes
- Block diagrams/transfer functions
- P, PI, PID control

- Tuning controllers
- Dead-time
- Tuning formulas
- Advanced control (feedforward, cascade)
- Statistical process control

Class Schedule: Varies
Contribution to Criterion 5:
Engineering Science: 3 credits or 100%
Engineering Design: 0 credits of 0%

PREPARED BY

Timothy Brenza, May 2, 2016. (Formatted to MET specifications by S. M. Howard May 22, 2016)

MET 440/540 MECHANICAL METALLURGY: (3-0)/3

INSTRUCTOR
Dr. G.A. Crawford, MI 104, (605) 394-5133, grant.crawford@sdsmt.edu

TEXTBOOK
Mechanical Metallurgy, Dieter, G. E., 3rd Ed., McGraw-Hill, Boston, 1986.

COURSE INFORMATION
Catalog Description: A course concerned with responses of metals to loads. Areas covered include elastic and plastic deformation under different force systems, dislocation theory, fracture, internal friction, fatigue, creep, residual stresses, and general fundamentals of metal working.
Prerequisites: MET 232 with a grade of "C" or better
Pre- or Co-requisite: ME 216 or EM 321
Required Course: B.S. Metallurgical Engineering
Selected Elective: B.S. Mechanical Engineering

COURSE GOALS
Specific Outcomes

- The objectives of this course are to provide hands on practical experience on metallurgical Graphical and analytical determination of state of stress in mechanical components. Vector and tensor representation in different system of axis. Calculation of elastic stresses from elastic strains and elastic stress/strain relationships.
- Stress distribution and stress concentration in mechanical components.
- Strength theories for design in brittle and ductile materials. Yield surfaces and yield envelops.
- Given the original dimensions of a mechanical component and the original tridimensional state of stress, calculate the final dimensions and the final state of stress in the mechanical component.
- Calculation in engineering materials of the: (a) theoretical cohesive tensile strength, (b) cohesive tensile strength from the stress concentration point of view, establishment of the fracture stress by the Griffith's equations and (d) establishment of the fracture stress by the Griffith-Orowan equations.
- Measurement of the fracture toughness of engineering materials: Plane strain, COD, CTOD, J integral and R curves. Calculation of plasticity corrections.
- Calculation of dimensions, failure stresses and failure envelopes in mechanical components using linear elastic fracture mechanics and fracture theories for design.
- Criteria for the fatigue design of mechanical components including fatigue crack initiation and fatigue crack propagation. Calculation of the dimensions and fatigue life of mechanical components under specific fatigue parameters.
- Establishment of creep mechanisms and plotting of creep data for engineering design. Working knowledge of creep deformations maps.
- Calculation of constants in creep equations, creep stresses and life time, in the creep design of engineering components.
- Introduction to the methodologies for evaluating failure analysis of metallic components.

- Calculation of stress intensity factors, strain energy release rates, fracture toughness, plane strain toughness, testing methods, and toughness of materials.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (e), (k), (i)

TOPICS

- Introduction to Mechanical Metallurgy and Mechanical Behavior in 1D stress state
- Theory of Elasticity and Mechanical Behavior
- Theory of Plasticity and Mechanical Behavior
- Fracture Theory
- Fracture Mechanics
- Fatigue
- Creep
- Metalworking Techniques

PREPARED BY

G.A. Crawford, April 22, 2016

MET 440L/540L – MECHANICAL METALLURGY LAB: (0-1)/1

INSTRUCTOR Dr. B.K. Jasthi, MI 101, Ph. (605) 394-2342, bharat.jasthi@sdsmt.edu

TEXTBOOK Mechanical Metallurgy, Dieter, G.E, 1996

COURSE INFORMATION

Catalog Description: A course that provides practical experience in the mechanical behavior of metals focusing on mechanical testing, mechanical processing, and failure analysis.
Prerequisites: MET 231
Pre- or Corequisites: MET 440/540
Required Course: B.S. Metallurgical Engineering
Selected Elective: none

COURSE GOALS

Specific Outcomes

- The objectives of this course are to provide hands on practical experience on metallurgical Students will be able to conduct a Rockwell hardness test on a metal sample using appropriate scales.
- Students will be able to perform a tensile test and generate an appropriate stress-strain curve.
- Students will be able to interpret important mechanical properties from a stress strain curve for a metal.
- Students will be able measure fracture toughness of engineering materials.
- Students will be able to perform Nano indentation of materials and will be able to interpret the mechanical properties.
- Students will develop their fundamental understanding of fatigue failures of metallic materials.
- Students will be able to perform basic statistical analysis and apply statistical process control in a typical industrial setting.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (b), (d), (k)

TOPICS

- Statistical Analysis and Gage Repeatability and Reproducibility
- Hardness Testing
- Nano Indentation
- Tensile Testing
- Fatigue Testing
- Statistical process Control
- Fracture Toughness Testing

PREPARED BY

B.K. Jasthi

MET 464 METALLURGICAL ENGINEERING DESIGN III: (0-2)/2

INSTRUCTOR
Dr. G.A. Crawford, MI 104, (605) 394-5133, grant.crawford@sdsmt.edu

TEXTBOOK
Optional: Engineering Design, a Materials and Processing Approach, George E. Dieter, McGraw-Hill Company, Third Edition, 2000.

COURSE INFORMATION
Catalog Description: A continuation of the design sequence
Prerequisites: MET 352
Co-requisites: none
Required Course: B.S. Metallurgical Engineering
Selected Elective: none

COURSE GOALS
Specific Outcomes

The objectives of this course are to provide hands on practical experience on metallurgical engineering design. Students develop their projects by working teams under the direction and supervision of one or more faculty mentors. During the semester students will demonstrate the ability to:

- Define the problem and establish the project requirements and constraints.
- Gather information and establish the state of the art on the design science and technology.
- Conceptualize various concept solutions to the design problem.
- Use decision matrices for the selection of the candidate solution.
- Establish the candidate design and the tasks needed to achieve this design.
- Establish a project schedule.
- Work effectively in a team environment.
- Write progress and final design reports.
- Make effective oral presentations.
- Integrate knowledge, vertically and horizontally, and apply analytical tools from a variety of metallurgical engineering courses.
- Manage the project effectively by using a project schedule and other management tools.
- Develop and implement appropriate and detailed manufacturing plans.
- Write progress and final design reports, incorporating ethical, environmental and societal issues pertinent to the specific design project.
- Test and evaluate prototype performance.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (c), (d), (e), (f), (g), (h), (k)

TOPICS
- Interdisciplinary senior capstone design projects.
- Design process
- Project management

- Effective teamwork
- Engineering statistics and the design process
- Trade studies and decision matrices
- Global, societal and environmental context
- Intellectual property and ethical considerations

PREPARED BY

G.A. Crawford, April 24, 2016

MET 465 METALLURGICAL ENGINEERING DESIGN IV: (0-1)/1.

INSTRUCTOR
Dr. G.A. Crawford, MI 104, (605) 394-5133, grant.crawford@sdsmt.edu

TEXTBOOK
Optional: Engineering Design, a Materials and Processing Approach, George E. Dieter, McGraw-Hill Company, Third Edition, 2000.

COURSE INFORMATION
Catalog Description: A continuation of the design sequence, which includes a final technical design report and appropriate display material for the School of Mines Design Fair.
Prerequisites: MET 464
Co-requisites: none
Required Course: B.S. Metallurgical Engineering
Selected Elective: none

COURSE GOALS
Specific Outcomes
The objectives of this course are to provide hands on practical experience on metallurgical engineering design. Students develop their projects by working teams under the direction and supervision of one or more faculty mentors. During the semester students will demonstrate the ability to:

- Define the problem and establish the project requirements and constraints.
- Gather information and establish the state of the art on the design science and technology.
- Conceptualize various concept solutions to the design problem.
- Use decision matrices for the selection of the candidate solution.
- Establish the candidate design and the tasks needed to achieve this design.
- Establish a project schedule.
- Work effectively in a team environment.
- Write progress and final design reports.
- Make effective oral presentations.
- Integrate knowledge, vertically and horizontally, and apply analytical tools from a variety of metallurgical engineering courses.
- Manage the project effectively by using a project schedule and other management tools.
- Develop and implement appropriate and detailed manufacturing plans.
- Write progress and final design reports, incorporating ethical, environmental and societal issues pertinent to the specific design project.
- Test and evaluate prototype performance.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (c), (d), (e), (f), (g), (h), (k)

TOPICS
- Interdisciplinary senior capstone design projects.

PREPARED BY

G.A. Crawford, April 23, 2016

MET 110 INTRODUCTION TO METALLURGICAL ENGINEERING: (1-0)/1

INSTRUCTOR
Dr. Michael West, MI 108, (605) 394-1283, Michael.West@sdsmt.edu

TEXT BOOK
No textbook required.

COURSE INFORMATION
Catalog Description: An introductory course for incoming freshmen in metallurgical engineering covering the history of, career opportunities in, and engineering practices of metallurgical engineering. This course will include group projects and presentations, problem solving, engineering ethics, technical reports and field trips.
Prerequisites: none
Co-requisites: none
Required Course: none
Selected Elective: B.S. Metallurgical Engineering

COURSE GOALS
The objectives of this course are to provide hands on practical initial experience in Metallurgical Engineering Design. Students develop their projects by working in interdisciplinary teams under the direction and supervision of one or more Faculty mentors. During the development of the course the students will demonstrate acquire skills to

- Gather information
- Conceptualize various solutions
- Evaluation of design concepts and select a candidate design
- Work in a team environment
- Communicate effectively by written reports and oral presentations

Specific Outcomes

- Understand metallurgical engineering curriculum
- Discuss potential career paths in metallurgical engineering
- Develop a working vocabulary of metallurgical engineering concepts
- Work effectively in a team environment
- Produce written reports
- Make effective oral presentations

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (c), (d), (e), (f), (g), (h), (j), (k)

TOPICS

Orientation for Metallurgical Engineering, Field Trips, Research Projects on Topics in Metallurgical Engineering, Presentation and Discussion of the Design Program, Literature Search, Brainstorming, Design of Experiments

PREPARED BY

Michael West, March 27, 2016

MET 426/526 - STEELMAKING: (3-0)/3

INSTRUCTOR

Dr. B.K. Jasthi, MI 101, Ph. (605) 394-2342, bharat.jasthi@sdsmt.edu

TEXTBOOK

The Making, Shaping and Treating of Steel, Vol. 2: Steelmaking and Refining Volume 11th Edition, Iron & Steel Institute, Richard J. Fruehan, 1998

COURSE INFORMATION

Catalog Description: Chemical reactions and heat and mass transport phenomena associated with the production of steel. Unit operations studied include the blast furnace, the basic oxygen furnace, the electric arc furnace, and selected direct reduction processes.
Prerequisites: MET 320 or graduate standing
Co-requisites: none
Required Course: None
Selected Elective: B.S. Metallurgical Engineering

COURSE GOALS

Specific Outcomes

- Students will be able to understand chemical reactions involved in various iron and steel making processes.
- Students will be familiar with blast furnace iron making and would be able to perform burden calculations.
- Students will be able to predict whether a carbothermic reduction of a particular metal oxide is feasible or not, at a specific temperature using an Ellingham diagram.
- Given the hot metal and raw material compositions, the students will be able to calculate the weight of ore used and weight of slag made in an iron making blast furnace.
- Given the Ellingham diagram of oxides, the students will be able to predict the sequence of oxidation reactions of various elements in a basic oxygen furnace.
- Students will be familiar with secondary steel making processes along with the physiochemical fundamentals of steel making process.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (e)

TOPICS

- History of Iron making; Principles of Iron making – Reduction, Smelting, Direct Reduction, and Raw materials for Iron making.
- Preparation of Iron ores; Coke Making, Agglomeration of Iron ore fines, Sintering and Pelletizing principles.
- General Physiochemical Fundamentals
- Blast Furnace iron making, general construction features, refractory lining, physical chemistry of Blast Furnace reactions and modern developments.
- Classification of steel making process, and Physical Chemistry of Primary Steel Making: Decarburization, desiliconization. Dephosphorization and desulphurization.
- Secondary Steel Making, Ladle Metallurgy and vacuum treatment of steels.

- Ingot and Continuous Casting.
- Specialty Steels; Stainless Steels and manufacturing of alloy steels (Electro Slag Refining, Vacuum Arc Remelting, Vacuum Induction Melting)

PREPARED BY

B.K. Jasthi, April 12, 2016

MET 430/430L – WELDING METALLURGY AND ENGINEERING: (2-1)/3

INSTRUCTOR
Dr. B.K. Jasthi, MI 101, Ph. (605) 394-2342,bharat.jasthi@sdsmt.edu

TEXTBOOK
The Procedure Handbook of Arc Welding, 14th ed., James F. Lincoln Arc Welding Foundation, 1994

COURSE INFORMATION
Catalog Description: Introduces the state-of-art in welding processes and technology. Discusses fundamentals of the fabrication welded structures by introducing basics of solidification in welds, metallurgy of welds, fatigue and fracture in welds, joint design and weld defects and inspection. Laboratory exercises will focus on advanced welding processes, characterization, and materials testing methods.
Prerequisites: MET 232
Corequisites: MET 430L
Required Course: None
Selected Elective: B.S. Metallurgical Engineering, B.S. Mechanical Engineering

COURSE GOALS
Specific Outcomes
- Given a fusion welding process for aluminum alloys, students will be able to select an alloy to avoid hot cracking in welds.
- Given geometry and type of steel alloy, students will be able to determine welding parameters to avoid cold cracking.
- Given the thermal history for a fusion weld or solid state weld, students will be able to predict the microstructure in weld and heat-affected zones in steel and aluminum alloys.
- Students will understand the nature of segregation in fusion welds.
- Students will be able to appropriately size butt and fillet welds for required loading on a welded structure.
- Students will be able to choose an appropriate non-destructive evaluation method to detect defects in a welded structure.
- Students will be able to locate appropriate standards which govern welding processes.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (k)

TOPICS
- Overview and classification of welding processes
- Fusion and non-fusion welding
- Flow of heat in welds
- Solidification theory basics
- Nature of residual stresses, shrinkage and distortion
- Review of metallurgy of steel, aluminum
- Review of microstructure development as a function of temperature
- Microstructure of the heat affected zone
- Nature of welding discontinuities/defects

- Weldability issues
- Welded joint design
- Introduction to fracture and fatigue in welded joints
- Corrosion in welds
- Inspection of welds

Lab Topics
In the laboratory section, students are instructed in proper welding safety. The laboratory section is designed to introduce students to welding processes through a number of hands-on activities. Written reports are required. Laboratory topics include:

- Gas Welding/Cutting
- GMA Welding
- GTA Welding
- Laser Welding
- Ultrasonic Welding
- Friction Stir Welding

PREPARED BY

B.K. Jasthi, April 13, 2016

MET 432/532 – ADVANCED MATERIALS AND PROCESSES: (3-0)/3

INSTRUCTOR

Dr. B.K. Jasthi, MI 101, Ph. (605) 394-2342, bharat.jasthi@sdsmt.edu

TEXTBOOK

There is no single text book that covers all the topics for this course. However, the following books are listed as reference materials.

- Superalloys-II "Principles and Prevention of Corrosion", C.T. Sims, N.S. Stoloff, and W.C. Hagel, 1987
- Superalloys – A technical Guide (2nd Edition) 2002-
- The superalloys: Fundamentals and Applications - Roger C. Reed (2006) .
- Superalloys - Alloying and Performance, Geddes, Blaine; Leon, Hugo; Huang, Xiao (2010).
- Manufacturing Engineering & Technology, Serope Kalpakjian, Steven Schmid, 7th Edition, 2013.

COURSE INFORMATION

Catalog Description: The physical metallurgy, structure, advanced processing methods, and applications of various advanced metallic materials will be covered in this course. Topics will include laser processing, advanced forging, powder metallurgy and other emerging techniques for materials such as superalloys, metal matrix composites, nanocrystalline materials, advanced steels, titanium alloys, shape memory alloys, amorphous materials and mechanical alloyed materials.
Prerequisites: MET 232 or graduate standing
Co-requisites: none
Required Course: None
Selected Elective: B.S. Metallurgical Engineering, B.S. Mechanical Engineering

COURSE GOALS

Specific Outcomes

- Given a specific high temperature application, students will be able to select a material that can survive a particular temperature and environment.
- Students will be able to perform Thermo-Calc simulations and calculate the thermal stability of various phases in superalloys.
- Students will be able to comprehend the microstructure and mechanical properties relationship for various advanced materials.
- Students will be able to choose an appropriate post weld heat treatment to achieve specific mechanical properties for materials.
- Given a powder material and particle size, students will be able to perform sintering time and temperature calculations needed for densification.
- Students will be able to select a specific surface engineering technique and coating that can give the optimum combination of microstructure and tribological properties.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (c), (e)

TOPICS

- Introduction to superalloys, guide to selection of superalloys for high temperature applications
- Physical metallurgy of superalloys; Structure properties relationship; and Heat treatment
- Forming and fabrication of superalloys (melting, casting, refining and joining)
- Friction stir processing, and Additive Manufacturing
- Powder metallurgy of high temperature materials (ODS materials, CIP & HIP processes).
- Surface Engineering (Laser, PVD, PEO, Cold Spray and Thermal Spray Processes)
- Amorphous Materials (Physical and mechanical properties, Formation and joining)
- Nanocrystalline materials, Shape Memory Alloys
- Physical metallurgy of Titanium and its alloys
- Review of High Entropy Alloys
- Review of Metal Matrix Composites

PREPARED BY

B.K. Jasthi, April 17, 2016

MET 443 COMPOSITE MATERIALS: (3-0)/3

INSTRUCTORS:

Dr. Jon J. Kellar, Office Hours: 2-3 pm M, Tu, W, Th
Dr. Lidvin Kjerengtroen, Office Hours, 2-3 pm M, Tu, W, Th

TEXTBOOK:

Engineering Mechanics of Composite Materials, 2nd Edition, Daniel and Ishai, Oxford 2006

COURSE INFORMATION

Catalog Description: The course will cover heterogeneous material systems; basic design concepts and preparation; types of composite materials; advances in filaments, fibers and matrices; physical and mechanical properties; failure modes; thermal and dynamic effects; and applications to construction, transportation and communication. This course is cross-listed with ME 443.
Prerequisites: ME 316 or concurrent enrollment in MET 440
Corequisites: none
Required Course: None
Selected Elective: B.S. Metallurgical Engineering, B.S. Mechanical Engineering

COURSE GOALS

Students will be able to determine the effects of mechanics and materials chemistry on composite performance

Specific Outcomes

- Given a particular matrix/reinforcement combination students will be able to identify a manufacturing process to produce a desired composite part.
- Given one of the major fibrous reinforcements the students will be able to describe the design, manufacturing and properties of advanced fibers.
- For a given matrix/reinforcement systems students will be able to determine the role of interfaces and interface phases and their properties in the design, manufacture and properties of PMCs, MMCs and CMCs.
- For a given matrix/reinforcement system student will be able to predict the microstructural properties (stiffness, strength, fracture toughness and fatigue).
- For a given composite system the student will be able to describe the fundamental properties/parameters such as anisotropic, orthotropic, and non-homogenous material behavior.
- For a given composite system the student will be able to carry out two dimensional transformations of stress, strain, and directional elastic parameters.
- For a given set of constituent properties the student will be able to estimate laminate material properties including laminate properties and strength estimates using common failure criteria**.**
- Given a laminate system the student will have basic understanding of the assumptions of laminate behavior and the significance of laminate stacking order.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (c)

TOPICS

- Fibers
- Fibers and Whiskers and Nanocomposites
- Reinforcement/Matrix Interface
- Interfaces-Wettability
- Interfaces-Bonding
- The Interphase Methods for Measuring Bond Strength
- Polymer Matrices
- Polymer Matrix Composite Processing
- Polymer Matrix Composite Interfaces/Interphases
- Structure, Properties and Applications of PMCs
- Elastic behavior of composite lamina-Micromechanics
    - Basic concepts including RVE
    - Stiffness
    - Thermal and moisture expansion
    - Lamina Strength
- Ply Mechanics
    - Coordinate systems
    - Stress, strain, and constitutive relationships
    - Off-axis Stiffness and properties
- Macro Mechanics
    - Basic assumptions of laminates
    - Computation of stress
    - Common laminate types: symmetric, balanced, and quasi-isotropic, and specially orthotropic
    - Carpet plots
- Failure and Strength
    - Tsai-Hill
    - Tsai-Wu
    - Maximum Strain Criterion

PERSON BY

Jon Kellar and Lidvin Kjerengtroen, May 6, 2010

MET/CBE 445/545 - OXIDATION AND CORROSION OF METALS: (3-0)/3

INSTRUCTOR

Dr. B.K. Jasthi, MI 101, Ph. (605) 394-2342, bharat.jasthi@sdsmt.edu

TEXTBOOK

Principles and Prevention of Corrosion, Denny Jones, Second Edition, Prentice Hall, 1996

COURSE INFORMATION

Catalog Description: Initially the thermodynamics of electrochemical processes are covered; use of the Nernst Equation and Pourbaix diagram is presented in this material. Fundamentals of electrode kinetics are then discussed with special emphasis on the derivation of the Butler-Volmer equation and application of the Evan's diagram. Following presentation of these fundamental concepts, phenomena observed in corrosion and oxidation such as uniform attack, pitting, stress corrosion cracking, and corrosion fatigue are discussed. Finally, selection of materials for site specific applications is covered.

Prerequisites: MET 320 or CHE 222 or ME 311 or graduate standing
Co-requisites: none
Required Course: None
Selected Elective: B.S. Metallurgical Engineering, B.S. Chemical Engineering, B.S. Mechanical Engineering

COURSE GOALS

Specific Outcomes

- Students will be able to understand what oxidation, reduction, anodic and cathodic reactions are in relation to corrosion of metals and alloys.
- Students will be able to obtain the EMF values from the free energy information and vice versa.
- Students will be able to understand the effect of ionic activity on EMF and obtain the activity coefficient for ionic species if concentration is given.
- Students will be able to understand origin of galvanic corrosion and its practical implication.
- Students will be able to understand what passivation is and how this property is used in practice to prevent or minimize corrosion of various metals and alloys.
- Students will be familiar with how complexing agents affect the corrosion behavior.
- Students will be able to understand how to construct and use the Pourbaix diagram for simple systems and how it is used in relation to metal corrosion.
- Students will be able to apply the role of various ingredients in alloy systems in corrosion prevention.
- Students will be able to apply various corrosion mechanisms and their preventive measures to practical systems.
- Students will be familiar with basic corrosion testing procedures for typical systems.
- Students will be familiar with various materials used in corrosion related areas and to know how to select right materials for various corrosive media.
- Students will be able to select various metals, alloys and other materials used in corrosion applications.

- Students will be able to understand the major differences between wet and dry corrosion situations and know important variables affecting dry corrosion.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (e), (k)

TOPICS

- Introduction
- Electrochemical aspects of corrosion cell potentials; Electromotive force; Ionic activity; Steps involved in corrosion; Cell polarization
- Stability of ions, metals and alloys; Pourbaix Eh-pH diagrams;
- Stability of ions in solutions
- Different forms of corrosion; Galvanic, Erosion, Crevice, Pitting, Selective leaching, Intergranular corrosion, Stress corrosion
- Corrosion testing; Classification, Purposes; Surface preparation; Duration
- Material selection; Metals, Alloys; Thermoplastics; Coatings
- Effect of mineral acids; Sulfuric acid, Nitric acid; Hydrochloric acid
- High temperature corrosion; Mechanisms and kinetics
- High temperature materials

PREPARED BY

B.K. Jasthi, April 14, 2016

MET 450/550 - FORENSIC ENGINEERING: (3-0)/3

INSTRUCTOR
Dr. G.A. Crawford, MI 104, (605) 394-5133, grant.crawford@sdsmt.edu

TEXTBOOK
Analysis of Engineering Materials, Brooks, C.R. and Chaudhury, A., *Failure,* McGraw-Hill, New York, 2002.

COURSE INFORMATION
Catalog Description: The principles of physical metallurgy, mechanical metallurgy, manufacturing processes, and service environments will be used to determine the cause(s) for failure of metallic, composite, and polymer engineering components. Analytical techniques and procedures to characterize fractographic features and microstructures will also be reviewed, such as optical metallography, macrophotography, and scanning electron microscopy. Actual failed engineering components from a variety of industrial applications will be used as examples and be evaluated in the course. Fundamental engineering concepts, legal procedures of forensic engineering, failure mechanisms, technical report writing, and remedial recommendations will also be discussed.
Prerequisites: MET 231, MET 232, and ME 216 or EM 321, or permission of instructor
Co-requisite: none
Required Course: None
Selected Elective: B.S. Metallurgical Engineering

COURSE GOALS
Specific Outcomes
- The objectives of this course are to provide hands on practical experience on metallurgical Understand and implement the approach (methodology) of failure analysis to fractured materials.
- Understand the application of optical microscopy, stereomicroscopy, scanning electron microscopy, energy dispersive spectroscopy and other related techniques in the analysis of failed components.
- Be able to prepare and preserve fractured samples, clean samples for proper evaluation, and document samples for future evaluation.
- Apply the mechanical aspects and macroscopic fracture surface orientation to failed components. This includes tensile testing, principle stresses, stress concentrations, plane stress, plan strain, strain rate, temperature, crack propagation, and fracture mechanics.
- Be able to identify fracture modes including ductile, brittle, and fatigue failures. This includes understanding the macroscopic features and characteristics.
- Be able to identify and explain the microscopic features and characteristics of fracture surfaces such as cleavage, river patterns, fan patterns, microvoid coalescence, quisicleavage, intergranular, striations.
- Understand the application of governmental and industrial standards to failures and how to apply them to failure analysis.
- Review a variety of case studies in a forensic engineering analysis.

- Understand the importance, purpose and legal issues associated with warnings and safety systems in mechanical devices.
- Be able to write a comprehensive forensic engineering report on an actual failed component including testing data and analysis.

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (e), (f), (k)

TOPICS

- Failure Analysis: An introduction
- Approach to failure analysis
- Mechanical aspects of failure
- Macroscopic aspects of failure
- Failure Modes
- Overload failure
- Fatigue failure
- Wear failures
- Corrosion failures
- Elevated temperature failures
- Failure Analysis Report Writing: content, style, terminology, etc.
- Legal Issues: liability, terminology, lawyers, requirements, etc.
- Microelectronic failure analysis
- Medical device failure analysis
- Case Studies: numerous case studies will be reviewed throughout the semester

PREPARED BY

G.A. Crawford, April 22, 2016

MES 475/575 – ADVANCES IN PROCESSING AND NANOENGINEERING OF POLYMERS: (2-0)/2

INSTRUCTOR

Dr. David. R. Salem, CAPE106, Ph. (605) 394-5279, david.salem@sdsmt.edu

TEXTBOOK

Selected peer-reviewed articles from the scientific literature and handouts are used

COURSE INFORMATION

Catalog Description: The course will begin with an overview of the basic principles of polymer rheology and structure formation. It will then review recent examples from the scientific literature in which concepts and theories of rheological behavior and structure formation at multiple length scales have been further developed and/or applied to the processing of polymers and composites with advanced functional and multifunctional properties. Special attention will be paid to research related to processing challenges in the formation of polymer nanocomposites, nanofibers and hierarchical composite structures. As part of this course, students will be expected to develop skills in reviewing and critically assessing the scientific literature, and in developing research strategies based on current state of knowledge. This course is cross-listed with CBE 475575 and NANO 475/575.
Prerequisites: CHEM 114 /CHEM 114L, or MES 604, or permission of instructor
Co-requisites: none
Required Course: None
Selected Elective: B.S. Metallurgical Engineering, B.S. Chemical Engineering

COURSE GOALS

Specific Outcomes

- The student will be able to understand the primary concepts of structure formation in polymers at scales of nanometers to micrometers, and how structure formation is influenced and controlled by processing conditions
- The student will be able to relate polymer structure to observed properties
- The student will be able to comprehend how nanotechnology is being applied to increase control over the structure and properties of polymer-based materials, and understand some of the central challenges involved.
- The student will be able to critically analyze and compare different approaches to the processing and creation of polymer nanocomposites with advanced properties
- The student will be able to develop an ability to review and condense complex scientific articles into clear, well organized summaries, especially in the form of scientific presentations

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (e), (g), (j), (k)

TOPICS

- Polymers and Polymer Processing (1 class)
- Polymer Structure, Morphology and Properties: Structure-Property Relationships, Crystallization, and Melting (1 class)

- Polymer Structure, Morphology and Properties: Strain Induced Orientation and Crystallization (1 class)
- Principles of Composites (1 class)
- Nanotechnology in Polymer Engineering: Concepts of Nanomaterial Synthesis (1 class)
- Articles for review, presentation and discussion are selected from leading peer reviewed journals covering processing and properties of advanced, multifunctional composites and nanocomposites. Journals used include: Materials Science and Engineering; Carbon; Nature Materials; Advanced Functional Materials; Composites, Part A; Composites Science and Technology; Journal of Polymer Science; ACS Nano; Proceedings of the National Academy of Sciences, and others. The articles are selected for both strengths and flaws, in order to develop skills in critical assessment. In addition to reviewing and debating the state of current technology, suggestions and strategies for advancing the state-of-the-art are discussed.

PREPARED BY

David Salem, April 23, 2016

MET 489/589 – COMPOSITES MANUFACTURING: (1-0)/1
INSTRUCTOR Dr. David. R. Salem, CAPE106, Ph. (605) 394-5279, david.salem@sdsmt.edu

TEXTBOOK

Selected peer-reviewed articles from the scientific literature and handouts are used

COURSE INFORMATION

Catalog Description: A background in the concepts of polymers and polymerization as well as an overview of composites concepts, constituent materials, and manufacturing processes provide the groundwork in the first half of the course. A more detailed study of the Vacuum Assisted Resin Transfer molding (VARTM) processing builds upon this groundwork, including topics such as process materials and parameters, mold design and manufacture, and product design considerations. The course concludes with post-processing topics. In conjunction with the concepts lecture, students spend time in the lab constructing and using a simple mold which will illustrate some of the challenges of molding and finishing a composite product. This course is cross-listed with CBE 489/589.
Prerequisites: none
Co-requisites: none
Required Course: None
Selected Elective: B.S. Metallurgical Engineering, B.S. Chemical Engineering

COURSE GOALS

Specific Outcomes

- The student will be able to comprehend basics concepts for polymers, polymerization and polymer processing; especially influence of process variables on physical structure of the polymer (molecular orientation, crystallinity etc.)
- The student will become familiar with the principles of composites and composite processing with emphasis on the VARTM method, including post-processing
- The student will demonstrate the ability to measure and interpret key rheological and thermal properties of a thermosetting matrix resin.
- The student will demonstrate the ability to measure and interpret key mechanical properties of a composite
- The student will demonstrate ability to run a VARTM molding process; apply post-processing; and identify and understand source of defects

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b), (d), (e), (k)

TOPICS

- Polymer Processing, Structure and Properties (2 classes)
- Principles of composites (1 class)
- Vacuum Assisted Resin Transfer Molding (VARTM) (1 class)
- Designing for VARTM processing (1 class)
- Post-processing (1 class)
- Rheology and glass transition measurements (1 lab)
- Impact resistance, anisotropy and tensile failure (1 lab)
- VARTM demonstration (1 lab)
- VARTM processing practice (2 labs)

- Post-processing practice (1 lab)

PREPARED BY

David Salem, April 23, 2016

MET 491 – Security Printing Technology: (3-0)/3

INSTRUCTOR
Dr. William M. Cross, MI 110, (605) 394-2485, William.Cross@sdsmt.edu

TEXT BOOK
Selected papers and handouts

COURSE INFORMATION
Catalog Description*: The security and anti-counterfeiting technology field will be covered with an emphasis on printing of security end products.
Prerequisites: none
Co-requisites: none
Required Course: None
Selected Elective: B.S. Metallurgical Engineering

COURSE GOALS
Specific Outcomes
The student will be able to describe the
- Importance and purpose of the security industry
- Principles involved in the
  - Manufacture and use of security inks
  - Use of substrates in security printing
  - Design and use secure documents and authentication tools

STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (f), (h), (j), (k)

TOPICS
- What is Security Printing and Security Printing Technology
- The Need for Security
- Investigating and Identifying Inauthentic Items
- Secure Document Requirements
- Security Inks: Manufacture and Use
- Printing Methods for Document Security
- Substrates for Printing in Security Applications
- Other Security Markings: Holograms, OVDs
- Secure Document Design
- Secure Document Authentication

PREPARED BY
William M. Cross, February 24, 2016

* This provisional, new course will be renumbered to MET 444/544 Security Printing Technology for Fall 2017.

EE 301/301L: Introductory Circuits, Machines, and Systems: (3-1)/4

Department: Electrical Engineering

Designation: Required
Catalog Data: (3-1) 4 credits. Introduces the essential concepts of electrical engineering concerning circuits, machines, electronics, and systems
Prerequisites: Math 125 completed with a "C-" or better, and Math321 completed or concurrent. Not for majors in Electrical or Computer Engineering.
Textbook: Principles and Applications of Electrical Engineering, (6^{th} ed.). Rizzoni, 2015

Course Learning Outcomes

- Apply the fundamentals of electric circuits including Ohm's Law, Kirchhoff's Current and Voltage Laws, and voltage and current division to analyze and build circuits.
- Use DC circuit analysis techniques such as node analysis, mesh analysis, and Norton and Thevenin equivalent circuits to solve for circuit parameters.
- Extend DC analysis techniques to AC networks using phasor notation and conversion of time domain sinusoidal voltages and currents.
- Identify the characteristics of first and second order transients.
- Have an awareness of the advantages of using the frequency domain by way of Bode plot, Fourier series and filtering.
- Use the basic operation and applications of operational amplifiers including inverting, non-inverting, summing, differential amplifiers using ideal analysis and the limitations of real op-amps.
- Be familiar with the basic operation and applications of semiconductor devices such as diodes, LED's, and BJT transistors.
- Be familiar with the basic operation of digital logic gates and their application and link to other technologies (PLC, microcontrollers).
- Have an awareness of electric machines and AC power and their uses.
- Use basic laboratory measurement equipment including the power supplies, digital multimeters, function generators, and oscilloscopes to conduct experiments.

Topics

- Introduction to EE Lab: Equipment Familiarization/Matlab Introduction
- Ohm's Law: Series Circuit/Parallel Circuit
- Voltage and Current Division: Series Circuit/Parallel Circuit
- Voltage and Current Division Applications: Variable Resistors as Input Devices (potentiometer, thermistor)/Wheatstone Bridge
- Nodal Analysis
- Mesh Analysis
- Thevenin and Norton Circuits
- Use of the Signal Generator and Oscilloscope - Study of AC Signal Properties
- Transient Response of a Circuit: First Order System/Second Order System
- Low and High Pass Filtering: First Order Filter/Second Order Filter
- Fourier Series and FFT

- Diodes, Transistors and Op-Amps: Half-wave Rectifier/Full-wave Rectifier/Common-emitter BJT/Common-emitter BJT with Motor and Snubber Diode/Inverting Amplifier
- Digital Logic: AND, OR, NOT, NAND, NOR circuits with switches and LED's/Cascaded circuit
- Laboratory Practical Exam (individual): Build Circuit/Measuring Critical Parameters/Equipment Identification and Knowledge of Uses

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (k)

EM 214 Statics: (3-0)/3

Department: Civil Engineering

Designation: Required
Catalog Data: (3-0) 3 credits. The study of the effects of external forces acting on stationary rigid bodies in equilibrium. Vector algebra is used to study two and three dimensional systems of forces. Trusses, frames and machines, shear and moment in beams, friction, centroids, moments of inertia, and mass moments of inertia are discussed.
Prerequisites: MATH 123 with a minimum grade of "C".
Textbooks: Vector Mechanics for Engineers, Statics, 10th Ed., Beer and Johnston

Course Learning Outcomes:
- Determine the components of a force in rectangular coordinates.
- Draw complete and correct free-body diagrams and write the appropriate equilibrium equations from the free-body diagram.
- Evaluate forces acting on static bodies including determining resultants and 3D components.
- Calculate moments in 2D and 3D about a point and an axis utilizing cross products and dot products.
- Determine the support reactions on a structure.
- Determine the connection forces in trusses and in general frame structures.
- Given standard shapes and corresponding centroids and/or moments of inertia, be able to compute centroids and/or moments of inertia for composite bodies.
- Determine how to identify and solve problems involving dry friction.
- Determine the internal reactions in a beam; draw shear force and bending moment diagrams.

Topics
- Fundamental Concepts and Laws
- Statics of Particles
- Equivalent Systems of Forces on Rigid Bodies
- Equilibrium of Rigid Bodies
- Distributed Forces: Centroids & Centers of Gravity & Moments of Inertia
- Analysis of Structures: Trusses, Frames & Machines
- Internal Forces
- Shear & Moment Diagrams of Beams
- Friction

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (e)

ME 216 - Introduction to Solid Mechanics: (3-0)/3

Department: Mechanical Engineering

Designation: Required

Catalog Data: (3-0) 3 Credits. This course covers the fundamental concepts of solid mechanics including the definition of stress, transformations and states of stress; plane stress, plane strain, octahedral stresses, three dimensional stresses, and principal stresses in two and three dimensions. Additional topics include strain analysis, strain measurements and rosette analysis, generalized Hooke's law, and orthotropic materials. Specific applications are an introduction to composite materials, analysis of thin and thick cylinders, statically indeterminate members, torsional loading of shafts, power transmission and the shaft analysis, torsional loads in non-circular components and thin tubes, stress concentrations, and combined loads.
Prerequisites: MATH 125, ME 210 with a minimum grade of "C", or permission of instructor.
Textbook: Mechanics of Materials; R. C. Hibbeler, 9th ed., Pearson Prentice Hall, 2014.

Course Learning Outcomes
- Understand basic definitions and sign conventions for normal and shearing stresses and strains.
- Use the stress transformation equations for the case of plane stress.
- Find principal stresses, maximum in-plane shearing stress, and absolute maximum shearing stress for the case of plane stress.
- Use the strain transformation equations for the case of plane strain.
- Find principal strains and maximum in-plane shearing strain for the case of plane strain.
- Understand the difference between plane stress and plane strain.
- Use the measurements from a strain rosette to determine the strain components at a point on the surface of a body.
- Understand the role of the stress-strain diagram in characterizing the mechanical behavior of a material.
- Identify the mechanical properties used to characterize the behavior of linear elastic isotropic materials.
- Use the generalized Hooke's law to relate the components of stress and strain.
- Quantify the strains induced by a change in temperature.
- Solve problems involving axially loaded members.
- Apply static stress concentration factors to determine the maximum stress in axially loaded members with stress raisers.
- Solve simple problems involving circular shafts subjected to torsion.

Topics:
- Analysis of Stress - Definition of stress, average normal stress in an axially loaded bar, average shear stress, allowable stress, plane stress, stress transformation equations for a state of plane stress, principal stresses and maximum in-plane shear stress for the case of plane stress, Mohr's circle for the case of plane stress, absolute maximum shear stress.

- Analysis of Strain - Deformation, definition of strain, plane strain, strain transformation equations for a state of plane strain, principal strains and maximum in-plane shearing strain for the case of plane strain, strain rosettes.
- Material Properties and Stress-Strain Relationships -The tension and compression test, the stress–strain diagram, stress–strain behavior of ductile and brittle materials, Hooke's law, strain energy, Poisson's ratio, the shear stress–strain diagram, Generalized Hooke's law, thermal strain.
- Axial Loading - Saint-Venant's principle, elastic deformation of an axially loaded member, principle of superposition, statically indeterminate axially loaded member, thermal stress, stress concentration.
- Torsion - Torsional deformation of a circular shaft, the torsion formula, power transmission, angle of twist.

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (e), (k)

EM 321 Mechanics of Materials: (3-0)/3

Department: Civil Engineering

Designation: Required
Catalog Data: (3-0) 3 credits. Basic concepts of stress and strain that result from axial, transverse, and torsional loads on bodies loaded within the elastic range. Shear and moment equations and diagrams; combined stresses; Mohr's circle; beam deflections; and column action and equations.
Prerequisites: EM 214 with a minimum grade of "C".
Textbooks: Mechanics of Materials, Beer/Johnston, 6^{th} Ed

Course Learning Outcomes
- Calculate a state of stress for a point on a loaded object
- Calculate section properties
- Calculate stress and strains
- Apply major concepts of equilibrium and compatibility
- Calculate principal stresses and strains
- Design members or systems to withstand prescribed loadings based on a maximum allowable stress
- Draw shear and bending moment diagrams

Topics
- Basic concepts of stress and strains.
- Deformation analysis due to torsion, axial flexural and combined loads.
- Design of simple structures to prevent failure.

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (e)

IENG 301 Basic Engineering Economics: **(2-0)/2**

Department: Industrial Engineering

Designation: Required
Catalog Data: (2-0) 2 credits**.** Introduces the concepts of economic evaluation regarding capital investments, including the time value of money and income tax effects
Prerequisite: Junior or higher standing preferred
Textbooks: Engineering Economy, 7th Ed. Blank, Leland; Tarquin, Anthony, ISBN: 978-0-07-337630-1

Course Learning Outcomes:
- Move various cash flows across time while accounting for discrete or continuous compound interest, e.g., single payment factors, uniform-series factors, and arithmetic and geometric gradient factors.
- Apply the concept of minimum attractive rate of return in economic decision-making.
- Identify the most appropriate engineering economy tool for evaluating alternatives.
- Evaluate asset alternatives using present worth analysis, annual worth analysis, rate of return analysis, and benefit / cost analysis.
- Utilize computer spreadsheets and their functions to solve engineering economy problems.
- Apply straight-line, declining balance, sum of years digits, units of production, and MACRS depreciation models to reduce the value of the capital investment in an asset.
- Calculate before-tax and after-tax cash flows.
- Determine break-even points on projects utilizing time value money.

Topics
- Time Value of Money
- Cash Flow Patterns
- Effective Interest Rates
- Complex Cash Flows
- Net Present Worth and Lifetime Issues
- Annual Worth Analysis
- Perpetuity (Capitalized Costs)
- Bonds
- Internal Rate of Return / Incremental Analysis
- Benefit/Cost Analysis
- Incremental Benefit/Cost Analysis
- Depreciation
- After Tax Cash Flow Analysis
- Break-Even and Sensitivity Analysis

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (c), (h), (k)

CHEM 112 General Chemistry I: (3-0)/3

Department: Chemistry

Designation: Required for most majors
Catalog Data: (3-0) 3 credits. An introduction to the basic principles of chemistry for students needing an extensive background in chemistry (including chemistry majors, science majors, and pre-professional students). Completion of a high school course in chemistry is recommended
Prerequisites: MATH 102
Textbook: Chemistry: The Molecular Nature of Matter, 7th Edition, Jespersen, N.D.; Hyslop, A.: Brady, J.E., January 2014, © 2015

Course Learning Outcomes

- Understand, and use correctly, the symbolic representations, chemical notation, formulas, and systematic rules of nomenclature that characterize the language of chemistry.
- Understand and apply the mole concept in a variety of chemical calculations, including calculating the number of particles in a given mass of substance (and vice versa), and the quantitative relationships between reactants and products in a chemical reaction.
- Recognize the different types of chemical transformations: acid-base, precipitation, combination, decomposition, single-replacement, oxidation-reduction, double replacement, and combustion.
- Understand the basic principles of energy transfer involving chemical systems, including the transfer of heat and work between system and surroundings, the qualitative and quantitative interpretation of thermochemical equations, and the application of Hess's Law.
- Understand the various models of atomic structure, the basic principles of quantum theory, and the experiments that led to those principles.
- Write ground-state electron configurations for atoms and ions of any representative element and the 3d transition series elements.
- Understand the fundamental aspects of chemical bonding, including writing Lewis structures, describing the bonding in molecules by simple valence-bond theory, and using Valence Shell Electron Pair Repulsion Theory to predict the geometries of molecules and ions.
- Use modern atomic theory to understand and predict the properties of different elements.
- Understand the properties of the different states of matter.
- Qualitatively and quantitatively describe the properties of the gaseous state and the fundamental laws governing the behavior of gases.
- Understand, qualitatively and quantitatively, the behavior of solutions and their colligative properties.
- Understand how fundamental intermolecular interactions among particles determine the physical and chemical properties of a system.
- Understand the fundamental postulates of kinetic-molecular theory and use them to explain the physical behavior of the three states of matter.

TOPICS

- Atoms and isotopes
- Scientific measurements
- Elements, Compounds, and the Periodic Table
- The Mole and Stoichiometry
- Molecular View of Reactions in Aqueous Solutions
- Oxidation-Reduction Reactions
- Energy and Chemical Change
- The Quantum Mechanical Atom
- The Basics of Chemical Bonding
- Theories of Bonding and Structure
- Properties of Gases
- Intermolecular Attractions and the Properties of Liquids and Solids
- Mixtures at the Molecular Level: Properties of Solutions

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a)

CHEM 112L General Chemistry I Laboratory: (0-1)/1

Department: Chemistry

Designation: Required
Catalog Data: (0-1) 1 credits. Laboratory designed to accompany CHEM 112
Pre or Corequisites: CHEM 112
Textbook: CHEM 112L General Chemistry I Manual

Course Learning Outcomes

- Understand and follow common laboratory safety practices
- Behave appropriately in the chemistry lab setting
- Understand the basic concepts of chemical experiments
- Study the properties and behavior of matter
- Identify and use common chemical glassware, such as flasks, pipettes, beakers, and graduated cylinders, and know what type to use for measurements
- Use common chemical lab equipment, such as balances, centrifuges, and Bunsen burners safely and properly
- Make accurate and precise quantitative measurements, and know why this is important
- Understand the importance of recording data properly and honestly by keeping true and complete
- Experimental records
- Make complete qualitative observations
- Meet deadlines for submission of work
- Understand the importance of preparation and the consequences for not being prepared
- Identify sources of error in an experiment AND understand **specifically** how those errors affect
- The result of the experiment and be able to predict these effects
- Differentiate qualitative and quantitative experiments
- Understand accuracy and precision and the difference between them
- Follow units and significant figures through calculations and be able to arrive at the correct units and significant figures for the final answer
- Interpret experimental results and draw reasonable conclusions from the results obtained
- Graph data in Excel and be able to use the graph produced to answer scientific questions about
- The experiment and its result
- Interpret data in graphical form and figure out the units on a linear trend line from the graph.

Topics

- Stoichiometry and moles
- Balancing chemical reactions
- Limiting reagents and calculations based on these
- Significant figures
- Density and factors that affect it

- Physical changes, and the temperature profile during a physical change
- Concentrations, molarity, and calculations based on these
- Constant pressure calorimetry
- Solubility rules for ionic materials in water
- Net ionic equations for metathesis reactions
- Lewis Structures and molecular geometry including VSEPR theory,
- Resonance and formal charges in Lewis structures
- Polarity in molecules
- How temperature affects vapor pressure of a liquid
- Naming compounds and writing formulae that are correct, and identifying common errors in names and formulae

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (b)

CHEM 114: General Chemistry II: (3-0)/3

Department: Chemistry

Designation: Required
Catalog Data: (3-0) 3 credits. A continuation of CHEM 112 . An introduction to the basic principles of chemistry for students needing an extensive background in chemistry
Prerequisites: CHEM 112 and MATH 102
Textbook: Chemistry: Matter and Its Changes, 7th ed., Jespersen, Hyslop

Course Learning Outcomes

- Understand rates of reaction and conditions affecting rates.
- Derive the rate equation, rate constant, and reaction order from experimental data.
- Use integrated rate laws.
- Understand the collision theory of reaction rates and the role of activation energy.
- Understand basic reaction mechanisms and identify intermediates and catalyst.
- Understand the nature and characteristics of chemical equilibria.
- Understand the significance of the equilibrium constant, K.
- Understand how to use the equilibrium constant in quantitative studies of chemical equilibria.
- Understand and use Le Châtelier’s Principle in predicting the effects of stresses on equilibrium systems.
- Use the Brønsted-Lowry and Lewis concepts of acids and bases.
- Understand the difference between strong and weak acids in aqueous solutions.
- Be able to relate pH to hydronium and hydroxide ion concentrations.
- Apply the principles of chemical equilibrium to acids and bases in aqueous solution.
- Understand the control of pH in aqueous solutions with buffers.
- Evaluate the pH in the course of acid-base titrations.
- Apply chemical equilibrium concepts to the solubility of ionic compounds.
- Understand the formation and properties of complex ions.
- Understand the concept of entropy and how it relates to spontaneity.
- Use tables of data in thermodynamic calculations.
- Define and use free energy in predicting the spontaneity of chemical processes.
- Be able to apply free energy to equilibrium concepts.
- Balance net ionic equations for oxidation-reduction reactions.
- Understand the principles of voltaic and electrolytic cells.
- Understand how to use electrochemical potentials.
- Be able to apply electrochemical potentials to free energy and equilibrium concepts.
- Be able to calculate energies for nuclear reactions.
- Be able to balance nuclear equations.
- Be able to predict methods of nuclear decay.
- Understand complex ions

TOPICS An introduction to the basic principles of chemistry for students needing an extensive background in chemistry

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a)

CHEM 114L General Chemistry II Laboratory: (0-1)/1

Department: Chemistry

Designation: Required
Catalog Data: (0-1) 1 credits. Laboratory designed to accompany CHEM 114.
Prerequisites: CHEM 112L
Pre or Corequisites: CHEM 114
Textbook: Lab Manual CHEM 114L: General Chemistry Lab II.

Course Learning Outcomes:
- Perform procedures for the analytical separation and qualitative determination of selected cations in an aqueous solution.
- Understand the fundamental and operational principles upon which common methods of separation and purification of chemical substances are based.
- Identify sources of error in chemical experiments.
- Interpret experimental results and draw reasonable conclusions.
- Practice laboratory safety procedures.
- Anticipate, recognize, and respond to hazards of chemical materials and manipulations.
- Learn the importance of following correct laboratory procedures.
- Keep legible and complete experimental records.
- Collaborate with peers in obtaining and interpreting data.

Topics
- Laboratory Techniques in class.
- Calorimetric Analysis of Food
- Iodine Clock
- Introducing Chemical Equilibrium
- Polymers
- Qualitative Cation Analysis
- Acid Base Titration
- Electrochemical Cells
- Polymers

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (b)

ENGL 101 Composition I: (3-0)/3

Department: Humanities and Social Sciences

Designation: Required
Catalog Data: (3-0) 3 credits.
Practice in the skills, research, and documentation needed for the effective academic writing. Analysis of a variety of academic and non-academic texts, rhetorical structures, critical thinking, and audience will be included.
Prerequisites: Appropriate student placement based on entry level assessment or completion of ENGL 033.
Textbook: Varies by section. Examples include Axelrod, Rise. B, St. Martin's Guide to Writing; Raimes, Ann, Pocket Keys to Writing; Eds. Lunsford, Ruskiewica, and Walters, Everything's an Argument

Course Learning Outcomes

- Write using standard American English, including correct punctuation, grammar, and sentence structure.
    - Recognize and repair common errors in grammar, punctuation, and usage in papers.
    - Apply standard English grammar, punctuation, and other mechanical aspects to all written assignments.
    - Compose clear, effective sentences and combine them into focused, coherent paragraphs that match the assigned writing purpose.
    - Improve their mastery of punctuation, grammar, and sentence structure through class discussions/exercises, quizzes, instructor feedback, and the draft and revision process.
- Write logically.
    - Recognize and repair common focus and organization errors in their papers.
    - Apply common organizational strategies to all written assignments.
    - Write clear, effective paragraphs and combine them into a logical sequence and focal pattern that matches the assigned writing purpose.
    - Improve their mastery of organization and logical writing through class discussions, written exercises, instructor feedback, and the draft and revision process.
- Write persuasively, with a variety of rhetorical strategies (e.g. expository, argumentative, descriptive).
    - Identify and repair common rhetorical and reasoning errors in their papers.
    - Apply common rhetorical and reasoning strategies to all written assignments.
    - Design and produce writing using appropriate rhetorical strategies that match audience needs and assigned writing purpose.
    - Improve their mastery of persuasion and rhetorical strategies through class discussions, written exercises, instructor feedback, and the draft and revision process.
- Incorporate formal research and documentation into their writing, including research obtained through modern, technology-based research tools.
    - Identify and repair common documentation errors in their papers.
    - Apply common research strategies to all written assignments that require it.

- Design and produce writing using appropriate research tools that match audience needs, proper documentation requirements, professional ethical standards, and assigned writing purpose.
- Improve their mastery of research and documentation methods through class discussion, written exercises, quizzes, instructor feedback, and the draft and revision process.

Topics

- Writing with emphasis on the essay format
- Research and documentation
- Grammar, punctuation, and mechanics review
- Improve and build confidence in writing ability

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (g)

English 279 Technical Communications I: (3-0)/3

Department: Humanities and Social Sciences

Designation: Required
Catalog Data: (3-0) 3 credits. Introductory written and oral technical communications with emphasis on research and explanations of scientific and engineering topics.
ENGL 101 or equivalent and sophomore standing.
Textbook: Strategies for Technical Communication in the Workplace. 3rd ed. Gurak, Laura and John M. Lannon, Boston: Longman, 2016

Course Learning Outcomes

- Write using standard American English, including correct punctuation, grammar, and sentence structure.
  - Recognize and repair common errors in grammar, punctuation, and usage in their written assignments.
  - Apply standard American English and correct grammar, punctuation, and mechanics in written assignments.
  - Compose clear and effective sentences and paragraphs that match the assigned writing purpose.
  - Improve their mastery of punctuation, grammar, and sentence structure through quizzes, instructor feedback, peer review, and the planning/drafting/revising process used to complete their technical writing assignments.
- Write logically.
  - Produce a variety of well-organized and effectively designed short, basic documents.
  - Use the process of planning, drafting, and revision to take a document from initial conception to final product.
  - Improve their mastery of organization and logical writing through class discussions, instructor feedback, peer review, and the planning/drafting/revising process used to complete their technical writing assignments.
- Write persuasively, with a variety of rhetorical strategies (e.g. expository, argumentative, and descriptive).
  - Produce individual and collaborative documents for a variety of technical, professional, and general audiences
  - Recognize and use appropriate conventional formats and visuals applicable to a variety of short, basic technical documents
  - Improve their mastery of persuasion and rhetorical strategies through class discussions, instructor feedback, peer review, and the planning/drafting/revising process used to complete their technical writing assignments.
  - Incorporate formal research and documentation into their writing, including research obtained through modern, technology-based research tools.
- Use the basic research skills and documentation techniques necessary to produce effective written technical communications.
- Exhibit awareness of ethical standards by accurately using sources and formulating text in their papers.

- Improve their mastery of research and documentation methods through class discussions, instructor feedback, peer review, and the planning/drafting/revising process used to complete their technical writing assignments.
- Prepare and deliver speeches for a variety of audiences and settings.
  - Analyze the relevant characteristics of their intended audience.
  - Prepare and deliver speeches of differing lengths, topics, and purposes for a variety of technical, professional, and general audiences.
  - Improve their mastery of audience and setting analysis through class discussion and exercises, peer review, instructor feedback, practice and final speeches.
- Demonstrate listening competencies including choice and use of topic, supporting materials, organizational pattern, language usage, presentational aids, and delivery.
  - Recognize the different speech goals and organizational patterns used for informational, demonstration, and/or persuasion speeches.
  - Demonstrate in individual and/or collaborative speeches their competency in selecting and using appropriate supporting materials and presentational aids for the intended type of speech and audience.
  - Demonstrate in individual and/or collaborative speeches their competency in using appropriate language for the intended type of speech and audience
  - Incorporate effective delivery techniques, both vocal and nonverbal, for the intended speech and audience in individual and/or collaborative speeches
  - Improve their mastery of choosing and using appropriate topics and organizational plans, supporting materials, language, presentation aids, and delivery techniques through class discussion and exercises, peer review, instructor feedback, practice and final speeches.
- Demonstrate listening competencies by summarizing, analyzing, and paraphrasing ideas, perspectives, and emotional content
  - Demonstrate listening competencies through peer review exercises.
  - Improve their mastery of listening skills through class discussions and exercises, instructor and student feedback, practice and final speeches.

Topics

- Basic short technical documents
- research and documentation
- Oral presentations.

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (g)

English 289 Technical Communications I: (3-0)/3

Department: Humanities and Social Sciences

Designation: Required
Catalog Data: (3-0) 3 credits. Advanced written and oral technical communications with emphasis on the research, preparation, and delivery of complex technical documents
Prerequisites: ENGL 279 or equivalent and sophomore standing.
Textbook: Varies by section. Examples include Axelrod, Rise. B, St. Martin's Guide to Writing; Raimes, Ann, Pocket Keys to Writing; Eds. Lunsford, Ruskiewica, and Walters, Everything's an Argument

Course Learning Outcomes

- Write using standard American English, including correct punctuation, grammar, and sentence structure.
  - Recognize and repair common errors in grammar, punctuation, and usage in their written assignments.
  - Apply standard American English and correct grammar, punctuation, and mechanics in written assignments.
  - Compose clear and effective sentences and paragraphs that match the assigned writing purpose.
  - Improve their mastery of punctuation, grammar, and sentence structure through quizzes, instructor feedback, peer review, and the planning/drafting/revising process used to complete their technical writing assignments.
- Write logically.
  - Produce a variety of well-organized and effectively designed short, basic documents.
  - Use the process of planning, drafting, and revision to take a document from initial conception to final product.
  - Improve their mastery of organization and logical writing through class discussions, instructor feedback, peer review, and the planning/drafting/revising process used to complete their technical writing assignments.
- Write persuasively, with a variety of rhetorical strategies (e.g. expository, argumentative, and descriptive).
  - Produce individual and collaborative documents for a variety of technical, professional, and general audiences;
  - Recognize and use appropriate conventional formats and visuals applicable to a variety of short, basic technical documents;
  - Improve their mastery of persuasion and rhetorical strategies through class discussions, instructor feedback, peer review, and the planning/drafting/revising process used to complete their technical writing assignments.
- Incorporate formal research and documentation into their writing, including research obtained through modern, technology-based research tools.
  - Use the basic research skills and documentation techniques necessary to produce effective written technical communications.
  - Exhibit awareness of ethical standards by accurately using sources and formulating text in their papers.

  - Improve their mastery of research and documentation methods through class discussions, instructor feedback, peer review, and the planning/drafting/revising process used to complete their technical writing assignments.
- Prepare and deliver speeches for a variety of audiences and settings.
  - Analyze the relevant characteristics of their intended audience.
  - Prepare and deliver speeches of differing lengths, topics, and purposes for a variety of technical, professional, and general audiences.
  - Improve their mastery of audience and setting analysis through class discussion and exercises, peer review, instructor feedback, practice and final speeches.
- Demonstrate listening competencies including choice and use of topic, supporting materials, organizational pattern, language usage, presentational aids, and delivery.
  - Recognize the different speech goals and organizational patterns used for informational, demonstration, and/or persuasion speeches.
  - Demonstrate in individual and/or collaborative speeches their competency in selecting and using appropriate supporting materials and presentational aids for the intended type of speech and audience.
  - Demonstrate in individual and/or collaborative speeches their competency in using appropriate language for the intended type of speech and audience
  - Incorporate effective delivery techniques, both vocal and nonverbal, for the intended speech and audience in individual and/or collaborative speeches
  - Improve their mastery of choosing and using appropriate topics and organizational plans, supporting materials, language, presentation aids, and delivery techniques through class discussion and exercises, peer review, instructor feedback, practice and final speeches.
- Demonstrate listening competencies by summarizing, analyzing, and paraphrasing ideas, perspectives, and emotional content
  - Demonstrate listening competencies through peer review exercises.
  - Improve their mastery of listening skills through class discussions and exercises, instructor and student feedback, practice and final speeches.

Topics
- Complex technical documents, and
- Visuals and graphic design
- Research and documentation
- Oral presentations.

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (g)

Math 123 Calculus I: (4-0)/4

Department: Mathematics

Designation: Required
Catalog Data: (4-0) 4 credits. The study of limits, continuity, derivatives, applications of the derivative, antiderivatives, the definite and indefinite integral, and the fundamental theorem of calculus.
Prerequisites: MATH 115 with a grade of C or appropriate mathematics placement or permission of instructor.
Textbooks: Calculus by Thomas plus MyMathLab, 13th ed

Course Learning Outcomes

- Take derivatives of trigonometric and algebraic functions using the power rule, chain rule, product rule, and quotient rule.
- Use the derivative in applications such as velocity and acceleration, related rates, optimization, and curve sketching.
- Integrate algebraic and trigonometric functions using the power rule and substitution.
- Demonstrate the use of the integral in an application. Examples may include area, volume, moments, work, arc length, and surface area.
- Use a computer algebra system to implement the solution techniques that are covered in Calculus 1

Topics

- Intro to Calculus & Trigonometry review
- Rates of Change, Limit Laws, One-Sided Limits
- Continuity, Limits of Infinity
- Derivative at Point, Derivative Functions
- Differential Rules, Trig Differentials, Chain Rule, Implicit Differentials
- Extreme Values, Concavity, Optimization, Anti-Derivatives
- Sums, Limit of Sums, Indefinite Integrals
- Area Bounded, Washers & Disks, Shells, Arc Length, Surface Revs

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a)

Math 125 Calculus II: (4-0)/4

Department: Mathematics

Designation: Required
Catalog Data: (4-0) 4 credits. A continuation of the study of calculus, including the study of sequences, series, polar coordinates, parametric equations, techniques of integration, applications of integration, indeterminate forms, and improper integrals.
Prerequisites: MATH 115 or MATH 120 with a minimum grade of "C" or appropriate score on departmental Trigonometry Placement Examination and MATH 123 with a minimum grade of C
Textbooks: Calculus by Thomas plus MyMathLab, 13th ed

Course Learning Outcomes

- Solve linear systems of equations and matrix equations.
- Evaluate integrals with advanced techniques, such as: substitution, Trigonometric substitution, integration by parts, and partial fractions.
- Produce the Taylor series expansions for functions, including many transcendental functions.
- Use a computer algebra system to implement the solution techniques that are covered in Calculus 2.

Topics

- Calculus with exponentials, logs,
- Inverse trig functions and hyperbolics
- Integration techniques
- Matrices and vectors
- Infinite series

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a)

Math 225 Calculus III: (4-0)/4

Department: Mathematics

Designation: Required

Catalog Data: (4-0) 4 credits. A continuation of the study of calculus, including an introduction to vectors, vector calculus, partial derivatives, and multiple integrals
Prerequisite: MATH 125 with a minimum grade of "C".
Textbooks: Calculus by Thomas plus MyMathLab, 13th ed

Course Learning Outcomes

- Analyze position, velocity, and acceleration in two or three dimensions using the calculus of vector valued functions.
- Use partial derivatives to calculate rates of change of multivariate functions.
- Use multiple integrals to compute the volume, mass, center of mass, and related quantities for multivariate functions.
- Compute line integrals, including those representing work done by a variable force in a vector field

Topics

- Parametric equations, equations of lines & planes
- Vector-valued functions, functions of several variables
- Polar coordinates, spherical coordinates, cylindrical coordinates, multiple integrals & applications
- Vector calculus & Green's Theorem

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a)

Math 321 Differential Equations: (3-0)/3

Department: Mathematics

Designation: Required
Catalog Data: (3-0) 3 credits. Selected topics from ordinary differential equations including development and applications of first order, higher order linear and systems of linear equations, general solutions and solutions to initial-value problems using matrices. Additional topics may include Laplace transforms and power series solutions. In addition to analytical methods this course will also provide an introduction to numerical solution techniques.
Prerequisites: MATH 125 with a minimum grade of "C".
Textbooks: A First Course in Differential Equations with Modeling Applications, Tenth Edition by Dennis G. Zill.

Course Learning Outcomes

- Identify an appropriate method to solve first order ordinary differential equation
- Solve homogeneous & non-homogeneous higher order ordinary differential equations
- Implement the use of Laplace Transforms to solve an ordinary differential equation
- Analyze and solve applications involving ordinary differential equations. Some examples of applications include: circuits, vibrating systems, chemical mixing, and population modeling.
- Apply the techniques for solving linear systems of ordinary differential equations
- Implement the use of a software package to aid in solving differential equations numerically and analytically

Topics

- Development & applications of 1^{st} order
- Higher order linear & systems of linear equations
- General solutions & solutions to initial-value problems using matrices
- Laplace transforms & power series solutions
- Introduction to numerical solution

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a)

MATH 373 Introduction to Numerical Analysis: (3-0)/3

Department: Mathematics

Designation: Required
Catalog Data: (3-0) 3 credits. This course is an introduction to numerical methods. Topics include elementary discussion of errors, polynomial interpolation, quadrature, non-linear equations, and systems of linear equations. The algorithmic approach and efficient use of the computer will be emphasized. Additional topics may include: calculation of eigenvalues and eigenvectors, numerical differentiation and integration, numerical solution of differential equations.
Prerequisites: MATH 321 and CSC 150/150L or permission of instructor
Textbooks: Applied Numerical Methods with Matlab for Engineers and Scientists by Chapra

Course Learning Outcomes

- Write finite approximations of the first and second derivative
- Identify the different types of error in numerical methods
- Implement the use of numerical approximation for integration
- Implement the use of Runge-Kutta to solve initial value problems
- Apply numerical methods to solve systems of differential equations
- Apply numerical methods to solve nonlinear equations
- Apply numerical methods to sovle linear systems
- Use some type of software to solve simple forms of partial differential equations

Topics

- Elementary discussion of errors
- Polynomial interpolation
- Quadrature, non-linear equations & systems of linear equations
- Algorithmic approach
- Calculation of eigenvalues & eigenvectors
- Numerical differentiation & integration
- Numerical solution of differential equations

Class Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a)

PHYS 211 University Physics I: (3-0)/3

Department: Physics

Designation: Required
Catalog Data: (3-0) 3 credits. This is the first course in a two semester calculus-level sequence, covering fundamental concepts of physics. This is the preferred sequence for students majoring in physical science or engineering. Topics include classical mechanics and thermodynamics. The School of Mines course covers classical mechanics only.
Prerequisites: MATH 123 or permission of instructor.
Textbook: Fundamentals of Physics, 10th Edition, Part 1, Halliday/ Resnick/ Walker

Course Learning Outcomes

- Demonstrate the scientific method in a laboratory experience. This outcome will be achieved and assessed in Phys 213L course.
- Gather and critically evaluate data using scientific method. Assessment: Students will be able to critically evaluate data (given or obtained) with proper accuracy using appropriate laws and formulas of classical mechanics for scientifically sound presentation of laboratory reports, homework assignments, and of solutions on quizzes and exams.
- Identify and explain the basic concepts, terminology and theories of selected natural sciences. Assessment: Students will be able to identify and apply basic concepts and appropriate laws of classical mechanics in order to solve assigned problems in homework, quizzes, exams, and in oral presentation.
- Apply selected natural science concepts and theories to contemporary issues. Assessment: Students will be able to explain how physics concepts, laws, and phenomena relate to contemporary engineering and science in classroom discussions and written assignments.

Topics

Classical mechanics

Class/Laboratory Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (c), (e), (f), (i), (k)

PHYS 213 UNIVERSITY PHYSICS II: (3-0)/3

Department: Physics

Designation: Required
Catalog Data: (3-0) 3 credits. This course is the second course in a two semester calculus-level sequence, covering fundamental concepts of physics. This is the preferred sequence for students majoring in physical science or engineering. Topics include electricity and magnetism, sound, light, and optics. The School of Mines course covers electricity and magnetism only.
Prerequisites: PHYS 211
Textbook: Fundamentals of Physics, 10th Edition, Part 1, Halliday/ Resnick/ Walker

Course Learning Outcomes

- Demonstrate the scientific method in a laboratory experience. This outcome will be achieved and assessed in Phys 213L course
- Gather and critically evaluate data using scientific method. Students will be able to critically evaluate data (given or obtained) with proper accuracy using appropriate laws and formulas of classical mechanics for scientifically sound presentation of laboratory reports, homework assignments, and of solutions on quizzes and exams.
- Identify and explain the basic concepts, terminology and theories of selected natural sciences. Students will be able to identify and apply basic concepts and appropriate laws of classical mechanics in order to solve assigned problems in homework, quizzes, exams, and in oral presentation.
- Apply selected natural science concepts and theories to contemporary issues. Students will be able to explain how physics concepts, laws, and phenomena relate to contemporary engineering and science in classroom discussions and written assignments.

Topics

- Electric Charge, charge, conductors and insulators, Coulomb's Law
- Applications of Coulomb's Law
- Applications of Coulomb's Law
- Electric Fields, electric field lines, electric field due to a point charge
- Electric field due to a dipole, continuous charge distributions
- Electric fields due to continuous charge distributions
- Electric fields due to continuous charge distributions
- Point charge and dipole in a electric field
- Gauss' Law, flux of an electric field, Gauss' Law
- Electric Potential , electric potential energy, electric potential, potential from the field
- Potential due to a point charge
- Potential due to continuous charge distributions
- Field from potential
- Capacitance, calculating the capacitance
- Capacitors in parallel and in series
- Energy stored in an electric field
- Capacitor with a dielectric

- Current and Resistance, current and current density
- Resistance and resistivity

Class/Laboratory Schedule: Varies

PRIMARY STUDENT OUTCOMES ADDRESSED BY THIS COURSE: (a), (c), (e), (f), (i), (k)

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APPENDIX B – FACULTY RESUMES

The following program faculty vitae are provided below.

- Grant A. Crawford
- William M. Cross
- Stanley M. Howard
- Bharat K. Jasthi
- Jon J. Kellar
- M. Sadegh Safarzadeh
- Michael K. West
- David R. Salem
- Christian A. Widener

GRANT A. CRAWFORD

Assistant Professor

DEGREES WITH FIELDS, INSTITUTION, AND DATE

- B.S., Metallurgical Engineering, South Dakota School of Mines and Technology (2004)
- Ph.D., Materials Science Engineering, Arizona State University, Tempe, AZ (2008)

ACADEMIC EXPERIENCE

2011-present Assistant Professor, Tenure Track

NON-ACADEMIC EXPERIENCE

2011	Intel Corporation, Litho Area DETD Chandler, AZ	Area Manager (Interim)
2010-2011	Intel Corporation, Litho Area DETD Chandler, AZ	Area Coordinator
2008-2010	Intel Corp, Materials Tech Development Chandler, AZ	Sen. Eng

CURRENT MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

TMS

HONORS AND AWARDS

2015	Outstanding Recent Graduate, South Dakota School of Mines and Technology
2009-2011	Intel Performance Awards (various)
2006-2008	Achievement Rewards for College Scientists (ARCS) Scholar (2006-2008)

SERVICE ACTIVITIES

1. Director, NSF REU Site: Security Printing and Anti-Counterfeiting Technology
2. Co-Director, Biomedical Engineering Graduate Program
3. Co-Organizer, Advanced Materials in Dental and Orthopedic Applications Symposium, TMS Annual Meeting 2015-2016
4. NSF Proposal review Panelist, National Science Foundation, Arlington, VA (2013-2014)
5. Member, University Admissions Committee (2012-present)
6. Member, University Faculty Workload Policy Committee (2015-2016)
7. Session Judge: SDSMT Undergraduate and Graduate Research Symposium (2012-2015)
8. Reviewer, Journal of Materials Science, Materials Science and Engineering A-C, Metallurgical and Materials Transactions A, Journal of Mechanical Behavior of Biomedical Materials, Surface Innovations

PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

1. Rokni MR, Widener CA, Champagne VK, Crawford GA, Microstructure and mechanical properties of cold sprayed 7075 deposition during non-isothermal annealing, Surface and Coatings Technology 276 (2015) 305–315.
2. Rokni MR, West M, Widener C, Crawford GA, An investigation into microstructure and mechanical properties of cold sprayed 7075 Al deposition, Materials Science and Engineering A, 625 (2015) 19-27.

3. Rokni MR, Widener C, Crawford GA, Microstructural Evolution of 7075 Al Gas Atomized Powder and High-Pressure Cold Sprayed Deposition, Surface and Coatings Technology 251 (2014) 254-263.
4. Meruga JM, Cross WM, May PS, Luu Q, Crawford GA, Kellar JJ, Security Printing of Covert Quick Response Codes Using Upconverting Nanoparticle Inks, Nanotechnology 23 (2012) 1-19.
5. Meruga JM, Fountain (Nesson) C, Kellar JJ, Crawford GA, Baride A, May PS, Cross W, Hoover R, Multi-Layered Covert QR Codes for Increased Capacity and Security, International Journal of Computers and Applications, Vol. 37, No. 01, 1–11, 2015.
6. Aravind, B., Meruga, J.M., Douma, C., Langerman, D., Crawford, G.A., Kellar, J.J., Cross, W.M., & May, P.S. (2015). A Tamper-Resistant Covert Print-and-Read System Based on NIR-to-NIR Upconversion Luminescence. RSC Advances, 2015, 5, 101338.
7. Kobayashi T, Owens M, Cross W, Kellar JJ, and Crawford GA, Structural Color for Security Printing: Patterned Robust Colloidal Crystals, NIP & Digital Fabrication Conference, Volume 2015, Number 1, January 2015, pp. 395-396(2).
8. Thompson F, Wicks G, Crawford GA, Porous-wall Hollow Glass Microspheres for Security Printing Applications, NIP & Digital Fabrication Conference, Volume 2015, Number 1, January 2015, pp. 391-394(4).
9. Meruga J.M., Kern, J., Petersen J., Logue, B.A., Baride, A., May, P.S., Cross, W.M., Crawford, G., Tamayo, D., Richards, J., and Kellar, J.J. (2015). Innovative Security Applications using Direct-Write Printing. Keesing Journal of Documents & Identity, 47.
10. Meruga, J.M., Holland, C., Petersen, J., Cross, W., Crawford, G., & Kellar, J, Polyaniline Nanofibers for Security Printing Applications. NIP & Digital Fabrication Conference, Volume 2015, Number 1, January 2015, pp. 69-71(3)
11. Bhatta E, Crawford GA Processing, Microstructure Characterization and Biological Response of Cold Sprayed Biocomposite Coatings. TMS Annual Meeting and Exhibition, Orlando, FL, March 2015.
12. Little M, Hong P, Crawford GA, Processing, Cytotoxicity Testing of Aluminum Magnesium Boride Powders for Medical Implant Applications. Innovations in Biomedical Materials Conference: Focus on Ceramics 2014 - American Ceramics Society, Columbus, OH, 7/2014.
13. Gegg C, McLinn C, Michael A, Sauter E, Crawford GA, Processing, Microstructure Characterization and Biological Performance of Hierarchical Surface Coatings for Titanium. TMS Annual Meeting and Exhibition, San Diego, CA, March 2014.
14. Crawford GA, Hierarchical TiO_2 Nanotube Coatings for Titanium Implants, Society for Biomaterials/University of South Dakota – Biomaterials Day Symposium, Sioux Falls, SD, May 2013. (**Invited - Plenary Speaker**)
15. G.A. Crawford, I. Salama, Misalignment Correction for Embedded Microelectronic Die Application, Patent No. US 8,372,666 B2, February 13, 2013.

RECENT PROFESSIONAL DEVELOPMENT ACTIVITIES

1. EPSCoR Young Investigator Recognition, EPSCoR Coalition Meeting, Washington, DC, March 2014.

WILLIAM M. CROSS

Associate Professor

DEGREES WITH FIELDS, INSTITUTION, AND DATE

- BS., Metallurgical Engineering, South Dakota School of Mines and Technology, Rapid City, SD (1984)
- MS., Metallurgical Engineering, South Dakota School of Mines and Technology, Rapid City, SD (1986)
- Ph.D., Metallurgical Engineering, University of Utah, Salt Lake City, UT (1999)

ACADEMMIC EXPERIENCE

1993-1997	Research Associate
1997-2007	Research Scientist III
1990, 1993, 1998, 2000-2006	Instructor
2007-present	Associate Professor, Tenured (2012)

NON-ACADEMIC EXPERIENCE

1983	Duval Corporation Battle Mountain, NV	Summer Engineer
1986 - 93	Department of Metallurgical Engineering University of Utah Salt Lake City, UT	Research Fellow
1995	IMI-TAMI Haifa, Israel	Consultant
2000	Allied-Signal Phoenix, AZ	Consultant

CERTIFICATIONS AND PROFESSIONAL REGISTRATIONS

none

CURRENT MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

SME, MRS

HONORS AND AWARDS

1990 Outstanding Teaching Assistant, University of Utah, Department of Metallurgical Engineering.

1993 Outstanding Graduate Seminar, University of Utah, Department of Metallurgical Engineering.

SERVICE ACTIVITIES

President, Soccer Rapid City, 2001-2010
SDSM&T Faculty Senate and Academic Affairs Subcommittee Chair, 2010-present
SDSM&T KTEQ Student Radio Faculty Advisor 2008-present
SDSM&T Curriculum Committee, 2010-present

PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

- Aravind Baride, Jeevan M. Meruga, Cecilia Douma, David Langerman, Grant Crawford, Jon J. Kellar, William M. Cross, P. Stanley May, **RSC Advances**, 5, pp. 101338-101346, 2015.
- J.M. Meruga, C. (Nesson) Fountain, J.J. Kellar, G. Crawford, A. Baride, P.S. May, W. Cross, and R. Hoover, **International Journal of Computers and Applications**, 37(1), pp. 1-11, 2015.
- Jeevan Manikyarao Meruga, Jamie Kern, Jacob Petersen, Brian Logue, Aravind Baride, P. Stanley May, William Cross, Grant Crawford, Domingo Tamayo and Jon J. Kellar, **Keesing Journal of Documents and Identity**, June, pp. 20-25, 2015.
- Mohammed N Alghamdi, Lidvin Kjerengtroen, Jon J Kellar, William M Cross, Selvin P Thomas, **Applied Mechanics and Materials,** 704, pp. 39-47, 2015.
- J.M. Meruga, A. Baride, W. Cross, P.S. May and J.J. Kellar, **Journal of Materials Chemistry C**, 2, pp. 2221-2227, 2014.
- S. Vunnam, K. Ankireddy, J. Kellar and W. Cross, **Nanotechnology**, 25(19), pp. 195301, 2014.
- Kenneth N. Han, Jon J. Kellar, William M. Cross and Sadegh Safarzadeh, **Geosystem Engineering**, 17(3), pp. 178-194, 2014.
- J. Petersen, J. Meruga, J. Randle, W. Cross and J. Kellar, **Langmuir**, 30(51), pp. 15514–15519, 2014.
- S. Vunnam, W. Cross, W., Ankireddy, K. and Kellar, J., **Thin Solid Films**, 531, pp. 294–301, 2013.
- K. Ankireddy, S. Vunnam, J. Kellar and W. Cross, **Journal of Materials Chemistry C**, 1, pp. 572-579, 2013.
- K. Ankireddy, M. Iskander, S. Vunnam, D. Anagnostou, J. Kellar and W. Cross, **Journal of Applied Physics**, 114, pp. 124303, 2013.
- J.M. Meruga, W.M. Cross, P.S. May, Q.A. Luu, G.A. Crawford and J.J. Kellar, **Nanotechnology**, 23(39), pp. 39521 (1-19), 2012.
- T. Blumenthal, J. Meruga, P.S. May, J. Kellar, W. Cross and Q.N. Luu, chosen as cover article, **Nanotechnology**, 23(8), pp. 185305 (1-7), 2012.
- D. Hansen, J. Kellar and W. Cross, **Leonardo Transactions**, 44(2), pp. 166-167, 2011.
- J. Ash, W. Cross, J. Kellar and L. Kjerengtroen., **Journal of ASTM International**, Volume 8, Issue 2 (February 2011), pages 11, 2011.

RECENT PROFESSIONAL DEVELOPMENT ACTIVITIES

- Optical Document Security Conference, San Francisco, CA, February 2016 (16 hours)
- Security Printing Technology Workshop, Rochester Institute of Technology, June 2015 (40 hours)
- External Reviewer Department of Energy, National Energy and Research Laboratory Program, DE-FOA-0001202, “Opportunities to Develop High Performance, Economically Viable, and Environmentally Benign Technologies to Recover Rare Earth Elements (REEs) from Domestic Coal and Coal Byproducts” (56 hours)

STANLEY M. HOWARD

Emeritus Professor and Senior Lecturer

DEGREES WITH FIELDS, INSTITUTION, AND DATE

- BS., Metallurgical Engineering, Colorado School of Mines, Golden, CO (1967)
- Ph.D., Metallurgical Engineering (Minor - Chemical Petroleum Refining Engineering), Colorado School of Mines, Golden, CO (1971)

ACADEMMIC EXPERIENCE

1971- 1976	Assistant Professor, Tenure Track - original appointment
1976 – 1980	Associate Professor, Tenured
1980 – 2014	Professor, Tenured
2014 –	Emeritus Professor and Senior Lecturer

NON-ACADEMIC EXPERIENCE

2005 - 07	Yucca Mountain Storage Facility, Summerlin, NV - Technical Auditor
2002 - 03	Oak Ridge National Laboratory, Metals and Ceramic Division - Consultant
1992 - 01	Caterpillar Corporation, Technical Center, Peoria, IL - Consultant
1988 - 91	Electronic Man. & Prod. Facility, U. S. Dept of the Navy, Ridgecrest, CA - Consultant
1986 - 87	Kerr-McGee Corporation, Oklahoma City, OK - Consultant
1981 - 88	Group V Metals, Inc., Rapid City, SD - Pres (81 - 84) & VP (84 - 88)
1976 - 77	Stanford Research Center, Menlo Park, CA - Visiting Scientist
1967 - 71	Dept of Met. Eng, Colorado School of Mines, Golden, CO - Research Fellow
1967	Atomic Weapons Division, Dow Chemical Company, Golden, CO - Engineer

CERTIFICATIONS AND PROFESSIONAL REGISTRATIONS

Professional Engineer: SD #2219 1972-present

CURRENT MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

TMS, ASM, ACeRS, AIST, SIGMA XI

HONORS AND AWARDS

2003 - AIME Mineral Industry Education Award
1994 - Benard A. Ennenga Faculty Award (1994)
1994 - Presidential Award: South Dakota School of Mines & Technology; Rapid City, SD
1974 - Honored Guest: Kroll Institute Dedication; Golden, CO
1970 - The Society of Sigma Xi
1966 - Alpha Sigma Mu Honorary Society

SERVICE ACTIVITIES

2016-17	TMS President
2015-18	TMS Board of Directors
2013-18	TMS Foundation Board of Trustees
2010-12	SDSM&T Faculty President and Senate Chair
1991-	SDSM&T Material Advantage Student Chapter Advisor
2016	Metallurgical & Materials Engineering PE Exam Standard-Setting Panel Observer

PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

- Barbara Szczerbinska, Stan Howard, et al.: *Center for Ultra-Low Background Experiments at DUSEL*, Acta Physica Polonica B, 2010, vol. 41, no. 6, pp.1709-18
- Bharat Jasthi, Edward Chen, William Arbegast, Matthew Heringer, Douglas Bice, Stanley Howard: *Friction Stir Processing of Cast Inconel 718*, Proceedings Friction Stir Welding and Processing VI, ed. R. S. Mishra, M W. Mahoney, Y. Sato, Y Hovanski, and R. Verma, Friction Stir Welding and Processing VI, 2011 TMS Annual Meeting & Exhibition, Feb 28, 2011, San Diego, The Materials, Metals, and Materials Society, Warrendale, PA, pp. 25-32
- B.K. Jasthi, E.Y. Chen, W.J. Arbegast, B. Kaligotla, M. West, C.A. Widener, and S. M. Howard: *Microstructure and Mechanical Properties of Friction Stir Processed Cast Alloy 718*, 9th International Symposium on Friction Stir Welding Proceedings, May 15-17, 2012, Huntsville, TWI Ltd, Granta Park, Great Abington, Cambridge, CB21 6AL, UK.
- Brahmanandam Kaligotla, Bharat K. Jasthi, William J. Arbegast, and Stanley M. Howard: *Effect of Thermomechanical Processing on Abnormal Grain Growth in Al-2195 Friction Stir Welds*, Trends in Welding Research 2012, Proceedings of the 9th International Conference, June 4-6, 2012, ed. S. Babu, H.K. Bhadeshia, C.E. Cross, S.A. David, T. DebRoy, J. DuPont, T. Koseki, S. Liu, Chicago, IL, ASM International, Materials Park, OH, pp. 553-7
- Bharat K. Jasthi, Glenn J. Grant, and Stanley M. Howard: *In-situ Reaction Processing Using Friction Stir Processing*, Trends in Welding Research 2012, Proceedings of the 9th International Conference, June 4-6, 2012, Editors S. Babu, H.K. Bhadeshia, C.E. Cross, S.A. David, T. DebRoy, J. DuPont, T. Koseki, S. Liu, Chicago, IL, ASM International, Materials Park, OH, pp. 978-82
- Brahmanandam Kaligotla, Bharat K. Jasthi, Christian A. Widener, and Stanley M. Howard: *Ultrasonic Spot Welding of 301 Stainless Steel to Aluminum 6061-T6*, Trends in Welding Research Proceedings of the 9th International Conference, June 4-8, 2012, ed. S. Babu, H.K. Bhadeshia, C.E. Cross, S.A. David, T. DebRoy, J. DuPont, T. Koseki, S. Liu, Chicago, IL, ASM International, Materials Park, OH, pp 631-4
- B.K. Jasthi, W. J. Arbegast, and S. M. Howard: *Effect of Thermal Aging on the Corrosion and Microstructure of Friction Stir Welded Alloy 22*, Metall. Trans. A, 2012, vol. 43A, pp. 3192-201
- Xiaoqian Ma, Stanley M. Howard and Bharat K. Jasthi: *Friction Stir Welding of Bulk Metallic Glass Vitreloy 106a*, Journal of Manufacturing Science and Engineering, 2014, vol. 136, issue 5, 7 pages. doi: 10.1115/1.4027941
- G.K. Giovanetti, -- , S. Howard; F. Avignone & W. Haxton, editors, *A Dark Matter Search with MALBEK*, Proceedings of the 13th International Conference on Topics in Astroparticle and Underground Physics, Physics Procedia, Elsevier, TAUP 2013.
- Xu, W., et al., *Testing the Ge Detectors for the MAJORANA DEMONSTRATOR.* Physics Procedia, 2015. **61**: p. 807-815.

RECENT PROFESSIONAL DEVELOPMENT ACTIVITIES

- ASAE Symposium for Chief Staff Executives and Chief Elected Officers
- LaTeX Training
- R Training
- Listening Workshop and Meetings Matter by Paul Axtell
- D2L Distant Learning Software Short Course
- Numerous ‘Lunch’N Learn’ seminars on interaction and team skills

BHARAT K. JASTHI

Assistant Professor

DEGREES WITH FIELDS, INSTITUTION, AND DATE

D.Met.E., Diploma in Metallurgical Engineering, JN Government Polytechnic, India (1999)
BS., Metallurgy & Materials Technology, JN Technological University, India (2003)
MS., Materials Engineering and Science, South Dakota School of Mines and Tech, Rapid City, SD (2005)
Ph.D., Materials Engineering and Science, South Dakota School of Mines and Tech, Rapid City, SD (2009)

ACADEMIC EXPERIENCE

2013- Present	Assistant Professor, Tenure Track – Materials and Metallurgical Engineering, SDSMT
2009-2013	Research Scientist, Arbegast Advanced Materials Processing Center

NON-ACADEMIC EXPERIENCE

1998	Vishakapatnam Steel Plant Vishakapatnam, India	Research Intern
1999	Mishra Dhathu Nigam Limited Hyderabad, India	Metallurgical Engineer
2003	International Advanced Research Centre for Powder Metallurgy Hyderabad, India	Research Fellow
2003-09	Department of Materials and Metallurgical Engineering South Dakota School of Mines and Technology Rapid City, SD	Research Fellow

CERTIFICATIONS AND PROFESSIONAL REGISTRATIONS

Six Sigma – Green Belt
Research Commercialization (National Council of Entrepreneurial Tech Transfer**)**

CURRENT MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

TMS, ASM,

SERVICE ACTIVITIES

ASM – Education Committee Member, 2012-
TMS – Education Committee Member, 2016
Reviewer for various peer-reviewed journals- Materials and Metallurgical Engineering-A, Corrosion Science, and American Society for Mechanical Engineers

PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

- Md Shamsujjoha, B.K. Jasthi, M. West and C. Widener, Friction stir lap welding of aluminum to steel using refractory metal pin tools, Journal of Engineering Materials and Technology, APRIL 2015, Vol. 137 / 021009-1.

- B.K. Jasthi, T. Curtis, C. Widener, M. West, M. Carriker, A. Dasgupta, and R. Ruokolainen, "Friction Stir Processing of Direct-Metal-Deposited 4340 Steel"- Friction Stir Welding and Processing-VIII, TMS 2015, pp. 191-198.
- T. Curtis, C. Widener, M. West, B.K. Jasthi, Y. Hovanski, B. Carlson, and R. Szymanski, "Friction Stir Scribe Welding of Dissimilar Aluminum to Steel Lap Joints", Friction Stir Welding and Processing-VIII, TMS 2015, pp. 163-169.
- M.R. Rokni, C.A. Widener, S.P. Ahrenkiel, B.K. Jasthi, V.R. Champagne, Annealing Behavior of 6061 Aluminum Deposited by High Pressure Cold Spray. *Surface Engineering*, **(30)-5,** (2014), pp. 361- 368.
- X. Ma, S. Howard, and B.K. Jasthi, "Friction Stir Welding of Bulk Metallic Glass Vitreloy 106a E", Journal of Manufacturing Science and Engineering, OCTOBER 2014, Vol. 136 / 051012-1.
- A.Zainulabdeen, M. Abbas, A. Ataiwi, S. Khanna, B.K. Jasthi, and C. Widener, "Investigation of Fatigue Behavior and Fractography of Dissimilar Friction Stir Welded Joints of Aluminum Alloys 7075-T6 and 5052-H34" International Journal of Materials Science and Engineering, Vol. 2, No. 2 December 2014.
- B.K. Jasthi, E. Klinckman, T. Curtis, C. Widener, M. West, R.B. Ruokolainen, A. Dasgupta, "Effect of Post-weld Aging on the Corrosion and Mechanical Properties of Friction Stir Welded Aluminum Alloy 7475-T73", Friction Stir welding and Processing, VII (2013), pp. 225-234.
- Md Shamsujjoha, B.K. Jasthi, M. West and C. Widener, "Microstructure and Mechanical Properties of FSW Lap Joint between Pure Copper and 1018 Mild Steel Using Refractory Metal Pin Tools", Friction Stir welding and Processing, VII (2013), pp. 151-160.
- B.K. Jasthi, W. J. Arbegast, and S. M. Howard, "Effect of Thermal Aging on the Corrosion Properties of Friction Stir Welded Alloy 22. Metallurgical and Materials Transactions-A, 43(A) (2012), pp. 3192-3201.
- B. Kaligotla, B.K. Jasthi, W.J. Arbegast, and S.M. Howard, "Effect of Thermomechanical Processing on Abnormal Grain Growth in Al-2195 Friction Stir Welds", Trends in Welding Research, (9) (2012), pp. 553-557.
- B.K. Jasthi, S.M. Howard, W.J. Arbegast, "Friction Stir Processing of Cast Inconel 718, Friction Stir Welding and Processing, VI (2011), pp. 25-32.
- B.K. Jasthi, Stanley M. Howard, William J. Arbegast, "Friction Stir Processing of Alloy 22" Friction Stir Welding and Processing, VI (2011), pp. 11-18.
- M. West, B.K. Jasthi, P. Hosemann, V. Sodesetti, "Friction Stir Welding of Oxide Dispersion Strengthened Alloy MA956", Friction Stir Welding and Processing, VI (2011), pp. 33-40.

RECENT PROFESSIONAL DEVELOPMENT ACTIVITIES

- D2L Distant Learning Software Short Course (8 hours)
- Listening Workshop and Meetings Matter by Paul Axtell (5 hours)
- 'Lunch'N Learn' seminars on Teaching with Technology and Teaming Skills

JON J. KELLAR

Professor

DEGREES WITH FIELDS, INSTITUTION, AND DATE

- B.S., Metallurgical Engineering, South Dakota School of Mines and Technology, Rapid City, SD (1984)
- M.S., Metallurgical Engineering, South Dakota School of Mines and Technology, Rapid City, SD (1986)
- Ph.D., Metallurgical Engineering, University of Utah, Salt Lake City, UT (1991)

ACADEMMIC EXPERIENCE

1990- 1994	Assistant Professor, Tenure Track - original appointment
1994 – 1999	Associate Professor, Tenured
1999 –	Professor, Tenured

NON-ACADEMIC EXPERIENCE

1983	Duval Corporation Sierrita, AZ	Engineer (Intern)
1984	Hecla Mining Company Wallace, ID	Engineer (Intern)
1992	Allied Signal	Consultant
1993	Dead Sea Bromine	Consultant
1995	Micron Inc.	Consultant

CERTIFICATIONS AND PROFESSIONAL REGISTRATIONS

Not Applicable

CURRENT MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

SME

HONORS AND AWARDS

1993	Benard A. Ennenga Faculty Award (SD Mines)
1994	Presidential Faculty Fellow Award (National Science Foundation)
1997	Award for Excellence in Research (SD Board of Regents)
1999	Presidential Faculty Award (SD Mines)
2008	Carnegie Foundation for Advancement of Learning Professor (South Dakota) of the Year
2015	Mineral Industry Education Award (American Institute of Mining, Metallurgical & Petroleum Engineers)
2016	Distinguished Member (Society of Mining, Metallurgy and Exploration)

SERVICE ACTIVITIES (last five years)

Society of Mining, Metallurgy and Exploration,

- Governmental Affairs and Planning Committee, (2011)
- Richards Award Committee, (2011)
- Mineral Processing Division, Wadsworth Award Committee, (2011)

- Governmental Affairs and Planning Committee (2012)
- Richards Award Committee (2012)
- Mineral Processing Division, Wadsworth Award Committee (2013)
- Mineral Processing Division, Nominating Committee (2013)
- Education Sustainability Committee, (2015)
- Taggart Award Committee (Chair), (2015)
- Rong Yu Wan Dissertation Award Committee, (2015)
- MPD Scholarship Committee, (2015)
- Richards Award Committee (Chair), (2015)

PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

- J. Meruga, J. Kern, J. Petersen, B. Logue, A. Baride, P.S. May, W. Cross, G. Crawford, D. Tamayo, J. Richards and J. Kellar, "Innovative Security Applications using Direct-Write Printing," Keesing Journal of Documents and Identity, V. 47, 6/15/15.
- A. Baride, J. Meruga, C. Douma, D. Langerman, G. Crawford, J.J. Kellar, W.M. Cross, and P.S. May, P.S. "A NIR-to-NIR upconversion Luminescence System for Security Printing Applications," RSC Advances, 5, 101338-101346, 2015.
- J.M. Meruga, A. Baride, W. Cross, P.S. May and J.J. Kellar, "Red-Green-Blue Printing using Luminescence-Upconversion Inks," Journal of Materials Chemistry C, 2014, 2, 2221-2227.
- S. Vunnam, K. Ankireddy, J. Kellar and W. Cross, "Highly Transparent and Conductive Al-doped ZnO Nanoparticulate Thin Films Using Direct Write Processing," Nanotechnology, 2014, 25, 195301.
- J.M. Meruga, C. (Nesson) Fountain, J.J. Kellar, G. Crawford, A. Baride, P.S. May, W. Cross, and R. Hoover, "Multi-Layered Covert QR Codes for Increased Capacity and Security," International Journal of Computers and Applications, 2015, V. 37, No1, pg. 1-11.
- K.N. Han, J.J. Kellar, W.M. Cross and S. Safarzadeh, "Opportunities and Challenges for Treating Rare-Earth Elements," Geosystem Engineering, 2014, V. 17, No. 3, pg. 178-194.
- S. Vunnam, K. Ankireddy, J. Kellar and W. Cross, "Environmental Stability of Solution Processed Al-doped ZnO Nanoparticulate Thin Films using Surface Modification Technique," Applied Surface Science, 2014, 322, pg 1-5.
- J.B. Petersen, J. Meruga, J., Randle, W.M. Cross and J.J. Kellar, "Hansen Solubility Parameters of Surfactant-Capped Silver Nanoparticles for Ink and Printing Technologies," Langmuir, 2014, 51, 15514-9.
- S. Vunnam, W. Cross, W., Ankireddy, K. and Kellar, J., "Surface Treatments of Indium-Tin Oxide for Printing Nanoparticle Inks using Direct Write Technologies", Thin Solid Films, V. 531, March 2013, Pages 294–301.

RECENT PROFESSIONAL DEVELOPMENT ACTIVITIES

- Materials Handling Institute Workshop, July 2015, Madison, WI (five days)

M. SADEGH SAFARZADEH

Assistant Professor

DEGREES WITH FIELDS, INSTITUTION, AND DATE

- BS, Materials Science Engineering, Sahand University of Technology, Iran (2003)
- MS, Materials and Metallurgical Engineering, Iran University of Science and Technology, Iran (2005)
- Ph.D., Metallurgical Engineering, University of Utah, Salt Lake City, UT (2013)

ACADEMMIC EXPERIENCE

2014 – Assistant Professor

NON-ACADEMIC EXPERIENCE

2004 - 2009 Iranian Zinc Mines Development Company Senior Research Scientist

CURRENT MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

TMS, SME

HONORS AND AWARDS

2012 - Wagner Equipment Award, MPD Annual Meeting, Colorado Springs, CO
2012 - International Precious Metals Institute (IPMI) Metalor Technologies Graduate Student Award, Las Vegas, NV
2013 - SME's Mineral and Metallurgical Processing Division (MPD) Award, Denver, CO
2015 - SME's Rong Yu Wan PhD. Dissertation Award, Denver, CO

SERVICE ACTIVITIES

Committee Member, Arthur F. Taggart Award, SME, 2015-2018
Key Reader, Metallurgical and Materials Transactions B, TMS, 2015-
Associate Editor of the Elsevier journal Hydrometallurgy, 2013-
Member of Faculty Senate Research and Scholarly Affairs Committee, SDSM&T, 2013-

PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

- M.S. Safarzadeh, M.S. Moats, J.D. Miller, 2014. "Recent trends in the processing of enargite concentrates." *Mineral Processing and Extractive Metallurgy Review*, 35, 283-367.
- M.S. Safarzadeh, M.S. Moats, J.D. Miller, 2014. "An update to "Recent trends in the processing of enargite concentrates"." *Mineral Processing and Extractive Metallurgy Review*, 35, 390-422.
- N. Dhawan, M.S. Safarzadeh, J.D. Miller, M.S. Moats, R.K. Rajamani, C.L. Lin, 2012. "Recent advances in the application of X-ray Computed Tomography in the analysis of heap leaching systems." *Minerals Engineering*, 35, 75-86.
- N. Dhawan, M.S. Safarzadeh, J.D. Miller, M.S. Moats, R.K. Rajamani, 2013. "Crushed ore agglomeration and its control for heap leach operations." *Minerals Engineering,* 41, 53-70.
- M.S. Safarzadeh, J. Li, M.S. Moats, J.D. Miller, 2012. "The stability of selected sulfide

minerals in sulfuric acid and acidic thiocyanate solutions." *Electrochimica Acta*, 78, 133-138.

- J. Li, M.S. Safarzadeh, M.S. Moats, J.D. Miller, K.M. LeVier, M. Dietrich, R.Y. Wan, 2011."Thiocyanate hydrometallurgy for the recovery of gold. Part I: Chemical and thermodynamic considerations." *Hydrometallurgy*, 113-114, 1-9.
- J. Li, M.S. Safarzadeh, M.S. Moats, J.D. Miller, K.M. LeVier, M. Dietrich, R.Y. Wan, 2011. "Thiocyanate hydrometallurgy for the recovery of gold. Part II: The leaching kinetics." *Hydrometallurgy*, 113-114, 10-18.
- J. Li, M.S. Safarzadeh, M.S. Moats, J.D. Miller, K.M. LeVier, M. Dietrich, R.Y. Wan, 2011. "Thiocyanate hydrometallurgy for the recovery of gold. Part III: Thiocyanate stability." *Hydrometallurgy*, 113-114, 19-24.
- J. Li, M.S. Safarzadeh, M.S. Moats, J.D. Miller, K.M. LeVier, M. Dietrich, R.Y. Wan, 2011. "Thiocyanate hydrometallurgy for the recovery of gold. Part IV: Solvent extraction of gold with Alamine 336." *Hydrometallurgy*, 113-114, 25-30.
- J. Li, M.S. Safarzadeh, M.S. Moats, J.D. Miller, K.M. LeVier, M. Dietrich, R.Y. Wan, 2011. "Thiocyanate hydrometallurgy for the recovery of gold. Part V: Process alternatives for solution concentration and purification." *Hydrometallurgy*, 113-114, 31-38.
- M.S. Safarzadeh, J.D. Miller, H.H. Huang, 2014. "Thermodynamic analysis of the Cu-As-S-(O) system relevant to sulfuric acid baking of enargite at 473 K (200 °C)." *Metallurgical and Materials Transactions B*, 45 (2), 568-581.
- M.S. Safarzadeh, J.D. Miller, 2014. "Reaction of enargite (Cu_3AsS_4) in hot concentrated sulfuric acid under an inert atmosphere. Part I: Enargite Concentrate." *International Journal of Mineral Processing*, 128, 68-78.
- M.S. Safarzadeh, J.D. Miller, 2014. "Reaction of enargite (Cu_3AsS_4) in hot concentrated sulfuric acid under an inert atmosphere. Part II: High-quality Enargite." *International Journal of Mineral Processing*, 128, 79-85.
- M.S. Safarzadeh, J.D. Miller, 2014. "Reaction of enargite (Cu_3AsS_4) in hot concentrated sulfuric acid under an inert atmosphere. Part III: Reaction Stoichiometry and Kinetics." *International Journal of Mineral Processing*, 130, 56-65.

RECENT PROFESSIONAL DEVELOPMENT ACTIVITIES

- Co-organizing a symposium for the 3rd Pan American Materials Congress, TMS, Minerals Extraction and Processing

DAVID R. SALEM

Professor and Director of Composites and Polymer Engineering (CAPE) Laboratory

DEGREES WITH FIELDS, INSTITUTION, AND DATE

- PhD, Polymer and Fiber, Manchester University, U.K. (1983)
- BS, Textile Science and Technology, Bradford University, U.K. (1979)

ACADEMMIC EXPERIENCE

- 2010 - Present Professor, Director of CAPE Laboratory, SDSM&T
- 2013 - Present Director, CNAM Center, SDSM&T

NON-ACADEMIC EXPERIENCE

- 2008-10 David Salem Consulting, Boulder CO - Materials Science Consultant
- 2007-08 NanoProducts Corp., Longmont CO - Director, Applications Development
- 2002-07 Charge Injection Technologies Inc., NJ - VP, Research & Development
- 1995-02 TRI/Princeton, Princeton NJ - Director of Research
- 1994 TRI/Princeton, Princeton NJ - Principal Scientist
- 1988-94 TRI/Princeton, Princeton NJ - Senior Scientist
- 1986-88 Rhône-Poulenc, St. Fons, France - Senior Scientist
- 1985-6 TRI/Princeton, Princeton NJ - Staff Scientist
- 1983-5 Post-Doctoral Fellow,

CERTIFICATES AND PROFESSIONAL REGISTRATIONS

Chartered Physicist, CPhys (1994)

PROFESSIONAL ORGANIZATION MEMBERSHIPS

Member of the Institute of Physics, U.K.
Society for the Advancement of Material and Process Engineering (SAMPE)
Fiber Society

HONORS AND AWARDS

Plenary Lecturer, International Conference on Oriented Polymers, Montreal, 1998
Award for Distinguished Achievement in Fiber Science, Fiber Society, 1996
CASE Studentship Award, 1979 - 83, Science and Engineering Research Council, U.K.

SERVICE ACTIVITIES

- Member of the Nanoscience and Nanoengineering Graduate Program Advisory committee
- Judge at the annual NanoExpo 2012, 2013 and 2014
- Faulty Advisor of SAMPE student chapter, SDSMT, 2013 - Present
- Member of Scientific Advisory Committee, International Conference on Polymer Fibers (2002 - 2010)
- Session Moderator, *SAMPE Tech Conference 2014*, Seattle, WA
- Session Chair, *International Symposium on Fibers Interfacing the World, 2013*, Clemson SC

PUBLICATIONS

1. H. Hong, G.P. Peterson and D.R. Salem, "Composite Materials with Magnetically Aligned Carbon Nanoparticles having Enhanced Electrical Properties and Methods of Preparation", US Patent 9,312,046 (2016)
2. Y. Zhao, T. Xu, X. Ma, M. Xi, D.R. Salem and H. Fong, "Hybrid multi-scale epoxy composites containing conventional glass microfibers and electrospun glass nanofibers with improved mechanical properties", *J. Appl. Polym. Sci*., **132**, 42731 (2015)
3. E. Schmid and D.R. Salem, "Fabrication Technique and Thermal Insulation Properties of Micro- and Nano-Channeled Polymer Composites", *Acta Astronautica*, **116**, 68 (2015)
4. B. Chu, A.T. Brady, B.D. Mannhalter and D.R. Salem, "Effect of Silica Particle Surface Chemistry on the Shear Thickening Behavior of Concentrated Colloidal Suspensions", *J. Phys. D: Appl. Phys.* 47, 335302 (2014)
5. B. Chu and D.R. Salem, "Flexoelectricity in Several Thermoplastic and Thermosetting Polymers", *Appl. Phys. Lett.* 101, 103905 (2012)

PRESENTATIONS

1. D.R. Salem, "The Composite and Nanocomposite Advanced Manufacturing Center: Activities and Goals", *Johns Manville Corporation*, Invited Seminar, Denver CO, October 2015*:*
2. D.R. Salem "Overview of Composite and Nanocomposite Research at the South Dakota School of Mines and Technology", *University of Clemson Invited Seminar*, Clemson SC, March 2015
3. E.D. Schmid and D.R. Salem, "Micro- and Nano-channeled Materials for Structural, Thermal Insulation Composites (STICs)", *Proceedings of the International Symposium on Fibers Interfacing the World*, p. 122 (2013)
4. A.T. Kulesa, M. J. Robinson, W. M. Cross, and D. R. Salem, "Analytical Study of Thermal and Mechanical Properties of Syntactic Foams for Space Applications", *64th Annual Astronautical Congress (IAC)*, Vol. 8., C2.6.4 p. 6031 (2013)
5. B. Chu, A.T. Brady, B.D. Mannhalter and D.R. Salem, "Controlling the Shear Thickening Behavior of Silica Nanoparticle Suspensions by Particle Heat Treatments", *Proceedings of the Annual Conference of the Society for the Advancement of Materials and Process Engineering (SAMPE)* (2013)

PROFESSIONAL DEVELOPMENT ACTIVITIES

- *CAMX Conference and Exhibition*, Dallas Texas 2015. Attendee.
- *CAMX Conference and Exhibition*, Orlando Florida 2014. Attendee.

MICHAEL K. WEST

Associate Professor, Department Head

DEGREES WITH FIELDS, INSTITUTION, AND DATE

- B.S.E. Nuclear Engineering, Arizona State University, Tempe, AZ (1994)
- MS., Nuclear Engineering, Texas A&M University, College Station, TX (1998)
- PhD., Materials Science and Engineering, University of Tennessee, Knoxville, TN (2006)

ACADEMIC EXPERIENCE

2006-2011 Assistant Professor, Materials and Metallurgical Engineering, SDSM&T

2012-present Associate Professor, Materials and Metallurgical Engineering, SDSM&T (Tenured 2011)

NON-ACADEMIC EXPERIENCE

2009-2010 Interim Director, Advanced Materials Processing Center (AMP), SDSM&T

2009-2010 Interim Director, Repair, Refurbish, and Return to Service (R3S) State of South Dakota "2010 Center", SDSM&T

CERTIFICATIONS AND PROFESSIONAL REGISTRATIONS

none

CURRENT MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

TMS, ASM, AWS

HONORS AND AWARDS

Tau Beta Pi, Engineering Honor Society, 1993

Alpha Nu Sigma, Nuclear Engineering Honor Society, 1996

Phi Kappa Phi, Academic Honor Society, 1997

Tennessee Advanced Materials Laboratory (TAML) Fellowship, 2001

SERVICE ACTIVITIES

Faculty advisor for Black Hills AWS Student Chapter, 2007-present.

Faculty advisor SDSM&T Racquetball Club, 2009-present

Site Director, NSF I/UCRC Center for Friction Stir Processing at SDSM&T, 2007-2014.

Site Director, NSF REU Site "Back to the Future", 2009-present. NSF/REU student research supervisor 2007, 2009-present.

Organizer, South Dakota Undergraduate Research Symposium, 2014-present.

Organizer/Instructor, ASM International "Materials Camp" for High School Students, SDSM&T 2009-present, University of Tennessee, Knoxville, 2004-2006.

Mentor, Army Educational Outreach Program for High School Students REAP/UNITE program, 2012-present.

Instructor, Fundamentals of Engineering (FE) SDSM&T Exam Review, Materials Engineering, 2009-2013.

Instructor, Gear-Up Program for Native American Students, South Dakota School of Mines and Technology, 2007-present.

GEAR-UP Program for Native American High School Students, 2007-present.

STEPS Science Technology and Engineering Preview Camp for Middle School Girls and Boys, 2007-2012.
SDSM&T Youth Engineering Adventure, 2007-2012.
NASA Space Observation Learning and Research SOLAR Program, 2009-2012.
NASA Space Days, 2008-2012.

PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

V. Champagne III, M. West, R. Rokni, T. Curtis, V. Champagne Jr, B. McNally, "Joining of Cast ZE41A to Wrought 6061 by the Cold Spray Process and Friction Stir Welding," Journal of Thermal Spray Technology, Vol. 25 (1-2) (2016) p. 143-159.

Md Shamsujjoha, B.K. Jasthi, M. West and C. Widener, "Friction Stir Lap Welding of Aluminum to Steel Using Refractory Metal Pin Tools," Journal of Engineering Materials and Technology, Vol. 137 (2) (2015).

M.R. Rokni, C. A. Widener, G. A. Crawford, M. K. West, "An investigation into microstructure and mechanical properties of cold sprayed 7075 Al deposition", Materials Science and Engineering: A, 2015 Volume 625, (2015) Pages 19-27.

T. Curtis, C. Widener, M. West, B.K. Jasthi, Y. Hovanski, B. Carlson, R. Szymanski, and W. Bane, "Friction Stir Scribe Welding of Dissimilar Aluminum to Steel Lap Joints" Friction Stir Welding and Processing-VIII, TMS 2015, pp. 191-198.

B.K. Jasthi, T. Curtis, C. Widener, M. West, M. Carriker, A. Dasgupta and R. Ruokolainen, "Friction Stir Processing of Direct-Metal-Deposited 4340 Steel" Friction Stir Welding and Processing-VIII, TMS 2015, pp. 191-198.

Timothy Johnson, Todd Curtis, Bharat Jasthi, Eric East, Christian Widener, Michael West, "Effect of Friction Stir Processing on Armor Grade Materials", Friction Stir Welding and Processing-VII, TMS 2013, pp. 173-182.

M. West, B. Jasthi, N. Smith, J. Oduor, Y. Chen, "Microstructure and Mechanical Properties of Friction Stir Processed Grade 40 Grey Cast Iron", Friction Stir Welding and Processing VI, Wiley-TMS, Edited by Mishra et al. (2011) 41-48.

RECENT PROFESSIONAL DEVELOPMENT ACTIVITIES

DOE SBIR/STTR Additive Manufacturing of Nuclear Components Reviewer, 2014.
NSF REU Programs Reviewer, 2010, 2013.
DOE Breakthrough Joining Proposals Reviewer, 2013.
NASA EPSCoR Proposal Reviewer, 2011-present.
DOE Nuclear Engineering University Programs Reviewer, 2011-2013.

CHRISTIAN A. WIDENER

Associate Professor and Director of Arbegast Materials Processing and Joining Laboratory

DEGREES WITH FIELDS, INSTITUTION, AND DATE

- B.S., Mechanical Engineering, Wichita State University (1996)
- M.S., Mechanical Engineering, Wichita State University (2004)
- Ph.D., Mechanical Engineering (Minor – Materials Engineering), Wichita State University (2005)

ACADEMIC EXPERIENCE

2005 – 10 Adjunct Lecturer, Wichita State University
2010 - Associate Professor, Tenured, South Dakota School of Mines & Technology

NON-ACADEMIC EXPERIENCE

1997-09	Westinghouse Electric Company Houston, TX	Gas Turbine Field Service Engineer
1999-02	Siemens Power Generation Orlando, FL	Gas Turbine Installation Site Manager
2004-10	National Institute for Aviation Research Wichita, KS	Research Scientist

CERTIFICATIONS AND PROFESSIONAL REGISTRATIONS

Thermal Spray Management Certificate, ASM Thermal Spray Society, 2015

CURRENT MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

TMS, ASM, ASME, SME, AWS

HONORS AND AWARDS

1991 – Kansas Honor Scholar
1993 – Wallace Scholar
1994 – Pi Tau Sigma Mechanical Engineering Honor Society Member
1996 – Emory Lindquist Honors Graduate
2004 – Dwayne & Velma Wallace Outstanding Graduate Student Teacher Award
2009 – Honorary Commander, McConnell Air Force Base
2015 – South Dakota Governor's Giant Vision (1st place – tie)

SERVICE ACTIVITIES

Guest Editor, International Journal of Thermal Spray, 2015
Associate Editor, International Thermal Spray Conference, 2015
SDSM&T University Research Committee Member 2014 –

PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

- Ozdemir, O.C., Widener, C.A., Helfritch, D., and Delfanian, F. (2015), Estimating the effect of helium and nitrogen mixing on deposition efficiency in cold spray, International Journal of Thermal Spray, (Under Review, 9/18/15).

- Widener, C.A., Hrabe, R.H., Stamey, T., Hoiland, B., Carter, M. and Champagne, V.K. (2016). Navy Valve Actuator Repair Using Cold Spray, International Journal of Thermal Spray, 25(1-2), 193-201.
- Rokni, M.R., Widener C.A., and Crawford, G.A. (2015). An Investigation into Microstructure & Mechanical Properties of Cold Sprayed 7075 Al deposition, Materials Science & Engineering A, v. 625; 19-27.
- Rokni, M.R., Widener, C.A., Champagne, V.K., and Crawford, G.A. (2015). Microstructure and mechanical properties of cold sprayed 7075 deposition during non-isothermal annealing, Surface and Coatings Technology Journal, v. 276; 305-315.
- Rokni, M.R., Widener, C.A. and Crawford, G.A. (2014). Microstructural evolution of 7075 Al gas atomized powder and high-pressure cold sprayed deposition, Surface and Coatings Technology Journal, v. 251; 254-263.
- Rokni, M.R., Widener C., and Champagne V.R. (2014). Microstructural Stability of Ultrafine Grained Cold Sprayed 6061 Aluminum Alloy, Applied Surface Science, v. 290 p. 482-489.
- Rokni, M.R., Widener, C. A., Ahrenkiel, S. P., Jasthi, B. K., & Champagne, V. R. (2014). Annealing behaviour of 6061 aluminium deposited by high pressure cold spray. Surface Engineering, 30(5); 361-368.
- Rokni, M.R., Zarei-Hanzaki, A. Widener, C.A., and Changizian, P. (2014). The Strain-Compensated Constitutive Equation for High Temperature Flow Behavior of an Al-Zn-Mg-Cu Alloy, Journal of Materials Engineering and Performance, 23(11); 4002-4009.
- Rokni, M.R., Widener, C.A., and Champagne, V. R. (2014). Microstructural Evolution of 6061 Aluminum Gas-Atomized Powder and High-Pressure Cold-Sprayed Deposition, Journal of Thermal Spray Technology, 23(3); 514-524.
- Rokni, M.R., Widener, C.A. and Champagne, V.K. (2014). Microstructural Stability of Ultrafine Grained Cold Sprayed 6061 Aluminum Alloy, Journal of Applied Surface Science, v. 290; 482-489.
- Misak, H., Widener, C.A., Burford, D., and Asmatulu, R. (2014). Fabrication and Characterization of CNT Nanocomposites into 2024-T3 Al Substrates via Friction Stir Welding Process, Journal of Engineering Materials and Technology, 136(2), 024501 (online 5 pages).
- Rokni, M.R., Widener, C.A., Nardi, A.T., and Champagne, V.K. (2013). Nano crystalline high energy milled 5083 Al powder deposited using cold spray, Applied Surface Science, v. 305; 797-804.
- Widener, C.A., Hrabe, R.H., Stamey, T., Hoiland, B., Carter, M. and Champagne, V.K. (2015). Navy Valve Actuator Repair Using Cold Spray, International Thermal Spray Conference and Exposition (ITSC), Long Beach, CA, May 11-14, 2015.
- Widener, C.A., Franklin, J., Jasthi, B.K., and West, M.K. (2013). Mechanical Properties of Repaired 7075-T73 Friction Stir Weld Butt Welds, Friction Stir Welding and Processing VII, Edited by R. Mishra, M. Mahoney, Y. Sato, Y. Hovanski, and R. Verma, John Wiley and Sons, Inc., Hoboken, NJ; pp. 205-213.

RECENT PROFESSIONAL DEVELOPMENT ACTIVITIES

- Business Launch Boot Camp Graduate, SD Technology Business Center, (40 hours)
- Lean Manufacturing Training, South Dakota MTS, (16 hours)

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Appendix C – Equipment

Using an approach to leverage research and private funding, the department has been successful to supplement limited state support for new equipment. Major pieces of equipment used by the program in support of instruction acquired since the last review (acquired since 2010) are summarized in Table C-1. Highlights include the following.

- 3D X-ray MicroCT system (NSF MRI proposal)
- Potentiostat, autoclave, and thermogravimetric analyzer (grants for critical minerals extraction)
- Atomic force microscope upgrade (SD Board of Regents)
- Grinder polishers and mounting press (industry donations)

Major equipment for the department acquired before 2010 is shown in Table C-2. The entire list of available equipment is available on request.

In addition to this equipment, the department has access to and uses equipment located in the Arbegast Advanced Manufacturing Center. This includes the following equipment:

- Five-axis friction stir welder
- Materials testing systems 110 kip and 70 kip
- Direct deposit laser deposition system with inert atmosphere and programmable 3-D position 2 kW YAG laser fitted with dual powder feeders
- Ultrasonic welder
- Cold Spray units
- Water jet cutter (10-x14-ft tank)

The department also has equipment not listed on the inventory list in Table C-1 including:

- Vacuum 30 kW induction melter
- Ultra-purity Zone refiner (1 meter, induction heated, inert and hydrogen gas atmosphere
- Czochralski Crystal grower (4-x4-in. melt pool, 25 kW induction generator)

Table C-1 Capital assets acquired since 2010

Asset Description	Acq Date	Cost	Room	Location
Leco, PR-36 Electro-hydraulic mounting press	08/06/2015	8,662	124	MI
Thermo Scientific, Still, 2 gph 120/208v 3ph	02/25/2015	6,358	126	MI
Workstation, Na-Haworth Unigroup: 48"x 24”	10/03/2014	14,682	123	MI
Millermatic 252, MIG Welders (2)	06/01/2014	5,000		MF
Lincoln Electric Precision TIG 225 Welders (2)	06/01/2014	5,000		MF
TA Instruments, Thermogravimetric analyzer with Au, 953000.908-Q500	02/18/2014	42,670	127	MI
Potentiostat/galvanostat/EIS analyzer, Parstat 4000	02/11/2014	46,647	131	MI
Pressure reaction apparatus, 4531-t-625-m(hc),115v	02/10/2014	29,698	131	MI
Sieving riffler, 02001-1-	01/27/2014	7,094	131	MI
Bruker Multimode 8-Upgrade Atomic Force Microscope + accessories	01/10/2013	174,970	127	MI
Video spectral comparator, VSC-6000/HS and Foram Raman	06/27/2012	178,083	228	MI
Action Mining Services, M5 Micron Mill Wave Table	05/22/2012	3,977	130	MI
Xradia, 3D X-ray tomography, MicroXCT-400, high-resolution, 1007548	05/11/2012	612,000	128C	MI
Metaserv 250 twin grinder polisher, 4910057	07/28/2011	15,447	124	MI
QPEC #7 Flotation Cell	05/30/2011	5,000	130	MI
Tube furnace	07/01/2010	6,470	121	MI
Hydrogen palladium purifier	05/24/2010	5,503	121	MI
Eriesz Magnetic separator	04/21/2010	13,181	130A	MI

Table C-2 Capital assets acquired before 2010

Asset Description	Acq Date	Amount	Room	Location
Carbon coater	12/30/2009	25,673	234	MMI
Rame-Hart Model 500 Advanced Goniometer/tensiometer	08/13/2009	36,870	113	MMI
Micro-force test system, MTS	08/13/2009	129,902	123	MMI
Air hammer	12/08/2008	6,393		MF
Tester, microhardness	05/14/2008	11,731	125	MMI
Image analysis system (microscope)	05/14/2008	16,000	124B	MMI
Action Mining Services, M5 Micron Mill Wave Table	05/22/2012	3,977	130	MMI
Grinder-polisher	04/28/2008	5,048	124	MMI
Abrasive cut-off saw	04/24/2008	5,978	125	MMI
Viscosity meter	12/18/2007	5,608	102	MMI
Prepregger, hot melt unidirectional	08/20/2007	470,000	112	MTDL
Trailer, 8x20 tandem auto	07/01/2007	7,030		MMI
Ellipsometer, discrete wavelength	05/07/2007	43,105	127	MMI
Electrometer	03/20/2007	5,456	111	MMI
Plasma cleaner w/vacuum pump	01/17/2007	8,288	113	MMI
Three roll mill	01/12/2007	11,245	111	MMI
Wilhelmy Plate Surface tension meter	12/21/2006	30,968	113	MMI
Dimatix materials printer	07/14/2006	31,720	102	MTDL
Ultra-microtome	06/30/2006	34,193	211	MEP
Spin coater	06/27/2006	5,477	113	MMI
Bath cryostat system	06/14/2006	29,121	133	MEP
Impact tester	06/07/2005	34,000	125	MMI
Nicomp 380 submicron particle size analyzer w/zeta potential	02/01/2005	53,182	113	MMI
Bohlin Rheometer	06/15/2004	32,945	113	MMI

Table C-2 Capital assets acquired before 2010 (Cont'd)

Asset Description	Acq Date	Amount	Room	Location
Bath cryostat system	06/14/2006	29,121	133	MEP
Impact tester	06/07/2005	34,000	125	MMI
Nicomp 380 submicron particle size analyzer w/zeta potential	02/01/2005	53,182	113	MMI
TA Instruments Q400 Thermomechanical analyzer	10/23/2003	46,158	127	MMI
Hot disk base w/desktop computer	05/20/2003	62,000	113	MMI
Specimen mounting press	05/15/2003	8,979	124	MMI
TA Instruments Q100 Differential scanning calorimeter	04/15/2003	36,039	127	MMI
TA Instruments Q800 Dynamic mechanical analyzer	04/15/2003	51,683	102	MCM
Leco image analysis system (upgrade)	04/15/2003	15,597	124B	MMI
Microtrac Laser particle analyzer	02/13/2003	44,076	113	MMI
Manning Polymer modulator	11/21/2002	22,390	123	MMI
Rheometric Minature materials tester	08/31/1998	9,500	124B	MMI
Microscope, Olympus	06/29/1998	27,137	324	MMI
Flotation machine cell	06/12/1996	5,000	130	MMI
Jaw crusher	06/12/1996	5,000	130	MMI
Tester, microhardness	10/01/1994	16,000	125	MMI
Goniometer	06/01/1993	13,253	127	MMI
Computer system IBM	06/01/1992	36,279	102	MMI
Grinder, dimple	07/01/1991	8,280	128C	MMI
Image Analysis System	09/01/1990	70,500	124B	MMI
Furnace, induction	04/01/1990	63,414	121	MMI
Furnace, tube/controller	06/01/1989	5,039	130A	MMI

Table C-2 Capital assets acquired before 2010 (Cont'd)

Asset Description	Acq Date	Amount	Room	Location
Ion Millier Fischion	12/01/1993	48,157	240	MEP
Goniometer	06/01/1993	13,253	127	MMI
Computer system IBM	06/01/1992	36,279	102	MMI
Grinder, dimple	07/01/1991	8,280	128C	MMI
Image Analysis System	09/01/1990	70,500	124B	MMI
Furnace, induction	04/01/1990	63,414	121	MMI
Furnace, tube/controller	06/01/1989	5,039	130A	MMI
Separator, magnetic	10/01/1987	8,000	126	MMI
Furnace, triple console	12/01/1976	5,268	128B	MMI
Test System, MTS	10/01/1974	23,917	125	MMI
Spectrometer, mass	07/01/1974	23,280	121	MMI
Rolling mill w/drive	12/01/1962	14,917	125	MMI

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Appendix D – Institutional Summary

This summary contains vital information about SDSM&T including address, president, provost, its organization and control.

A. The institution

a. South Dakota School of Mines and Technology
501 E. Saint Joseph St.
Rapid City, SD 57701

b. Dr. Heather Wilson, President
O'Harra building, room 215a
Heather.Wilson@sdsmt.edu
605-215-2411

c. Dr. Demitris Kouris, Provost and Vice President for Academic Affairs
O'Harra building, room 215b
Demitris.Kouris@sdsmt.edu
605-394-2256

d. Organizations by which the institution is now accredited and the dates of the initial and most recent accreditation evaluations.

Accreditation Unit	Date of Initial Accreditation	Date of Most Recent Accreditation or Approval
Higher Learning Commission of the North Central Association	1925	2014-2015
Engineering Accreditation Commission of ABET, Inc.	1936	Mining Engineering 2010 Chemical Engineering 2011 Civil Engineering 2011 Computer Engineering 2011 Electrical Engineering 2011 Geological Engineering 2011 Industrial Engineering and Engineering Management 2011 Mechanical Engineering 2011 Metallurgical Engineering 2011
American Chemical Society*	1950	Chemistry 2007 (approval for 2015 review cycle is pending)
Computing Accreditation Commission of ABET, Inc.	1992	Computer Science 2014

* The American Chemical Society "approves" programs in chemistry on a 5-year review cycle

B. Type of control
State public university, governed by the South Dakota Board of Regents

C. Educational unit
Academic Affairs at SD Mines is a single division without colleges. Fifteen departments (listed in Section 4 below) offer 16 undergraduate programs, 14 Master's programs, and 9 Ph.D. programs (see http://www.sdsmt.edu/Academics/Degrees/All-SD-Mines-Degrees/). The department heads and program chairs or directors meet twice monthly with Dr. Kouris, Provost and Vice President for Academic Affairs, in the Academic Leadership Council (ALC). In addition, the department heads meet as needed on a one-on-one with the provost.

The department heads of all programs under review by the EAC of ABET, Inc. in the 2016-2017 cycle are members of the Academic Leadership Council (ALC) and, as such, report directly to the provost. The provost reports directly to Dr. Wilson, President of SD Mines. An associate provost, Dr. Kate Alley, and an associate provost for academic administration, Molly Moore, assist the provost but are not members of the ALC.

The Dean of Graduation Education, Dr. Doug Wells, reports to Dr. Kouris, Provost and Vice President for Academic Affairs and is a member of the ALC. (See the Office of Graduate Education at (http://www.sdsmt.edu/GraduateEducation/).

Additional units reporting directly to the provost include the Center for Advanced Manufacturing and Production (CAMP), the Deveraux Library, Information Technology Services, Admissions and the Registrar and Academic Services, the Museum of Geology, Youth Programs, and the Women in Science and Engineering program.

The organizational chart for SD Mines is below in Figure D-1 and can be viewed in larger format online at
http://www.sdsmt.edu/About/Office-of-the-President/Organizational-Chart/

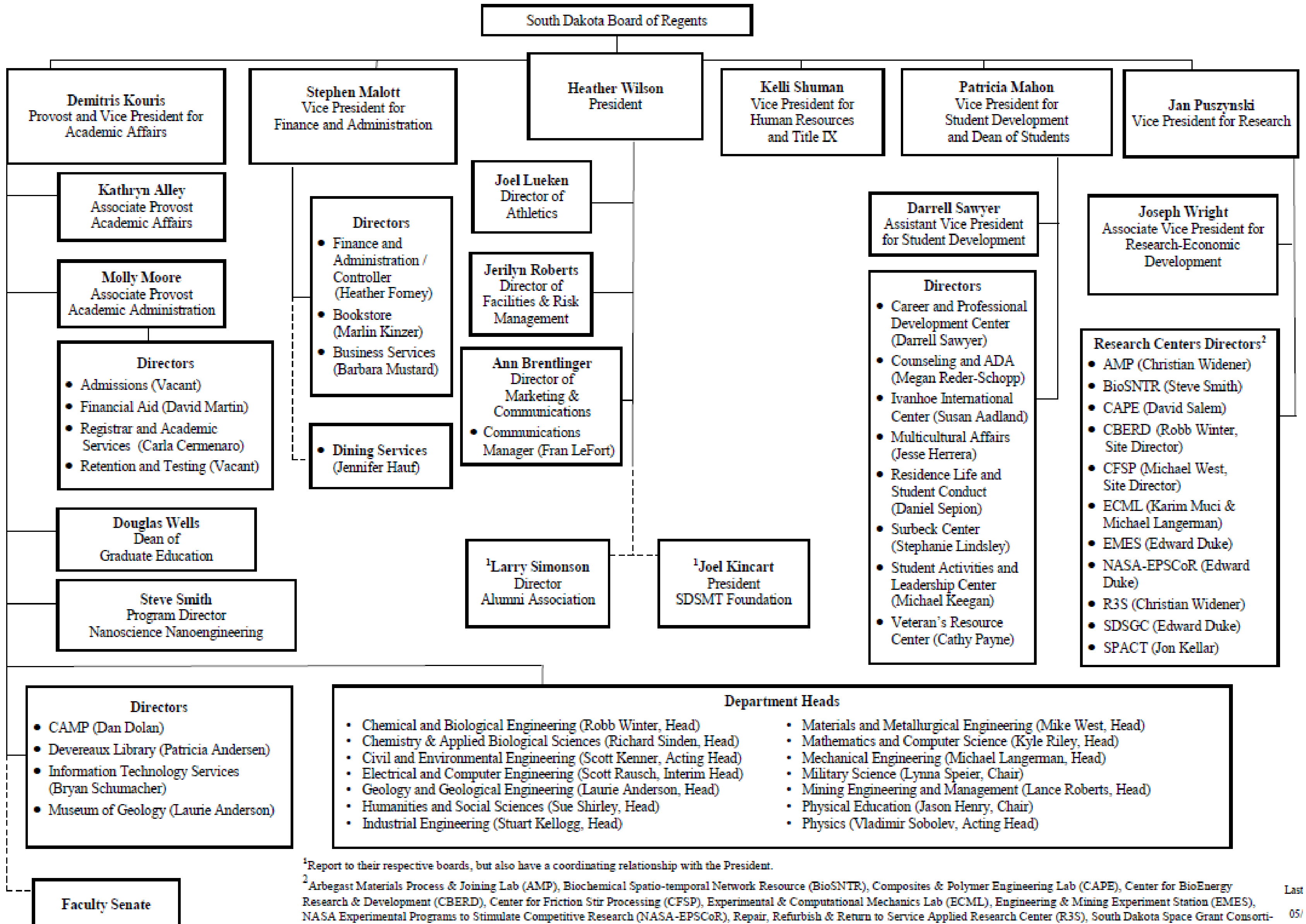
D. Academic support units
The following are the department names and the names and titles of the individuals responsible for each of the units that teach courses required by the program being evaluated or may be taken by students in the program being evaluated:

Chemical and Biological Engineering

> Dr. Robb M Winter, Head and Professor Chemical and Biological Engineering, Chemical and Biological Engineering building, room 2202A, (605) 394-1237, robb.winter@sdsmt.edu secretary: Lila.Baskerville@sdsmt.edu, 605-394-2421

Chemistry and Applied Biological Sciences

> Dr. Richard R Sinden, Head and Professor Chemistry and Applied Biological Sciences, Chemical and Biological building, room C219, (605) 394-1678, Richard.Sinden@sdsmt.edu, secretary: Tara.Huber@sdsmt.edu (605) 394-1238



[1]Report to their respective boards, but also have a coordinating relationship with the President.

[2]Arbegast Materials Process & Joining Lab (AMP), Biochemical Spatio-temporal Network Resource (BioSNTR), Composites & Polymer Engineering Lab (CAPE), Center for BioEnergy Research & Development (CBERD), Center for Friction Stir Processing (CFSP), Experimental & Computational Mechanics Lab (ECML), Engineering & Mining Experiment Station (EMES), NASA Experimental Programs to Stimulate Competitive Research (NASA-EPSCoR), Repair, Refurbish & Return to Service Applied Research Center (R3S), South Dakota Space Grant Consortium (SDSGC), Security Printing and Anti-Counterfeiting Technology (SPACT)

Figure D-1 Organizational Chart for SD Mines (updates 05/04/16)

Civil and Environmental Engineering

Dr. Scott J Kenner, Interim Department Head and Professor Civil and Environmental Engineering, Civil and Mechanical Engineering building, room 122, (605) 394-1697, scott.kenner@sdsmt.edu secretary: Ellen.Haffner@sdsmt.edu (605) 394-2490

Electrical and Computer Engineering

Dr. Scott E Rausch, Interim Department Head and Instructor Electrical and Computer Engineering, Electrical and Computer Engineering building, room 318, (605) 394-1219, Scott.Rausch@sdsmt.edu secretary: deb.tompkins@sdsmt.edu (605) 394-2451

Geology and Geological Engineering

Dr. Laurie C Anderson, Head and Professor Geology and Geological Engineering, Metallurgical building, room 303, (605) 394-1290, Laurie.Anderson@sdsmt.edu secretary: Cleo.Heenan@sdsmt.edu (605)-394-2461

Humanities

Dr. Sue Shirley, Head Social Sciences, Head and Professor Humanities, Classroom building, room 310, (605) 394-2482, susan.shirley@sdsmt.edu secretary: debra.zeidler@sdsmt.edu (605) 394-2481

Industrial Engineering

Dr. Stuart Kellogg, Department Head and Pietz Professor Industrial Engineering, Devereaux Library lower level, (605) 394-6152, stuart.kellogg@sdsmt.edu secretary: c.krein@sdsmt.edu (605) 394-1271

Materials and Metallurgical Engineering

Dr. Michael K West**,** Head and Associate professor Materials and Metallurgical Engineering, Metallurgical building, room 108, (605) 394-1283, Michael.West@sdsmt.edu secretary Jessica.Zacher@sdsmt.edu (605) 394-2341

Mathematics and Computer Science

Dr. Kyle L Riley, Head and Professor Mathematics and Computer Science, Math and Computer Science building, room 308, (605) 394-2471, kyle.riley@sdsmt.edu secretary: Reta.Davies@sdsmt.edu, (605) 394-2471

Mechanical Engineering

Dr. Michael A. Langerman, Head and Professor, Mechanical Engineering Civil and Mechanical Engineering building, room 133, (605) 394-2408, michael.langerman@sdsmt.edu, secretary: Leslee A Moore (605) 394-2401

Military Science

Col Lynna M. Speier, Classroom building room 115, (605)-394-2769, Lynna.Speier@sdsmt.edu

Mining Engineering and Management

Dr. Lance A. Roberts, Head and Professor Mining Engineering and Management, Metallurgical building, room 235B, 605-394-1973, Lance.Roberts@sdsmt.edu secretary: cindy.hise@sdsmt.edu, (605) 394-2344

Physical Education

Jason P. Henry, Head Men's Basketball Coach/Assistant Athletic Director/Department Chair/Associate Professor, King Center building, room 118, (605) 355-3023, Jason.Henry@sdsmt.edu

Physics

Dr. Andre Petukhov, Head and Professor Physics, Electrical and Computer Engineering building, room 235A, (605) 394-2364, Andre.Petukhov@sdsmt.edu secretary: Connie.Krosschell@sdsmt.edu, (605) 394-2361

Social Sciences

Dr. Sue Shirley, Head Social Sciences, Head and Professor Humanities, Classroom building, room 310, (605) 394-2482, susan.shirley@sdsmt.edu secretary: debra.zeidler@sdsmt.edu (605) 394-2481

E. Non-academic support units

The following are the department names and the names and titles of the individuals responsible for each of the units that provide non-academic support to the program being evaluated:

Admissions

Molly Moore, O'Harra building room 216A, 605-394-5236, Molly.Moore@sdsmt.edu

Athletic Department

Joel Lueken, King Center room 113, 605-394-2352, Joel.Lueken@sdsmt.edu

The Career and Professional Development Center

Darrell Sawyer, Surbeck Center, (605) 394-2667, Darrell.Sawyer@sdsmt.edu

Dean of Students Office

Dr. Patricia Mahon, Surbeck Center, (605) 394-2416, Patricia.Mahon@sdsmt.edu

Devereaux Library

Patricia M Andersen, Library 213, (605) 394-1255, Patricia.Andersen@sdsmt.edu

Disability Services/ADA – Counseling

Megan Reder-Schopp, Surbeck Center, 394-6988, Megan.Reder-Schopp@sdsmt.edu

Information Technology Services

Bryan J Schumacher, Electrical Engineering Building room 134, (605) 394-5102, Bryan.Schumacher@sdsmt.edu

Ivanhoe International Center
Susan R Aadland, Surbeck Center room IIC, (605) 394-6884, Susan.Aadland@sdsmt.edu

Multicultural Affairs
Jesse Herrera, Surbeck Center lower Level, (605) 394-1828, Jesse.Herrera@sdsmt.edu

Office of Residence Life
Dan Sepion, Surbeck Center, (605) 394-2348, Daniel.Sepion@sdsmt.edu

Office of the Registrar and Academic Services
Carla Cermenaro, O'Harra building room 201, 605-394-2649, Carla.Cermenaro@sdsmt.edu

The Omniciye Bridge Program and Jump Start Program
Jesse Herrera, Surbeck Center lower Level, (605) 394-1828, Jesse.Herrera@sdsmt.edu

Student Activities and Leadership Center
Michael Keegan, Surbeck Center lower level, (605) 394-2336, Michael.Keegan@sdsmt.edu

Testing, Tutoring and Academic Support
Tom Mahon, Devereaux Library room 110, (605) 394-2428, Thomas.Mahon@sdsmt.edu

Tiospaye in Engineering and Tiospaye in Science Program
Dr. Carter J. Kerk, McLaury 104A, room 309, (605) 394-1291/(605) 394-6067, carter.kerk@sdsmt.edu

University Counseling
Megan Reder-Schopp, Surbeck Center, 394-6988, Megan.Reder-Schopp@sdsmt.edu

Veterans' Resource Center
Cathy Payne, Surbeck Center lower level, (605) 394-2560, catherine.payne@sdsmt.edu

Women in Science and Engineering (WiSE)
Lisa Carlson, McLaury room 202, (605) 394-5261, Lisa.Carlson@sdsmt.edu

F. Credit unit

One semester credit represents one class hour or three laboratory hours per week. One academic year normally represents at least 28 weeks of classes, exclusive of final examinations.

G. Tables

Tables D-1 and D-2 show enrollment data and summarize personnel data for the BS Metallurgical Engineering program.

Table D-1 BS Metallurgical Engineering Program Enrollment and Degree Data

Academic Year	FT/PT	Year of matriculation (fall enrollment)					Total undergrad	Total grad	Degrees awarded (For one year period))			
		1st	2nd	3rd	4th	5th			Assoc (N/A)	Bachelors (Met Eng)	MS*	PhD*
2015-16 (Current)	FT	48	32	17	25		122	20		17	6	0
	PT	1		3	7		11	14				
2014-15	FT	42	17	17	26		102	20		13	8	2
	PT		2	4	3		9	12				
2013-14	FT	21	20	8	27		76	19		7	5	2
	PT	3	1		2		6	10				
2012-13	FT	15	12	17	19		63	22		14	6	1
	PT		1		4		5	11				
2011-12	FT	20	15	21	19		75	22		16	7	1
	PT		1				1	9				

*Number of MES and Biomedical Engineering graduates having a MET ENG major thesis advisor

Table D-2 Personnel in Metallurgical Engineering in 2015-16

Category	HEAD COUNT		FTE
	FT	PT	
Administrative (West)	1		0.5
Faculty (tenure-track) (Crawford, Cross, Jasthi, Kellar, Safarzadeh, Salem, West, Widener)	8		7.5
Other faculty (Howard)		1	0.3
Student teaching assistants		5	5.0
Technicians/specialists (Hong, Meruga, Qiung, Randle)	3	1	4.064
Office/clerical employees (Schweigerdt, Zacher)	2		2.0
Others (none)			

One FTE equals the institutional-defined full-time load. For student teaching assistants, one FTE equals 20 hours per week of work or service. For undergraduate and graduate students, one FTE equals 15 semester credit-hours per term of institutional course work.

Table D-3 SDSM&T executive

Cohort Data										
		Entering Cohort Year	2011	2010	2009	2008	2007	2006	2005	2004	2003
1. Student Success		Exit -- Year Six	2017	2016	2015	2014	2013	2012	2011	2010	2009
Prepare more undergraduate		Goal									
	Six year graduation rate (Full-time freshmen)	>54%				52.3%	45.1%	54.2%	47.7%	43.3%	35.0%
		Graduating Cohort	2017	2016	2015	2014	2013	2012	2011	2010	2009
	Placement rate (12 months)	>96%				98%	98%	98%	97%	97%	96%
Annual Data											
1. Student Success (Lead: Provost and Dean of Students)			**2017**	**2016**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**
Prepare more undergraduate		**Goal**									
	Total Headcount Fall Enrollment	3500			2843	2798	2640	2424	2311	2354	2177
	Headcount Undergraduate Fall Enrollment	3000			2485	2471	2328	2101	2008	2050	1913
	FTE Fall Undergraduate Enrollment	>2800			2404	2391	2234	2070	1982	1997	1846
	First-time, full-time Freshman enrolled	650			495	591					
	First-time, full-time Freshman-Sophomore Retention @Mines (From starting year.)	>83%				75.1%	77.6%	79%	79.8%	78.1%	78.3%
	Annual number of Associate Degrees (AY-Aug to Aug)					1	7	5	10	5	8
	Annual number of Bachelors Degrees (AY-Aug to Aug)	>400				291	289	250	237	277	214

Table D-3 SDSM&T executive metrics (cont'd)

2. Research (Lead: VP of Research)					**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**
Increase research to prepare science and		**Goal**									
	Research Grant and Contract Expenditure (FY**), $'s in Millions	Steady Growth			$14.09	$ 9.38	$10.73	$16.56	$31.75	$27.55	$13.00
	PhD Fall Enrollment	140			115	94	89	90	78	93	76
	Masters Degree Fall Enrollment	360			228	233					
	Annual number of PhD Graduates (AY-Aug to Aug)	>20				9	18	5	8	8	Data
	Annual number of Master's Degree Graduates (AY-Aug to Aug)					91	82	77	84	66	data
	Annual number of Professional (non-thesis) Masters Degree Graduates (AY-Aug to Aug)					46	54	36	n/a	n/a	n/a
	Annual number of Research (thesis) Masters Degree Graduates (AY-Aug to Aug)					45	28	41	n/a	n/a	n/a
	Invention Disclosures (FY)				16	11	19	14	5	4	1
	License agreements executed (FY)				2	4	2	0			

Table D-3 SDSM&T executive metrics (cont’d)

3. Facilities (Lead: Director of Facilities)				**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**
Redevelop and expand need living, learning										
Facility Condition Index -- Dorms/Surbeck/Wellness: Maintenance, Repair, Replacement Deficiencies/Current Replacement Value (<.05=Good; .05 - .10=Fair; >.1=Poor)	<.1			0.012						
Facility Condition Index -- Classrooms/Labs/Plant/Stadium/Library: Maintenance, Repair, Replacement Deficiencies/Current Replacement Value (<.05=Good; .05 -.10=Fair; >.1=Poor)	<.1			0.21						
Average Weekly Classroom Hours of Instruction (Total Room hours of instruction/number of classrooms)	35				19.8	20.6	19.4	20.4	n/a	n/a
Average Weekly Use of Student Stations in Classrooms (Total Student Contact Hours/Total Student Stations)	22.75				13.2	12.1	11.5			
Average Weekly Class lab hours of instruction (Total room hours of instruction/total number of class labs)	20				16.4	14.9	13.6	13.5	n/a	n/a
Average Weekly Use of Student Stations in Class Labs (Total Student Contact Hours/Total Student Stations)	16				15.6	6.9	6.8			

Table D-3 SDSM&T executive metrics (cont'd)

4. People (Lead: VP Human Resources)					**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**
Recruit, develop and retain excellent faculty and											
	Noel-Levitz SSI Benchmark Score for Service Excellence (Seniors) - Importance (7-Point Scale)				5.57	5.63	5.78	5.63	5.60	5.65	5.57
	Noel-Levitz SSI Benchmark Score for Service Excellence (Seniors) - Satisfaction (7-Point Scale)				4.96	5.18	5.27	5.17	5.10	5.16	5.06
	Noel-Levitz SSI Benchmark Score for Service Excellence (Seniors) - Gap				-0.6	-0.45	-0.51	-0.46	-0.50	-0.49	-0.51
	Noel-Levitz SSI Benchmark Score for Instructional Effectiveness (Seniors) - Importance (7-Point Scale)				6.35	6.17	6.23	6.15	6.06	6.15	6.03
	Noel-Levitz SSI Benchmark Score for Instructional Effectiveness (Seniors) - Satisfaction (7-Point Scale)				5.41	5.45	5.56	5.36	5.35	5.47	5.27
	Noel-Levitz SSI Benchmark Score for Instructional Effectiveness (Seniors) - Gap				-0.9	-0.72	-0.67	-0.79	-0.71	-0.68	-0.76
	Noel-Levitz SSI Benchmark Score for Student Centeredness (Seniors) - Importance (7 Point Scale)				5.99						
	Noel-Levitz SSI Benchmark Score for Student Centeredness (Seniors) - Satisfaction (7 Point Scale)				5.29						
	Noel-Levitz SSI Benchmark Score for Student Centeredness (Seniors) - Gap				-0.7						
	Noel Levitz Employee Engagement (5-Point Scale)					3.98					

Table D-3 SDSM&T executive metrics (cont'd)

5. Administration (Lead: CFO)			**2017**	**2016**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**
Responsibly steward financial and physical resources											
	Goal: Minimum end FY Unrestricted Cash Balance (without paying back 2013 BOR Loan), $'s in Millions	**Goal:**	$ 2.50	$ 0.83	$ (0.85)						
	Actual Unrestricted Cash Balance (FY), $'s in Millions				$ 1.32	$ (2.37)					
	Loan Repayment Amount, $'s in Millions		$ 1.00	$ 0.75							
6. Development (Lead: Foundation President and Athletic Director)											
Establish a robust culture of											
	Total Foundation Fundraising (FY) (New cash plus new pledges), $'s in Millions				$ 5.53	$ 9.89	$ 6.82	$ 6.00	$10.50	$ 4.10	$ 6.10
	Total Foundation Plus Hardrock Club (FY) (New cash plus new pledges), $'s in Millions				$ 6.00	$ 10.77	$ 8.10	$ 6.12	$ 10.04		
	Number of Donors (FY), $'s in Millions				2,579	2,183	1,960	2,322	2,526		

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Appendix E - Continuous Improvement System (CIS) documents

Contents

Items not present in Appendix E but available in hard copy form at the time of review are

- Archival Records
- Score Cards
- Outcome Summaries
- A panoply of Grand Summary renderings including
  - Graphical Summary of each outcome over time
  - Graphical Summary of all outcomes for each year
  - Two-year Averaged Grand Summary

All of this information is also continuously available to program faculty via the CIS web site.

Part I

Metrics for Program Outcomes (a-k)

Description:

The following metrics are used to assess the program outcomes (a) – (k). Each outcome instrument is scored with a 1, 3, or a 5. The (a-k) descriptors for each metric are truncated on each table and serve only as a reminder of each outcome's focus.

Table E-I.1: Metric for Assessing Outcome (a)

Metric Title	(a) Apply Knowledge of Math, Science, and Engineer		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
Proficient in Fundamental Concepts and Skills	· No application of statistics to analysis of data	· Minor errors in statistical analysis of data	· Correctly analyzes data sets using statistical concepts
	· No use of math software	· Some use of math software	· Uses mathematical software
	· Calculations not performed or performed incorrectly by hand	· Minor errors in calculations by hand	· Executes calculations correctly By hand
	· Mathematical terms are interpreted incorrectly or not at all	· Most mathematical terms are interpreted correctly	· Translates academic theory into engineering applications and accepts limitations of mathematical models of physical reality
	· Does not understand the application of calculus and linear algebra in solving engineering problems	· Shows nearly complete understanding of applications of calculus and/or linear algebra in problem-solving	· Shows appropriate engineering interpretation of mathematical and scientific terms
Proficient in Theoretical and Practical Relationships	· Does not appear to grasp the connection between theory and the problem	· Some gaps in understanding the application of theory to the problem and expects theory to predict reality	· Translates academic theory into engineering applications and accepts limitations of mathematical models of physical reality
	· Does not understand the connection between mathematical models and chemical, physical, and/or in engineering systems	· Chooses a mathematical model or scientific principle that applies to an engineering problem, but has trouble in model development	· Combines mathematical &/or scientific principles to formulate chemical and physical models for relevant to engineering
Proficient in basic science	Student applies basic science concepts as minimal components of work or has major misconceptions.	Student applies concepts from basic science as significant components of work with few errors.	Student applies concepts from basic science as essential components of work with virtually no conceptual errors.

Table E-I.2: Metric for Assessing Outcome (b)

Metric Title	(b) Desg/Cond Exps & Anal/Intrp Data and Info		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
Conducts the design of experiments.	Has not designed experiments.	Has shown some knowledge in the design of experiments.	Has demonstrated on a regular basis the skill of designing experiments.
Operates equipment and collects data for analysis.	Has not demonstrated an interest in learning how to operate experimental equipment.	Is interested in learning how to operate experimental equipment, but has not shown high proficiency.	Quickly developed expertise in using laboratory equipment.
Compares results for experimental measurements to the literature and conducts interpretation of results in written reports.	Has shown no interest in evaluating experimental data developed in the Metallurgy labs to that found in the literature.	Resists using experimental data developed in the Metallurgy labs to that found in the literature.	Makes a major effort to compare engineering result obtain in Metallurgy labs to that found in the literature.
Is able to collect global information and to use this information in evaluation and interpretation of laboratory data	Has poor library and literature searching skills and shows no interest in improving these skills.	As adequate library and literature searching skills. Has demonstrated these skills in written laboratory reports.	Has demonstrated exemplary skill at finding quality information from the global society on Metallurgy laboratory topics.

Table E-I.3: Metric for Assessing Outcome (c)

Metric Title	(c) Design a system, component, or process		
Performance Criteria	**Low Performance:1**	**Average:3**	**Exemplary Performance:5**
Understand the engineering design process	Demonstrates weak understanding of engineering design and decision-making process.	Demonstrates basic comprehension of major aspects of engineering design in the conversion of resources.	Demonstrates advanced comprehension of engineering design process, including optimal conversion of resources for the benefit of the human race.
Formulate possible engineering solutions	Poorly articulated statement of engineering design problem; immature strategy for solution.	Reasonable statement of engineering design problem; designs acceptable strategy for solution.	Clearly states and articulates engineering design problem; designs efficient strategy for solution.
Master the iterative process in engineering design	Completes few or none of necessary iterations in decision-making process for solution.	Completes some of the necessary iterations in decision-making process to arrive at solution.	Completes all necessary iterations in decision-making process to arrive at solution.
Recognize and observe economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints in engineering design	Fails to specify materials, uses them in ways that exceed their service properties, or pays little attention to constraints.	Partially or marginally specifies material properties, uses materials in ways that unnecessarily pushes their properties, or only partially considers constraints.	Exhaustively specifies materials, uses them in ways that clearly meet their properties, and pays close attention to optimizing within all engineering constraints.

Table E-I.4: Metric for Assessing Outcome (d)

Metric Title	(d) Function Well on Teams		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
Responsible Participation	Is absent from team meetings or work sessions >50% of the time	Absent occasionally, but does not inconvenience group	Routinely present at team meetings or work sessions
	Routinely fails to prepare for meetings	Prepares somewhat for group meetings, but ideas are not clearly formulated	Is prepared for the group meeting with clearly formulated ideas
Interaction Skills	Claims work of group as own or frequently blames others	Makes subtle references to other's poor performance or sometimes does not identify contributions of other team members	Shares credit for success with others and accountability for team results
	Does not willingly assume team roles	Takes charge when not in the position to lead	Demonstrates the ability to assume a designated role in the group
	Is discourteous to other group members	Is not always considerate or courteous towards team members	Is a courteous group member
Assimilation and Receptiveness Skills	Does work on his/her own; does not value team work	Occasionally works as a loner or interacts to a minor extent with extra-disciplinary team members	Cooperates with others (outside of the discipline)
	Has no knowledge of disciplines outside of metallurgical engineering	Has some knowledge of other disciplines, but gets lost in discussions with extra-disciplinary team members	Has knowledge of technical skills, issues and approaches germane to disciplines outside of metallurgical engineering

Table E-I.5: Metric for Assessing Outcome (e)

Metric Title	(e) Identify, Formulate, and Solve Engineering Pro		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
Identify	Does not see the connection between theory and practical problem solving	Connects theoretical concepts to practical problem-solving when prompted	Can relate theoretical concepts to practical problem solving
	Does not realize when major components of the problem are missing	Is missing some of the pieces of the whole problem	Demonstrates understanding of how various pieces of the problem relate to each other and the whole
Formulate	Is unable to predict or defend problem outcomes	Occasionally predicts and defends problem outcomes	Can predict and defend problem outcomes
	Demonstrates solutions implementing simple applications of one formula or equation with close analogies to class/lecture problems	Demonstrates solution with integration of diverse concepts or derivation of useful relationships involving ideas covered in course concepts; however, no alternative solutions are generated	Demonstrates creative synthesis of solution and creates new alternatives by combining knowledge and information
Solve	The answer is incorrect and not checked for its reasonableness	The answer is nearly correct, but properly labeled (within reasonable and logical range of the correct answer—it's in the "ballpark")	The answer is correct and properly labeled
	No attempt at checking the obviously incorrect solution no commentary	The solution is correct, but not checked in other ways	The solution is correct and checked in other ways when it can be; the interpretation is appropriate and makes sense

Table E-I.6: Metric for Assessing Outcome (f)

Metric Title	(f) Know Professional and Ethical Responsibilities		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
Carries out responsibilities in a professional and ethical manner	Receives a poor rating by the faculty on the ethics and professional practice writing in assigned subjects	Receives a satisfactory rating by the faculty on the ethics and professional practice writing in assigned subjects	Receives an excellent rating by the faculty on the ethics and professional practice writing in assigned subjects
Understands basic engineering principles and practices, in terms of professional ethics and behavior	Demonstrate little understanding of, or concern for, professional ethics in written essay and during classroom discussions.	Demonstrate basic understanding of, or concern for, professional ethics in written essay and during classroom discussions.	Demonstrate sound understanding of, or concern for, professional ethics in written essay and during classroom discussions

Table E-I.7: Metric for Assessing Outcome (g)

Metric Title	(g) Communicate Effectively		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
The content of the written or oral presentation is effective.	Demonstrates poor justification for the document, makes numerous errors, cannot focus on the subject, is not following the rules of writing or speech.	The audience can understand the content and context of the document or presentation, but the document or oral presentation is not well organized.	Will organized written or oral presentation. The presentation holds the attention of the audience. The presentation is prepared at the proper level for the intended peer group.
The organization of memorandum and technical reports is consistent with styles accepted by the person's primary professional engineering society.	No effort to conform technical writing style required by the instructor.	Make an effort to follow the rules of writing, position figure and table of captions, and placement of citations within a technical report.	The student is careful organizing and writing technical reports. All figure and table captions stand-alone from the report, and references are carefully cited throughout the document.
The design of slides shows an understanding of vision limitation of the audience and the total time the presenter plans to spend on the visual aid during oral presentations.	The simple rules for audio-visual presentation are not followed.	Some understand of the font size on slides and the amount of information being transmitted per slide is apparent.	Large readable font is used, only one thought or idea is presented on a slide, and comfortable easy to read presentation colors are used.

Table E-I.8: Metric for Assessing Outcome (h)

Metric Title	(h) Know the impact of engineering solutions		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
Has the broad education necessary to understanding impact of engineering solutions in global and societal context	In the global and societal practice writing in assigned subjects, students show marginal ability of applying general education knowledge to engineering problems. Work addresses a problem that directly affects global or society issues	In the global and societal practice writing in assigned subjects, students show general ability of applying general education knowledge to engineering problems. Work addresses a problem that directly affects global or society issues	In the global and societal practice writing in assigned subjects, students show outstanding ability of applying general education knowledge to engineering problems. Work addresses a problem that directly affects global or society issues
Awareness of contemporary state of knowledge and relationship to engineering solutions	Little attempt is made to link work to current issues; work has little value except as a student exercise.	Literature review demonstrates adequate knowledge of the current sate of the problem; work addresses useful information or insight into of contemporary issue.	Literature review demonstrates detailed knowledge of the current sate of the problem; work addresses a question at the forefront of a contemporary issue.
Know the impact of engineering on global, economic, environmental, and societal issues.	Shows little understanding of the need to remain aware of changing societal and global conditions.	Demonstrate general understanding of the need to remain aware of changing societal and global conditions.	Demonstrate clear understanding of the need to remain aware of changing societal and global conditions.

Table E-I.9: Metric for Assessing Outcome (i)

Metric Title	(i) Engage in Life-Long learning		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
Ability to adapt to changing technology.	Has only limited ability to adapt to new and changing technology.	Shows reasonable flexibility and ability to make use of new and changing technology	Shows great flexibility in updating skills and making use of new and changing technology
Understanding of the need to continually update one's skills and knowledge.	Shows little awareness of, or concern for, the necessity of updating skills and continuing to learn	Shows basic awareness of the necessity of updating skills, gaining new skills, and continuing to learn throughout life.	Shows clear awareness of the necessity of updating skills, gaining new skills, and continuing to learn throughout life.

Table E-I.10: Metric for Assessing Outcome (j)

Metric Title	(j) Know Contemporary Issues		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
Ability to identify basic problems and contemporary issues in engineering.	Student fails to comprehend at least some major aspects of basic problems and issues.	Student demonstrates reasonable ability to understand problems and addressing issues.	Student shows clear ability to comprehend basic problems and flexibility in addressing challenges and issues.
Application of knowledge of contemporary issues to Metallurgical Engineering	Demonstrates little ability to apply knowledge of contemporary issues to Metallurgical Engineering problems in more than narrowly defined areas.	Demonstrates reasonable ability to apply knowledge of contemporary issues to Metallurgical Engineering problems in most important areas.	Demonstrates clear ability to apply knowledge of contemporary issues to Metallurgical Engineering problems in almost all-important areas.

Table E-I.11: Metric for Assessing Outcome (k)

Metric Title	(k) Use Engineering Techniques, Skills, and Tools		
Performance Criteria	**Low Performance:1**	**Moderate Performance:3**	**Exemplary Performance:5**
Capable of using tools such as Excel, SolidWorks, MathCAD ---	Is not using computer-based and other resources. Demonstrates an unwillingness to develop computer or library skills.	Is using computer and library resources to the extent that are presented in class handouts. Is not exploring the global context of the subject matter being presented	Is able to research, apply and articulate information beyond the information presented in the textbook and class holdouts.
Proficient in operating equipment used in the laboratory program such as the MTS machine, rolling mill, hardness tester ---	Shows no interest in learning how to operate laboratory equipment. Has not used the Virtual Laboratory web site.	Make an effort to learn how to use laboratory equipment, but is willing to let another person take charge in the group.	Comes to class with current knowledge about the equipment, and has used the laboratory equipment Virtual Laboratory to develop first hand experience in regard to vocabulary and safety.
Understands the engineering design method and can apply this method in developing solutions to engineering problems.	Has not demonstrated the concept of need as it pertains to engineering design and economics.	Has shown some understanding as to why a part is designed or redesigned for the betterment of society.	Understands all the elements of design from the beginning statement of need to placing the product on the market.

Part II

Assessment Forms

Description:

Table E-II.1: Outcome Assessment Score Card Input Form (Sample for Outcome (a))

Outcome Score Card		(a)	*(a) Apply knowledge of math, science, and engineering*			
Instrument **Acd.Year:**__________ **Description: (Course, etc.)** _______________ **Instrument: (Final Exam , etc.)** _____________		Team / Student	Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in basic science	
	EnvEng					
Check Here if Teams		1				
		2				
		3				
		4				
		5				
		6				
Enter only a 1, 3, or 5		7				
		8				
Leave blank any column that does not apply		9				
		10				
Designate every EnvEng student by entering the student's initials in Column D		11				
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				
		26				
		27				
		28				
		29				
		30				
		31				
		32				
		33				
		34				
Reviewer's Initials: _____		35				
Date:_________		36				

Table E-II.2 Outcome Assessment Score Card (Sample for Outcome (a))

Outcome Summary			*(a) Apply knowledge of math, science, and engineering*		
	Average Summary	***Max***			
	# Assessments	***Min***			
	# Averages	***Ave***			
Instrument		**Team / Student**	Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in basic science
Inst_1	Check if Teams				
MET 320 - Annually (Fall)	Student	1			
. Final Exam	Student	2			
1	Add Student	**Max**			
Reviewer's Initials		**Min**			
	Remove All	**Average**			
Inst_2	Check if Teams				
MATH 373 - Annually (Fall/Spring)	Student	1			
. Project Reports	Student	2			
Method 1	Add Student	**Max**			
Reviewer's Initials		**Min**			
	Remove All	**Average**			
Inst_3	Check if Teams				
MET 422 - Even years (Fall)	Student	1			
. Final Exam	Student	2			
Method 1	Add Student	**Max**			
Reviewer's Initials		**Min**			
	Remove All	**Average**			
Inst_4	Check if Teams				
MET 310 - Even years (Spring)	Student	1			
. Selected Hour Exam	Student	2			
Method 1	Add Student	**Max**			
Reviewer's Initials		**Min**			
	Remove All	**Average**			
Inst_5	Check if Team				
Other Course Work	Student	1			
. From Campus Assess Comm.	Student	2			
Method 1	Add Student	**Max**			
Reviewer's Initials		**Min**			
	Remove All	**Average**			
Inst_6	Check if Team				
General	Student	1			
. FE Exam	Student	2			

Table E-II.3: Assessment Summary form

Assessment Metric Summary							
Calendar Year		2008					
Outcome	Description	Performance Objective 1	Performance Objective 2	Performance Objective 3	Performance Objective 4		
a						Instrument Average	
#Totals/#Aves						Max Ave Min	
b						Instrument Average	
#Totals/#Aves						Max Ave Min	
c						Instrument Average	
#Totals/#Aves						Max Ave Min	
d						Instrument Average	
#Totals/#Aves						Max Ave Min	
e						Instrument Average	
#Totals/#Aves						Max Ave Min	
f						Instrument Average	
#Totals/#Aves						Max Ave Min	
g						Instrument Average	
#Totals/#Aves						Max Ave Min	
h						Instrument Average	
#Totals/#Aves						Max Ave Min	
I						Instrument Average	
#Totals/#Aves						Max Ave Min	
j						Instrument Average	
#Totals/#Aves						Max Ave Min	
k						Instrument Average	
#Totals/#Aves						Max Ave Min	

Table E-II.4: Outcome Review Form

Outcome Review Form Met Eng

Calendar Year: ______________________________
Outcome: (a) Apply Knowledge of Math, Science, and Engineering
Reviewer: ______________________________
Date: ______________________________

Please complete the following table and indicate if 1) any instruments were missing or incomplete and 2) if you reassessed any instrument.

Course	Instrument	Missing	Reassessed

Review Results:
Each review always consists of two elements: curriculum results and assessment processes.

Recommendations

Curriculum Result
Perform a critical analysis on the accuracy, validity, and value of this outcome's assessment based on the Outcome Summary. This review may also include a review of the actual assessment documents but such depth is not typically required. Note any significant differences among instruments, performance criteria, and instrument assessors. Compare the assessed performance with previous years' performance and recommend curriculum improvements, as needed. The improvement does not need to be curriculum specific, but it would be helpful to suggest possible improvements for faculty consideration. If no improvement is needed, state that the curriculum is performing adequately. If a problem may be developing but there is inadequate evidence on which to act, note that the outcome should be watched and note the concern.

(Insert review here)

Assessment Process
Comment on the adequacy of the assessment instruments and related processes. Suggest possible changes that would improve the assessment of this outcome. Possible discussion might include such things as the adequacy of triangulation by multiple assessment methods, statistical variations from small class size, sparse student participation, etc. If the process appears to be functioning adequately, state that.

(Insert review here)

Table E-II.5 Outcome Review Summary Form

Outcome Review

yyyy	(-) Outcome	Reviewer	
		Date	

Instruments for Review

Course	Instrument	Unused

Reviews

Curriculum

Previous Curriculum Action Review Summary

Curriculum Review Summary

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*

Assessment Process

Previous Assessment Process Action Review Summary

Assessment Process Review Summary

Code	*Assessment Process Acti*	*Assessment Process Action Brief Description*

Part III

Outcome Assessment Results
For all Instrument Collections up to and Including 2009

Contents

1. Tabular Outcome Assessments Summaries

Table E-III-1 2010 Assessment Summary

Assessment Metric Summary

Calendar Year **2010**

Outcome	Description	Performance Objective 1	Performance Objective 2	Performance Objective 3	Performance Objective 4		
a	(a) Apply knowledge of math, science, and engineering	Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in Basic Science		Instrument Average	
#Totals/		4.67	4.29	3.81		Max	4.22
288		4.22	3.35	3.39		Ave	3.65
14		3.81	1.75	3.07		Min	3.35
b	(b) Design and Conduct experiments Analyze and interpret data and information	Conducts the design of experiments.	Operates equipment and collects data for analysis.	Compares results for experimental measurements to the literature and conducts interpretation of results in written reports.	Is able to collect global information and to use this information in evaluation and interpretation of laboratory data	Instrument Average	
#Totals/		4.17	4.50	4.00	3.84	Max	4.16
224		3.97	4.16	3.76	3.04	Ave	3.73
17		3.80	3.93	3.00	1.00	Min	3.04
c	(c) Optimally select material and design materials treatment and production processes	Understand the engineering design process	Formulate possible engineering solutions	Master the iterative process in engineering design	Recognize and observe constraints in engineering design	Instrument Average	
#Totals/		4.27	5.00	4.34	4.79	Max	4.50
148		3.56	4.50	3.91	3.86	Ave	3.96
12		2.60	4.20	3.40	3.40	Min	3.56
d	(d) Function well on teams	Responsible Participation	Interaction Skills	Assimilation and Receptiveness Skills		Instrument Average	
#Totals/		4.80	4.40	4.27		Max	4.04
119		4.03	4.04	3.84		Ave	3.97
9		3.40	3.40	3.40		Min	3.84
e	(e) Identify, formulate, and solve engineering problems	Identify	Formulate	Solve		Instrument Average	
#Totals/		4.71	4.57	4.42		Max	4.22
313		4.22	4.17	3.46		Ave	3.95
14		3.74	3.37	1.55		Min	3.46
f	(f) Know professional and ethical responsibilities and practices	Carries out responsibilities in a professional and ethical manner	Understands basic engineering principles and practices, in terms of professional ethics and behavior			Instrument Average	
#Totals/		4.40	4.67			Max	4.30
72		4.30	4.04			Ave	4.17
7		4.20	3.00			Min	4.04
g	(g) Communicate effectively	The content of the written or oral presentation is effective.	The organization of memorandum and technical reports is consistent with styles accepted by the person's primary professional engineering society.	The design of slides shows an understanding of vision limitation of the audience and the total time the presenter plans to spend on the visual aid during oral presentations.		Instrument Average	
#Totals/		4.76	4.67	4.20		Max	4.24
208		4.24	4.04	3.93		Ave	4.07
14		3.67	3.57	3.53		Min	3.93
h	(h) Know engineering's global societal context	Has the broad education necessary to understanding impact of engineering solutions in global and societal context	Awareness of contemporary state of knowledge and relationship to engineering solutions	Recognizes the need to be aware of societal issues especially those that can be engaged by engineering solutions		Instrument Average	
#Totals/		4.00	4.20	4.60		Max	4.00
84		3.76	3.87	4.00		Ave	3.88
8		3.40	3.42	3.40		Min	3.76
I	(i) Engage in life-long learning	Ability to adapt to changing technology.	Understanding of the need to continually update one's skills and knowledge.	Cognitive Level Assessment		Instrument Average	
#Totals/		4.40	4.40	3.75		Max	4.40
97		4.40	3.68	3.75		Ave	3.94
5		4.40	2.69	3.75		Min	3.68
j	(j) Know contemporary issues	Ability to identify basic problems and contemporary issues in engineering.	Application of knowledge of contemporary issues to Metallurgical Engineering			Instrument Average	
#Totals/		4.40	4.00			Max	4.16
32		4.16	4.00			Ave	4.08
3		3.92	4.00			Min	4.00
k	(k) Use engineering techniques, skills, and tools	Capable of using tools such as Excel, SolidWorks, MathCAD ---	Proficient in operating equipment used in the laboratory program such as the MTS machine, rolling mill, hardness tester ---	Understands the engineering design method and can apply this method in developing solutions to engineering problems.		Instrument Average	
#Totals/		4.85	4.83	4.20		Max	4.12
167		3.98	4.12	3.70		Ave	3.93
12		3.00	3.33	3.00		Min	3.70

Table E-III-2 2011 Assessment Summary

Assessment Metric Summary

Calendar Year 2011

Outcome	Description	Performance Objective 1	Performance Objective 2	Performance Objective 3	Performance Objective 4		
a	(a) Apply knowledge of math, science, and engineering	Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in Basic Science		Instrument Average	
#Totals/		4.71	4.62	3.47		Max	3.87
281		3.69	3.87	3.17		Ave	3.58
14		2.71	2.83	2.71		Min	3.17
b	(b) Design and Conduct experiments Analyze and interpret data and information	Conducts the design of experiments.	Operates equipment and collects data for analysis.	Compares results for experimental measurements to the literature and conducts interpretation of results in written reports.	Is able to collect global information and to use this information in evaluation and interpretation of laboratory data	Instrument Average	
#Totals/		4.60	4.60	4.20	5.00	Max	4.35
89		3.78	4.35	3.32	3.54	Ave	3.75
13		3.00	4.20	2.75	2.75	Min	3.32
c	(c) Optimally select material and design materials treatment and production processes	Understand the engineering design process	Formulate possible engineering solutions	Master the iterative process in engineering design	Recognize and observe constraints in engineering design	Instrument Average	
#Totals/		4.60	4.00	4.20	3.00	Max	4.01
43		4.01	3.50	3.93	3.00	Ave	3.61
9		3.00	3.00	3.67	3.00	Min	3.00
d	(d) Function well on teams	Responsible Participation	Interaction Skills	Assimilation and Receptiveness Skills		Instrument Average	
#Totals/		4.60	5.00	3.00		Max	3.67
30		3.63	3.67	3.00		Ave	3.43
7		3.00	3.00	3.00		Min	3.00
e	(e) Identify, formulate, and solve engineering problems	Identify	Formulate	Solve		Instrument Average	
#Totals/		4.20	4.00	4.82		Max	3.74
115		3.42	3.00	3.74		Ave	3.38
9		2.33	2.00	2.93		Min	3.00
f	(f) Know professional and ethical responsibilities and practices	Carries out responsibilities in a professional and ethical manner	Understands basic engineering principles and practices, in terms of professional ethics and behavior			Instrument Average	
#Totals/		5.00	5.00			Max	4.83
28		4.77	4.83			Ave	4.80
7		4.60	4.33			Min	4.77
g	(g) Communicate effectively	The content of the written or oral presentation is effective.	The organization of memorandum and technical reports is consistent with styles accepted by the person's primary professional engineering society.	The design of slides shows an understanding of vision limitation of the audience and the total time the presenter plans to spend on the visual aid during oral presentations.		Instrument Average	
#Totals/		4.60	4.20	5.00		Max	3.49
77		3.49	3.32	3.44		Ave	3.42
13		2.33	3.00	2.33		Min	3.32
h	(h) Know engineering's global societal context	Has the broad education necessary to understanding impact of engineering solutions in global and societal context	Awareness of contemporary state of knowledge and relationship to engineering solutions	Recognizes the need to be aware of societal issues especially those that can be engaged by engineering solutions		Instrument Average	
#Totals/		4.74	3.80	1.00		Max	3.73
52		3.73	3.31	1.00		Ave	2.68
8		1.00	2.33	1.00		Min	1.00
I	(i) Engage in life-long learning	Ability to adapt to changing technology.	Understanding of the need to continually update one's skills and knowledge.	Cognitive Level Assessment		Instrument Average	
#Totals/		4.87	5.00			Max	5.00
34		4.57	5.00			Ave	4.79
4		4.43	5.00			Min	4.57
j	(j) Know contemporary issues	Ability to identify basic problems and contemporary issues in engineering.	Application of knowledge of contemporary issues to Metallurgical Engineering			Instrument Average	
#Totals/		4.60	5.00			Max	4.82
45		4.59	4.82			Ave	4.70
4		4.57	4.64			Min	4.59
k	(k) Use engineering techniques, skills, and tools	Capable of using tools such as Excel, SolidWorks, MathCAD ---	Proficient in operating equipment used in the laboratory program such as the MTS machine, rolling mill, hardness tester ---	Understands the engineering design method and can apply this method in developing solutions to engineering problems.		Instrument Average	
#Totals/		4.60	4.60	4.60		Max	4.16
99		4.05	4.16	3.89		Ave	4.03
9		3.29	3.71	3.00		Min	3.89

Table E-III-3 2012 Assessment Summary

Assessment Metric Summary

Calendar Year **2012**

Outcome	Description	Performance Objective 1	Performance Objective 2	Performance Objective 3	Performance Objective 4		
a	(a) Apply knowledge of math, science, and engineering	Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in Basic Science		Instrument Average	
#Totals/		4.60	4.26	4.00		Max	3.59
280		3.47	3.59	3.24		Ave	3.43
14		3.00	2.92	2.56		Min	3.24
b	(b) Design and Conduct experiments Analyze and interpret data and information	Conducts the design of experiments.	Operates equipment and collects data for analysis.	Compares results for experimental measurements to the literature and conducts interpretation of results in written reports.	Is able to collect global information and to use this information in evaluation and interpretation of laboratory data	Instrument Average	
#Totals/		3.50	5.00	4.83	4.11	Max	4.32
217		3.10	4.32	4.16	3.23	Ave	3.70
18		2.80	3.50	3.67	1.67	Min	3.10
c	(c) Optimally select material and design materials treatment and production processes	Understand the engineering design process	Formulate possible engineering solutions	Master the iterative process in engineering design	Recognize and observe constraints in engineering design	Instrument Average	
#Totals/		5.00	3.55	3.45	3.30	Max	3.56
206		3.56	3.48	3.37	2.97	Ave	3.34
12		2.60	3.40	3.25	2.60	Min	2.97
d	(d) Function well on teams	Responsible Participation	Interaction Skills	Assimilation and Receptiveness Skills		Instrument Average	
#Totals/		5.00	5.00	3.50		Max	4.25
30		3.87	4.25	3.50		Ave	3.87
6		3.10	3.50	3.50		Min	3.50
e	(e) Identify, formulate, and solve engineering problems	Identify	Formulate	Solve		Instrument Average	
#Totals/		3.65	3.50	4.26		Max	3.47
314		2.76	3.00	3.47		Ave	3.08
14		1.96	1.89	3.06		Min	2.76
f	(f) Know professional and ethical responsibilities and practices	Carries out responsibilities in a professional and ethical manner	Understands basic engineering principles and practices, in terms of professional ethics and behavior			Instrument Average	
#Totals/		3.60	4.00			Max	3.53
35		3.53	3.50			Ave	3.52
6		3.50	3.00			Min	3.50
g	(g) Communicate effectively	The content of the written or oral presentation is effective.	The organization of memorandum and technical reports is consistent with styles accepted by the person's primary professional engineering society.	The design of slides shows an understanding of vision limitation of the audience and the total time the presenter plans to spend on the visual aid during oral presentations.		Instrument Average	
#Totals/		4.27	3.55	4.00		Max	3.37
191		3.37	3.37	3.30		Ave	3.35
13		2.60	3.00	2.60		Min	3.30
h	(h) Know engineering's global societal context	Has the broad education necessary to understanding impact of engineering solutions in global and societal context	Awareness of contemporary state of knowledge and relationship to engineering solutions	Recognizes the need to be aware of societal issues especially those that can be engaged by engineering solutions		Instrument Average	
#Totals/		3.50	3.70	3.90		Max	2.97
71		2.64	2.97	2.85		Ave	2.82
8		1.80	2.20	1.80		Min	2.64
I	(i) Engage in life-long learning	Ability to adapt to changing technology.	Understanding of the need to continually update one's skills and knowledge.	Cognitive Level Assessment		Instrument Average	
#Totals/		4.00	4.50	3.48		Max	4.02
123		3.43	4.02	3.48		Ave	3.65
6		2.88	3.55	3.48		Min	3.43
j	(j) Know contemporary issues	Ability to identify basic problems and contemporary issues in engineering.	Application of knowledge of contemporary issues to Metallurgical Engineering			Instrument Average	
#Totals/		4.20	4.00			Max	3.50
56		3.40	3.50			Ave	3.45
5		3.00	3.00			Min	3.40
k	(k) Use engineering techniques, skills, and tools	Capable of using tools such as Excel, SolidWorks, MathCAD ---	Proficient in operating equipment used in the laboratory program such as the MTS machine, rolling mill, hardness tester ---	Understands the engineering design method and can apply this method in developing solutions to engineering problems.		Instrument Average	
#Totals/		4.80	3.25	4.33		Max	3.87
150		3.87	3.08	3.67		Ave	3.54
11		2.20	3.00	3.00		Min	3.08

Table E-III-4 2013 Assessment Summary

Assessment Metric Summary

Calendar Year **2013**

Outcome	Description	Performance Objective 1	Performance Objective 2	Performance Objective 3	Performance Objective 4		
a	(a) Apply knowledge of math, science, and engineering	Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in Basic Science		Instrument Average	
#Totals/		4.31	4.50	4.19		Max	3.72
358		3.72	3.55	3.24		Ave	3.50
14		2.71	2.59	2.41		Min	3.24
b	(b) Design and Conduct experiments Analyze and interpret data and information	Conducts the design of experiments.	Operates equipment and collects data for analysis.	Compares results for experimental measurements to the literature and conducts interpretation of results in written reports.	Is able to collect global information and to use this information in evaluation and interpretation of laboratory data	Instrument Average	
#Totals/		3.57	4.88	4.29	4.38	Max	4.37
133		3.04	4.37	3.71	2.90	Ave	3.51
12		2.56	3.67	3.33	1.00	Min	2.90
c	(c) Optimally select material and design materials treatment and production processes	Understand the engineering design process	Formulate possible engineering solutions	Master the iterative process in engineering design	Recognize and observe constraints in engineering design	Instrument Average	
#Totals/		4.33	3.60	4.21	4.00	Max	4.03
114		4.03	3.60	3.61	3.60	Ave	3.71
8		3.60	3.60	3.00	3.20	Min	3.60
d	(d) Function well on teams	Responsible Participation	Interaction Skills	Assimilation and Receptiveness Skills		Instrument Average	
#Totals/		4.43	4.29	2.60		Max	3.74
76		3.74	3.24	2.60		Ave	3.19
6		3.00	2.20	2.60		Min	2.60
e	(e) Identify, formulate, and solve engineering problems	Identify	Formulate	Solve		Instrument Average	
#Totals/		4.56	4.07	3.86		Max	3.85
156		3.85	3.24	3.62		Ave	3.57
8		2.56	2.41	3.44		Min	3.24
f	(f) Know professional and ethical responsibilities and practices	Carries out responsibilities in a professional and ethical manner	Understands basic engineering principles and practices, in terms of professional ethics and behavior			Instrument Average	
#Totals/		4.57	5.00			Max	4.06
67		3.68	4.06			Ave	3.87
6		2.80	2.60			Min	3.68
g	(g) Communicate effectively	The content of the written or oral presentation is effective.	The organization of memorandum and technical reports is consistent with styles accepted by the person's primary professional engineering society.	The design of slides shows an understanding of vision limitation of the audience and the total time the presenter plans to spend on the visual aid during oral presentations.		Instrument Average	
#Totals/		5.00	4.33	4.43		Max	3.64
142		3.64	3.59	3.48		Ave	3.57
13		2.80	2.80	2.60		Min	3.48
h	(h) Know engineering's global societal context	Has the broad education necessary to understanding impact of engineering solutions in global and societal context	Awareness of contemporary state of knowledge and relationship to engineering solutions	Recognizes the need to be aware of societal issues especially those that can be engaged by engineering solutions		Instrument Average	
#Totals/		4.47	3.86	3.00		Max	4.01
114		4.01	3.53	3.00		Ave	3.51
8		3.00	3.20	3.00		Min	3.00
I	(i) Engage in life-long learning	Ability to adapt to changing technology.	Understanding of the need to continually update one's skills and knowledge.	Cognitive Level Assessment		Instrument Average	
#Totals/		4.38	4.43	4.26		Max	4.43
93		4.19	4.43	4.26		Ave	4.29
4		4.00	4.43	4.26		Min	4.19
j	(j) Know contemporary issues	Ability to identify basic problems and contemporary issues in engineering.	Application of knowledge of contemporary issues to Metallurgical Engineering			Instrument Average	
#Totals/		4.47	4.14			Max	4.36
65		4.36	4.14			Ave	4.25
4		4.29	4.14			Min	4.14
k	(k) Use engineering techniques, skills, and tools	Capable of using tools such as Excel, SolidWorks, MathCAD ---	Proficient in operating equipment used in the laboratory program such as the MTS machine, rolling mill, hardness tester ---	Understands the engineering design method and can apply this method in developing solutions to engineering problems.		Instrument Average	
#Totals/		4.69	4.43	4.43		Max	4.05
136		3.86	4.05	3.71		Ave	3.88
9		2.56	3.67	3.00		Min	3.71

Table E-III-5 2014 Assessment Summary

Assessment Metric Summary

Calendar Year **2014**

Outcome	Description	Performance Objective 1	Performance Objective 2	Performance Objective 3	Performance Objective 4		
a	(a) Apply knowledge of math, science, and engineering	Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in Basic Science		Instrument Average	
#Totals/		4.33	3.67	3.83		Max	3.58
293		3.56	2.86	3.58		Ave	3.33
13		2.64	1.62	3.33		Min	2.86
b	(b) Design and Conduct experiments Analyze and interpret data and information	Conducts the design of experiments.	Operates equipment and collects data for analysis.	Compares results for experimental measurements to the literature and conducts interpretation of results in written reports.	Is able to collect global information and to use this information in evaluation and interpretation of laboratory data	Instrument Average	
#Totals/		4.52	4.71	4.67	4.05	Max	4.25
244		3.66	4.25	3.89	3.53	Ave	3.83
17		2.45	3.67	3.44	3.31	Min	3.53
c	(c) Optimally select material and design materials treatment and production processes	Understand the engineering design process	Formulate possible engineering solutions	Master the iterative process in engineering design	Recognize and observe constraints in engineering design	Instrument Average	
#Totals/		4.09	3.89	4.67	4.33	Max	4.04
99		3.58	3.69	3.83	4.04	Ave	3.79
12		2.75	3.50	3.25	3.75	Min	3.58
d	(d) Function well on teams	Responsible Participation	Interaction Skills	Assimilation and Receptiveness Skills		Instrument Average	
#Totals/		4.33	4.67	2.75		Max	3.71
47		3.54	3.71	2.75		Ave	3.33
6		2.75	2.75	2.75		Min	2.75
e	(e) Identify, formulate, and solve engineering problems	Identify	Formulate	Solve		Instrument Average	
#Totals/		4.33	3.67	4.00		Max	3.52
302		3.52	3.16	3.21		Ave	3.29
13		2.94	2.79	2.67		Min	3.16
f	(f) Know professional and ethical responsibilities and practices	Carries out responsibilities in a professional and ethical manner	Understands basic engineering principles and practices, in terms of professional ethics and behavior			Instrument Average	
#Totals/		4.67	4.67			Max	4.17
66		4.17	3.53			Ave	3.85
6		3.75	2.93			Min	3.53
g	(g) Communicate effectively	The content of the written or oral presentation is effective.	The organization of memorandum and technical reports is consistent with styles accepted by the person's primary professional engineering society.	The design of slides shows an understanding of vision limitation of the audience and the total time the presenter plans to spend on the visual aid during oral presentations.		Instrument Average	
#Totals/		5.00	4.67	4.67		Max	3.91
114		3.91	3.83	3.75		Ave	3.83
12		3.25	2.75	2.75		Min	3.75
h	(h) Know engineering's global societal context	Has the broad education necessary to understanding impact of engineering solutions in global and societal context	Awareness of contemporary state of knowledge and relationship to engineering solutions	Recognizes the need to be aware of societal issues especially those that can be engaged by engineering solutions		Instrument Average	
#Totals/		3.91	4.67	2.50		Max	3.42
73		3.36	3.42	2.50		Ave	3.09
7		2.50	2.75	2.50		Min	2.50
I	(i) Engage in life-long learning	Ability to adapt to changing technology.	Understanding of the need to continually update one's skills and knowledge.	Cognitive Level Assessment		Instrument Average	
#Totals/		4.22	4.33	3.22		Max	3.89
116		3.77	3.89	3.22		Ave	3.63
7		3.55	3.44	3.22		Min	3.22
j	(j) Know contemporary issues	Ability to identify basic problems and contemporary issues in engineering.	Application of knowledge of contemporary issues to Metallurgical Engineering			Instrument Average	
#Totals/		4.00	3.67			Max	3.86
50		3.86	3.67			Ave	3.77
4		3.73	3.67			Min	3.67
k	(k) Use engineering techniques, skills, and tools	Capable of using tools such as Excel, SolidWorks, MathCAD ---	Proficient in operating equipment used in the laboratory program such as the MTS machine, rolling mill, hardness tester ---	Understands the engineering design method and can apply this method in developing solutions to engineering problems.		Instrument Average	
#Totals/		4.50	4.33	4.33	4.53	Max	4.53
140		4.12	4.04	4.17	4.53	Ave	4.22
12		3.40	3.80	4.00	4.53	Min	4.04

Table E-III-6 2015 Assessment Summary

Assessment Metric Summary

Calendar Year **2015**

Outcome	Description	Performance Objective 1	Performance Objective 2	Performance Objective 3	Performance Objective 4		
a	(a) Apply knowledge of math, science, and engineering	Proficient in Fundamental Concepts and Skills	Proficient in Theoretical and Practical Relationships	Proficient in Basic Science		Instrument Average	
#Totals/		4.14	3.82	3.62		Max	3.48
324		3.48	3.22	3.26		Ave	3.32
11		2.74	2.69	2.74		Min	3.22
b	(b) Design and Conduct experiments Analyze and interpret data and information	Conducts the design of experiments.	Operates equipment and collects data for analysis.	Compares results for experimental measurements to the literature and conducts interpretation of results in written reports.	Is able to collect global information and to use this information in evaluation and interpretation of laboratory data	Instrument Average	
#Totals/		3.57	4.57	4.29	3.75	Max	3.77
106		2.84	3.77	3.51	3.23	Ave	3.34
11		1.67	3.00	3.00	2.71	Min	2.84
c	(c) Optimally select material and design materials treatment and production processes	Understand the engineering design process	Formulate possible engineering solutions	Master the iterative process in engineering design	Recognize and observe constraints in engineering design	Instrument Average	
#Totals/		4.14	3.75	4.21	4.00	Max	4.00
100		3.91	3.75	3.86	4.00	Ave	3.88
8		3.75	3.75	3.50	4.00	Min	3.75
d	(d) Function well on teams	Responsible Participation	Interaction Skills	Assimilation and Receptiveness Skills		Instrument Average	
#Totals/		4.43	4.29	3.75		Max	4.14
64		4.14	4.02	3.75		Ave	3.97
6		4.00	3.75	3.75		Min	3.75
e	(e) Identify, formulate, and solve engineering problems	Identify	Formulate	Solve		Instrument Average	
#Totals/		4.43	4.07	4.03		Max	4.05
155		3.31	4.05	3.95		Ave	3.77
7		2.66	4.03	3.86		Min	3.31
f	(f) Know professional and ethical responsibilities and practices	Carries out responsibilities in a professional and ethical manner	Understands basic engineering principles and practices, in terms of professional ethics and behavior			Instrument Average	
#Totals/		4.57	4.75			Max	4.66
56		4.30	4.66			Ave	4.48
5		3.83	4.57			Min	4.30
g	(g) Communicate effectively	The content of the written or oral presentation is effective.	The organization of memorandum and technical reports is consistent with styles accepted by the person's primary professional engineering society.	The design of slides shows an understanding of vision limitation of the audience and the total time the presenter plans to spend on the visual aid during oral presentations.		Instrument Average	
#Totals/		5.00	4.29	4.43		Max	4.19
118		4.07	3.73	4.19		Ave	4.00
13		3.29	2.71	3.90		Min	3.73
h	(h) Know engineering's global societal context	Has the broad education necessary to understanding impact of engineering solutions in global and societal context	Awareness of contemporary state of knowledge and relationship to engineering solutions	Recognizes the need to be aware of societal issues especially those that can be engaged by engineering solutions		Instrument Average	
#Totals/		4.67	3.86	3.00		Max	3.84
76		3.84	3.26	3.00		Ave	3.37
7		3.00	2.75	3.00		Min	3.00
I	(i) Engage in life-long learning	Ability to adapt to changing technology.	Understanding of the need to continually update one's skills and knowledge.	Cognitive Level Assessment		Instrument Average	
#Totals/		4.38	4.43	3.83		Max	4.30
104		4.02	4.30	3.83		Ave	4.05
6		3.83	4.17	3.83		Min	3.83
j	(j) Know contemporary issues	Ability to identify basic problems and contemporary issues in engineering.	Application of knowledge of contemporary issues to Metallurgical Engineering			Instrument Average	
#Totals/		4.33	4.14			Max	4.15
64		4.15	3.99			Ave	4.07
5		3.83	3.83			Min	3.99
k	(k) Use engineering techniques, skills, and tools	Capable of using tools such as Excel, SolidWorks, MathCAD ---	Proficient in operating equipment used in the laboratory program such as the MTS machine, rolling mill, hardness tester ---	Understands the engineering design method and can apply this method in developing solutions to engineering problems.		Instrument Average	
#Totals/		4.50	4.43	4.43	4.26	Max	4.26
168		4.24	3.71	3.91	4.26	Ave	4.03
10		3.80	3.00	3.40	4.26	Min	3.71

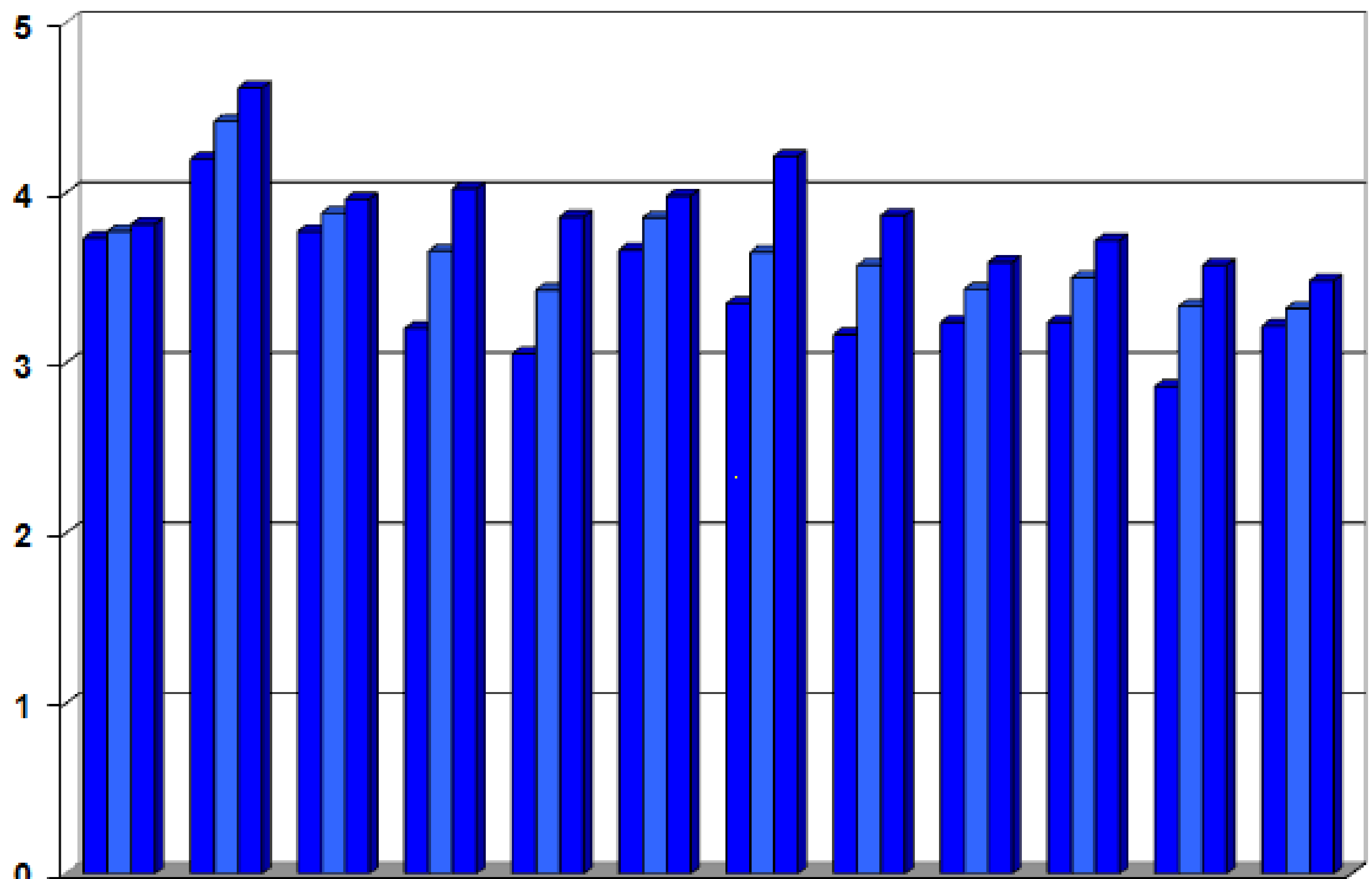
Part IV

Outcome Assessment Summaries
2004-2009

Contents

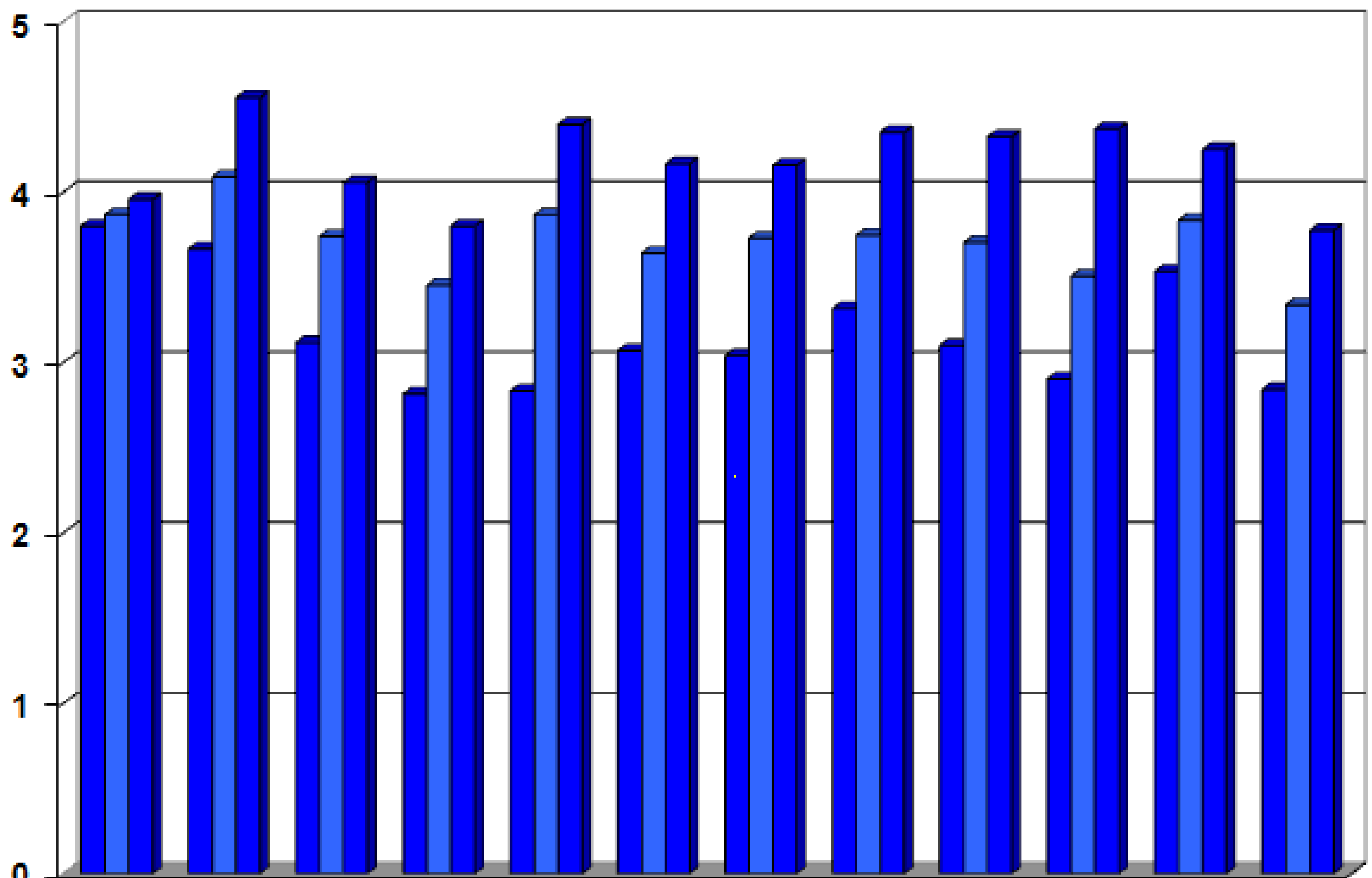
These summaries show the evaluation of previous year actions and the statement of new actions.

Outcome (a) Apply knowledge of math, science, and engineering



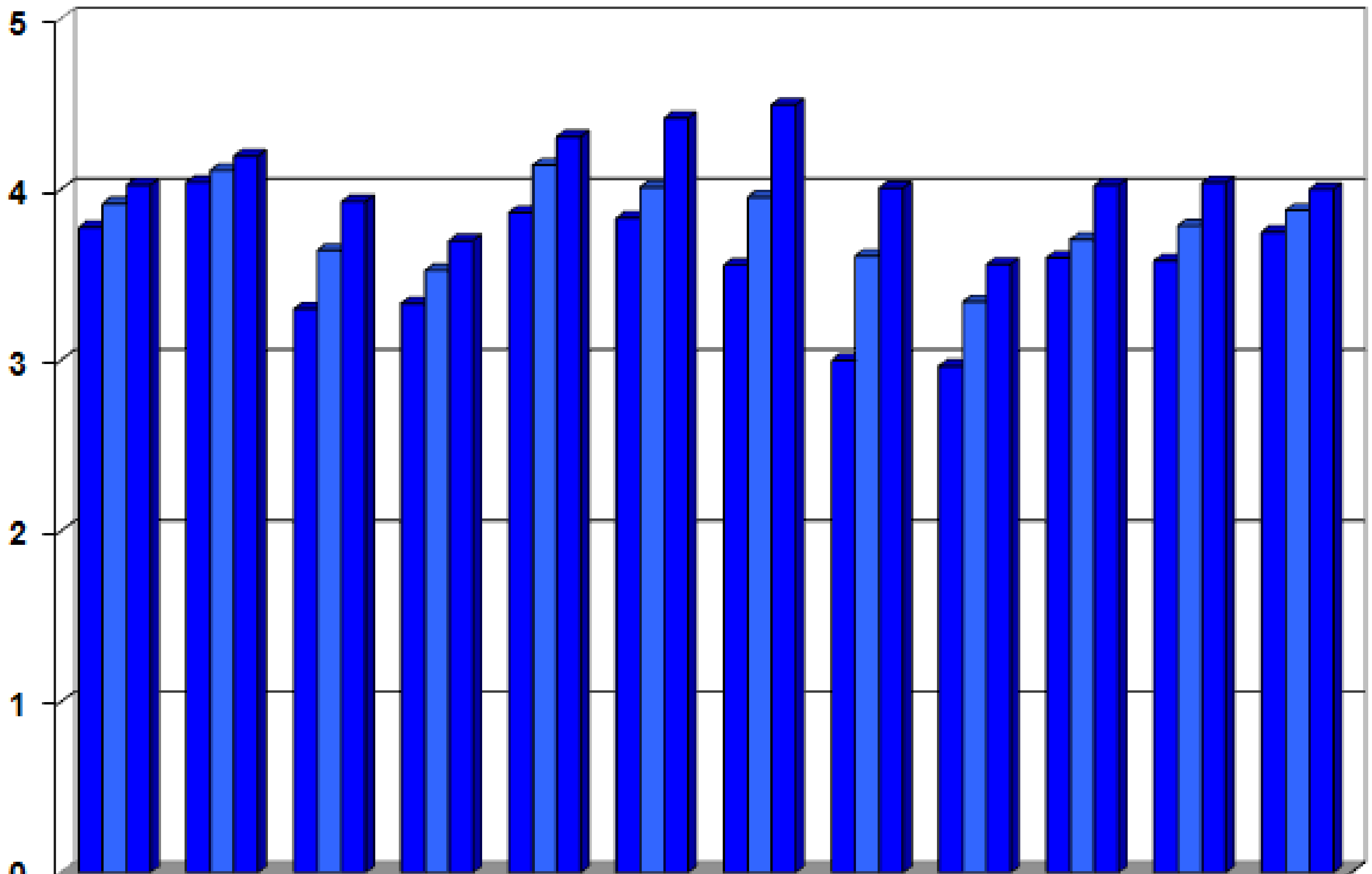
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	3.73	4.20	3.77	3.20	3.06	3.67	3.35	3.17	3.24	3.24	2.86	3.22
A	3.77	4.42	3.88	3.66	3.43	3.86	3.65	3.58	3.43	3.50	3.33	3.32
H	3.82	4.62	3.96	4.03	3.86	3.98	4.22	3.87	3.59	3.72	3.58	3.48

Outcome (b) Design and Conduct experiments Analyze and interpret data and information



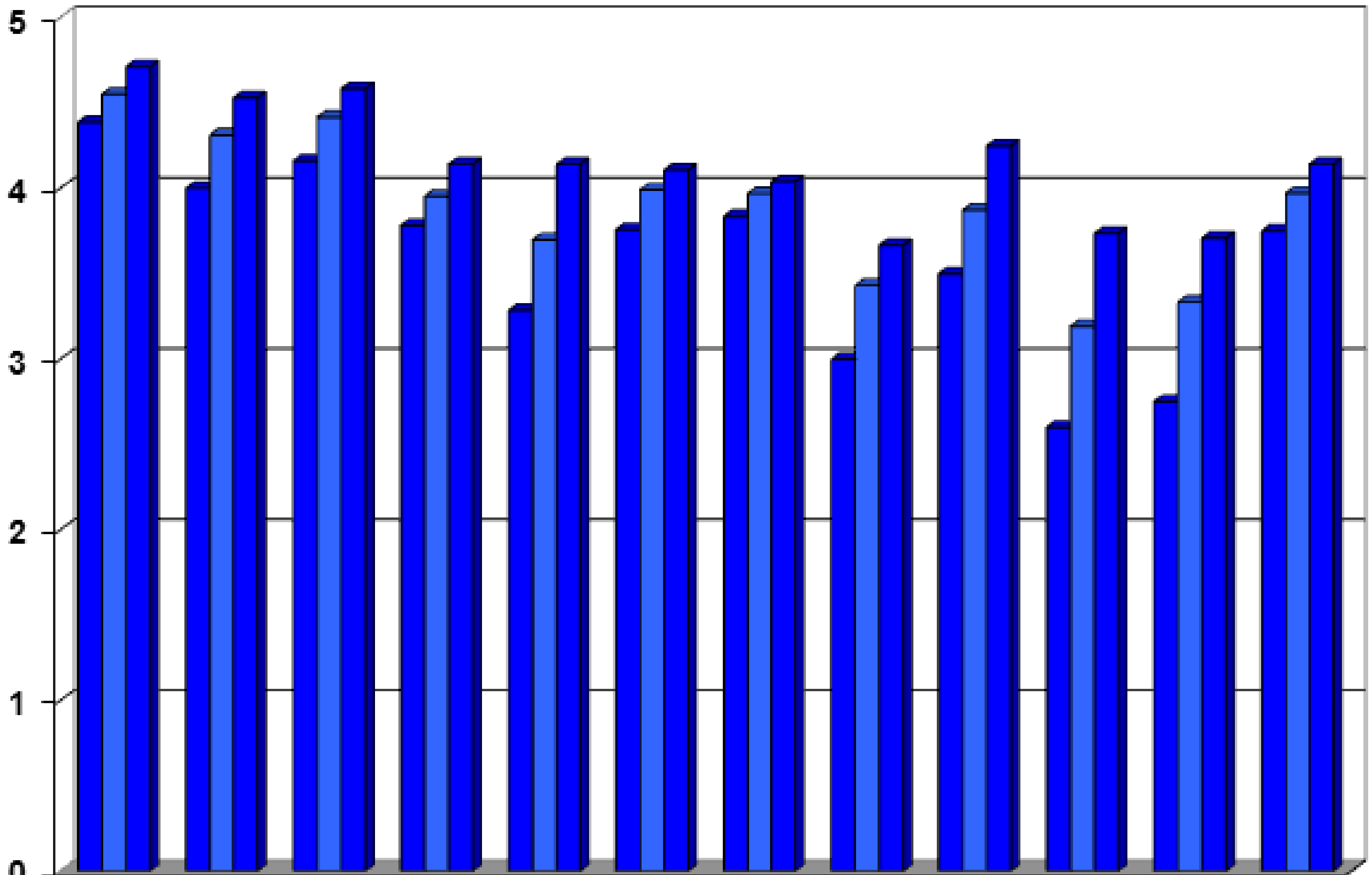
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	3.80	3.67	3.12	2.82	2.83	3.07	3.04	3.32	3.10	2.90	3.53	2.84
A	3.87	4.09	3.74	3.45	3.87	3.64	3.73	3.75	3.70	3.51	3.83	3.34
H	3.96	4.56	4.06	3.80	4.40	4.17	4.16	4.35	4.32	4.37	4.25	3.77

Outcome (c) Optimally select material and design materials treatment and production processes



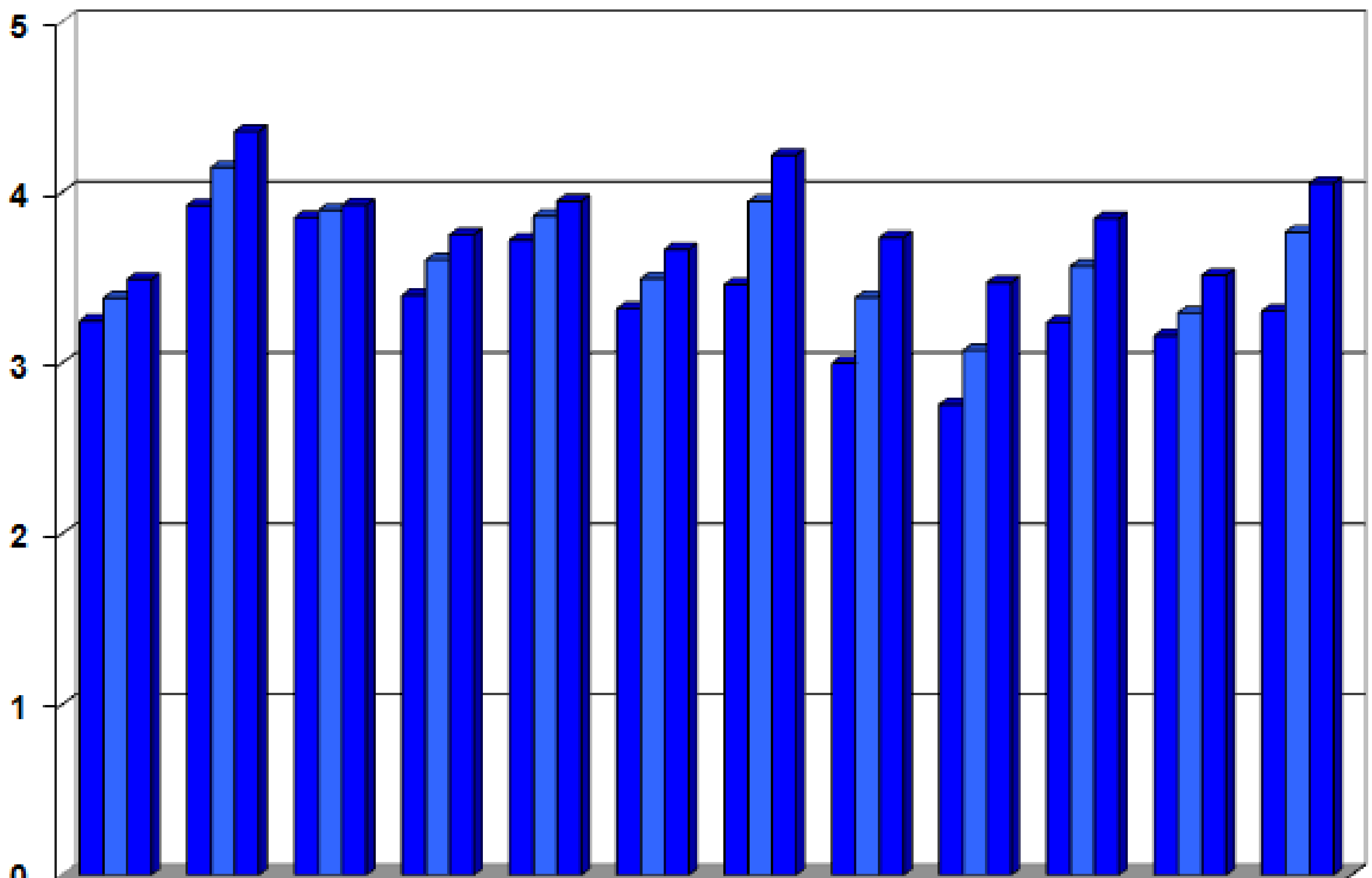
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	3.78	4.04	3.30	3.33	3.87	3.83	3.56	3.00	2.97	3.60	3.58	3.75
A	3.92	4.11	3.65	3.53	4.14	4.01	3.96	3.61	3.34	3.71	3.79	3.88
H	4.03	4.20	3.93	3.70	4.31	4.42	4.50	4.01	3.56	4.03	4.04	4.00

Outcome (d) Function well on teams



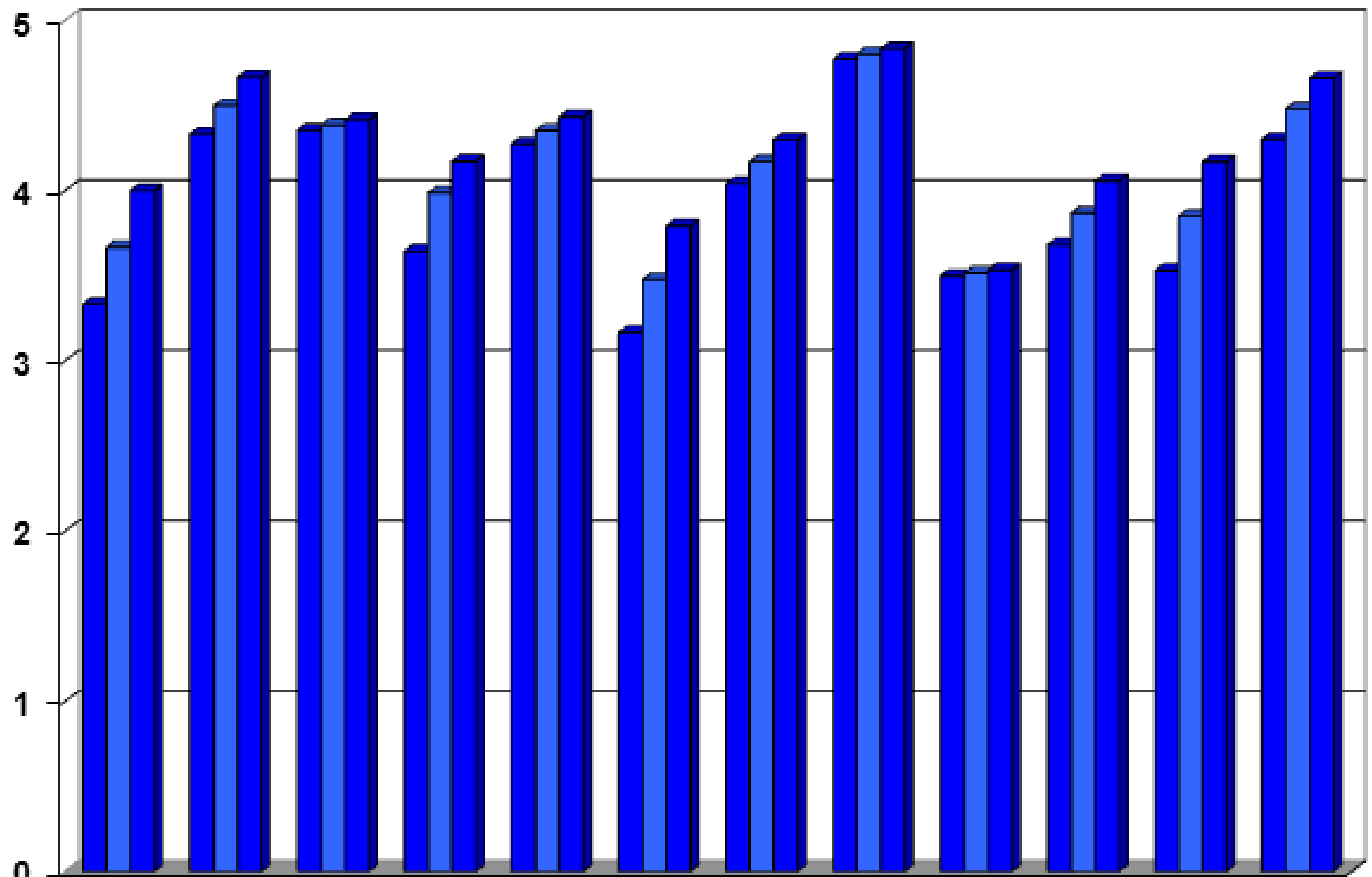
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	4.39	4.00	4.16	3.78	3.29	3.76	3.84	3.00	3.50	2.60	2.75	3.75
A	4.55	4.31	4.42	3.95	3.70	3.99	3.97	3.43	3.87	3.19	3.33	3.97
H	4.71	4.53	4.58	4.14	4.14	4.11	4.04	3.67	4.25	3.74	3.71	4.14

Outcome (e) Identify, formulate, and solve engineering problems



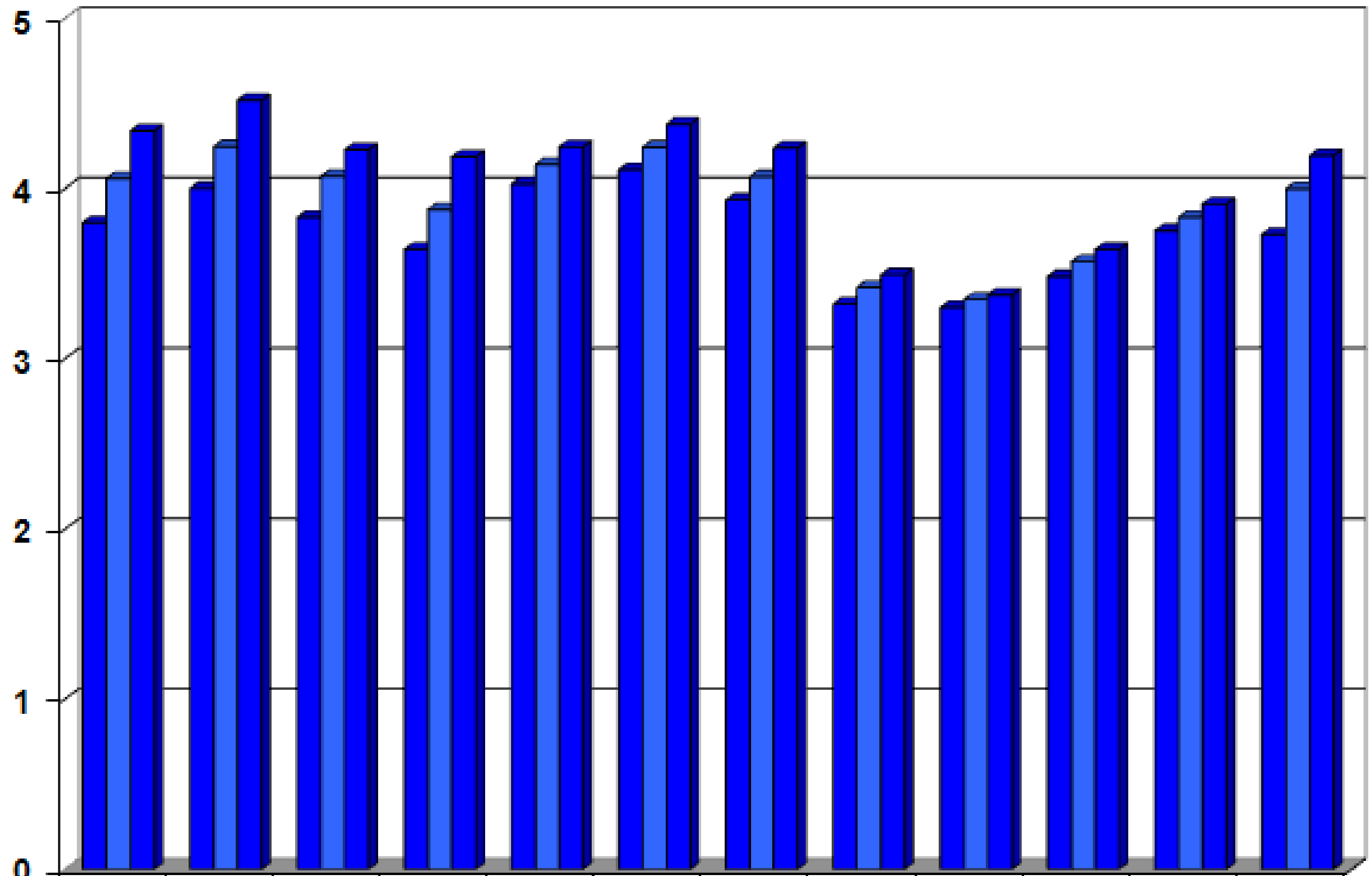
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	3.25	3.93	3.85	3.40	3.72	3.32	3.46	3.00	2.76	3.24	3.16	3.31
A	3.38	4.15	3.90	3.61	3.86	3.50	3.95	3.38	3.08	3.57	3.29	3.77
H	3.49	4.36	3.93	3.75	3.95	3.67	4.22	3.74	3.47	3.85	3.52	4.05

Outcome (f) Know professional and ethical responsibilities and practices



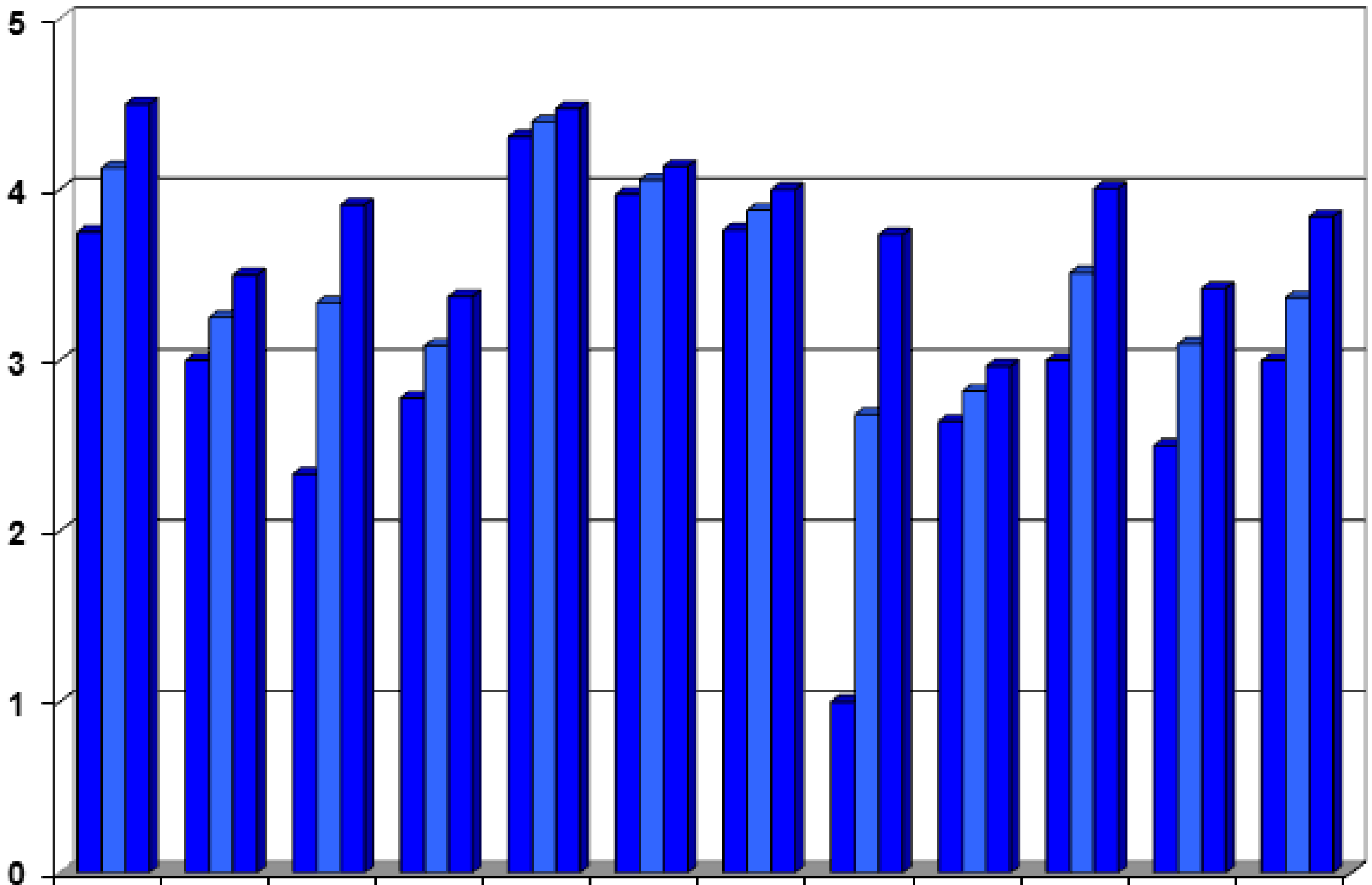
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	3.33	4.33	4.36	3.64	4.27	3.17	4.04	4.77	3.50	3.68	3.53	4.30
A	3.67	4.50	4.39	3.99	4.35	3.48	4.17	4.80	3.52	3.87	3.85	4.48
H	4.00	4.67	4.42	4.17	4.43	3.79	4.30	4.83	3.53	4.06	4.17	4.66

Outcome (g) Communicate effectively



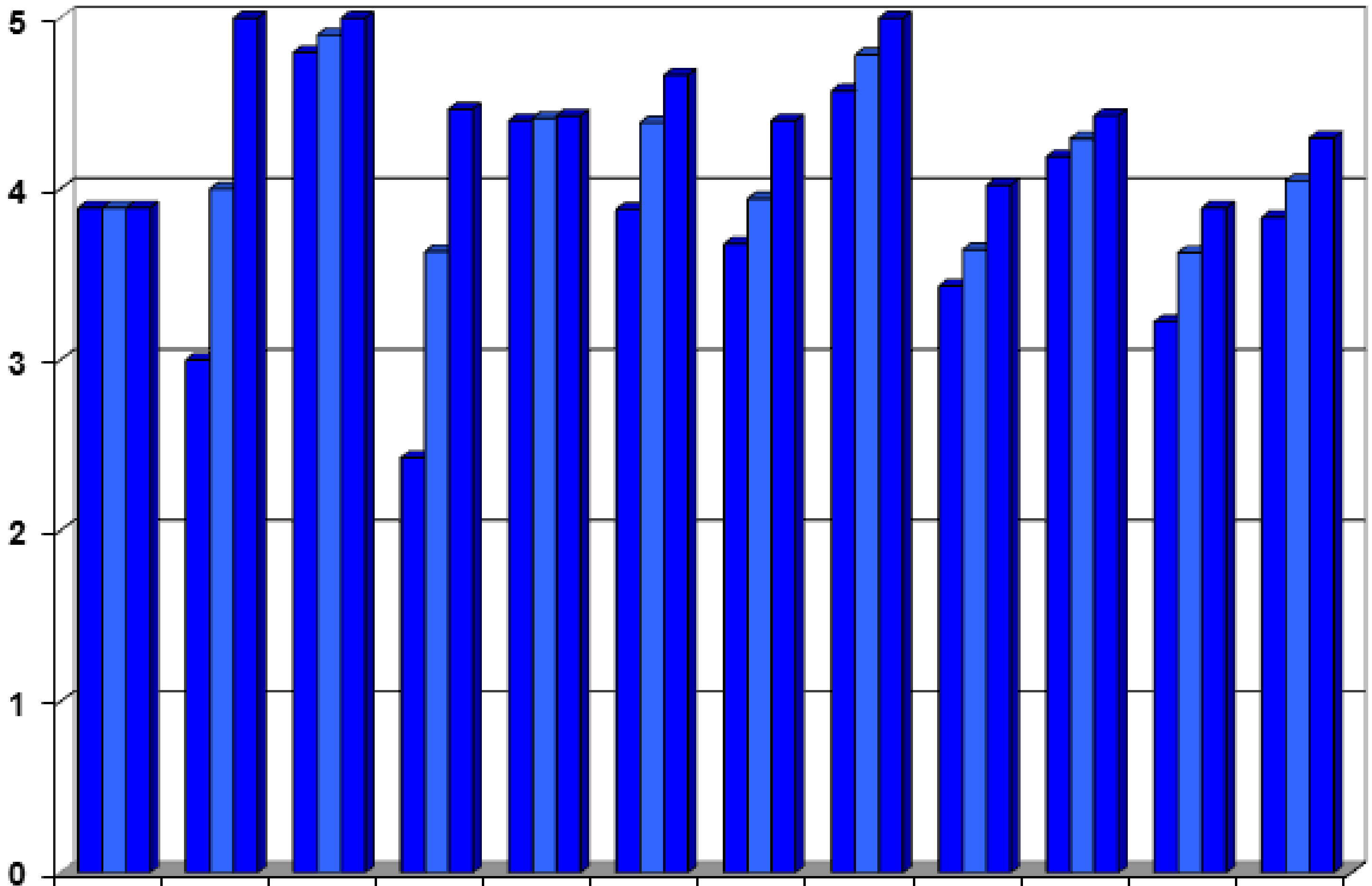
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	3.80	4.00	3.83	3.64	4.03	4.11	3.93	3.32	3.30	3.48	3.75	3.73
A	4.06	4.25	4.07	3.88	4.14	4.24	4.07	3.42	3.35	3.57	3.83	4.00
H	4.34	4.52	4.23	4.19	4.24	4.38	4.24	3.49	3.37	3.64	3.91	4.19

Outcome (h) Know engineering's global societal context



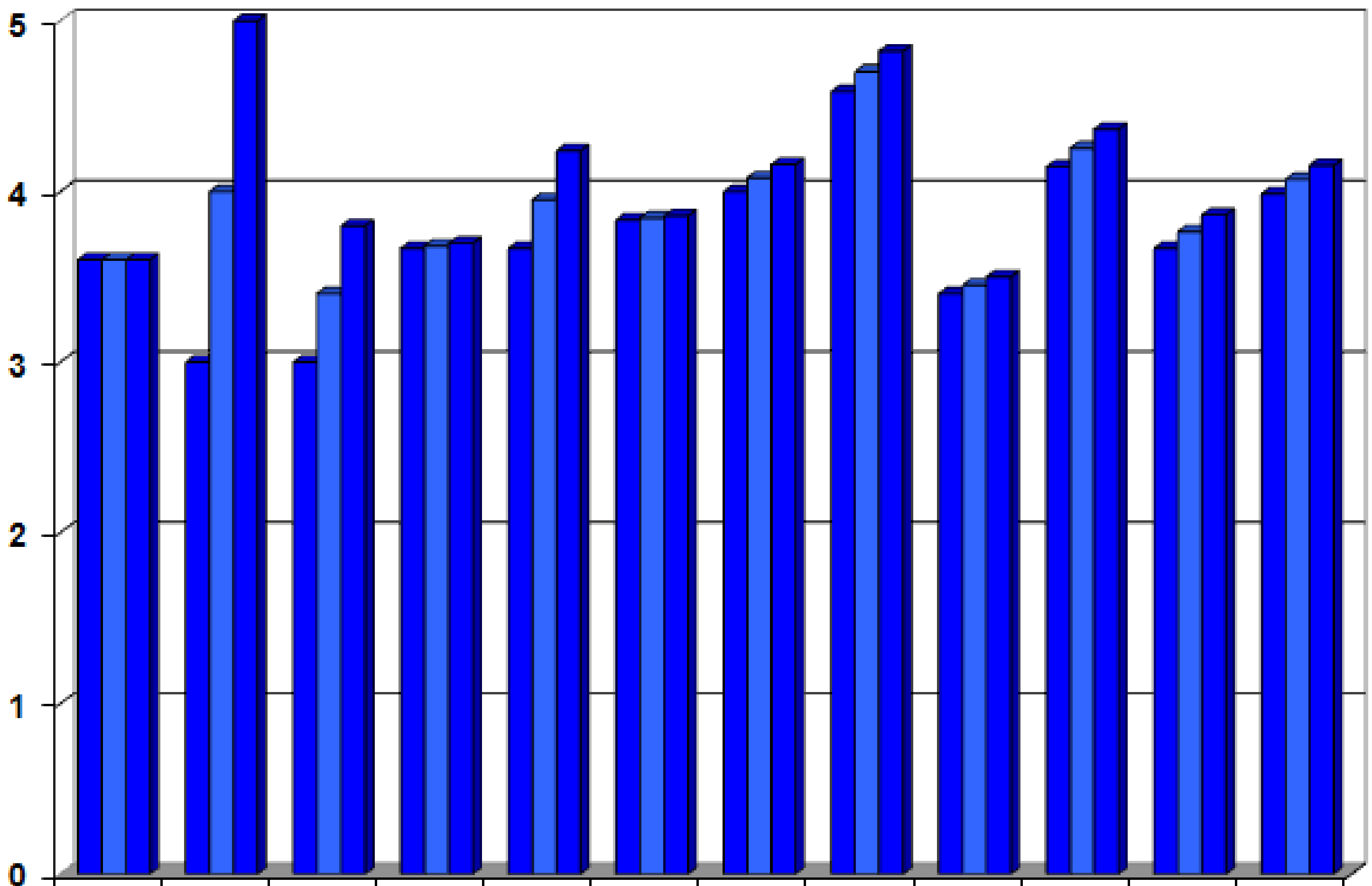
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	3.75	3.00	2.33	2.78	4.31	3.97	3.76	1.00	2.64	3.00	2.50	3.00
A	4.13	3.25	3.34	3.08	4.40	4.05	3.88	2.68	2.82	3.51	3.09	3.37
H	4.50	3.50	3.91	3.37	4.48	4.13	4.00	3.73	2.97	4.01	3.42	3.84

Outcome (i) Engage in life-long learning



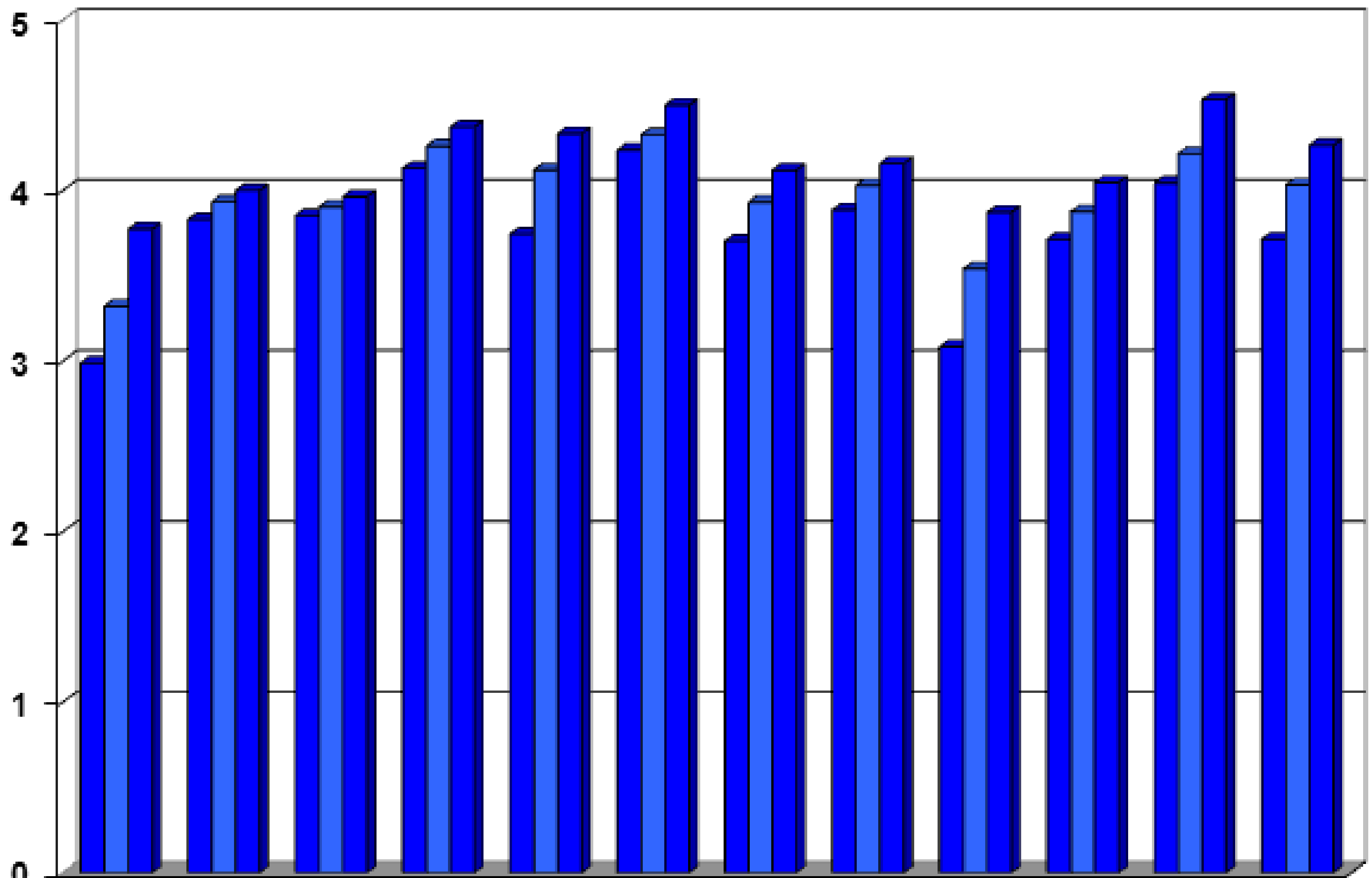
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	3.89	3.00	4.80	2.43	4.40	3.88	3.68	4.57	3.43	4.19	3.22	3.83
A	3.89	4.00	4.90	3.64	4.41	4.39	3.94	4.79	3.65	4.29	3.63	4.05
H	3.89	5.00	5.00	4.47	4.43	4.67	4.40	5.00	4.02	4.43	3.89	4.30

Outcome (j) Know contemporary issues



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	3.60	3.00	3.00	3.67	3.67	3.83	4.00	4.59	3.40	4.14	3.67	3.99
A	3.60	4.00	3.40	3.68	3.95	3.85	4.08	4.70	3.45	4.25	3.77	4.07
H	3.60	5.00	3.80	3.70	4.24	3.86	4.16	4.82	3.50	4.36	3.86	4.15

Outcome (k) Use engineering techniques, skills, and tools



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
L	2.99	3.83	3.85	4.13	3.75	4.24	3.70	3.89	3.08	3.71	4.04	3.71
A	3.32	3.93	3.90	4.26	4.12	4.33	3.93	4.03	3.54	3.88	4.22	4.03
H	3.77	4.00	3.96	4.37	4.33	4.50	4.12	4.16	3.87	4.05	4.53	4.26

Part V

Outcome Reviews and Actions

Outcome reviews contain a summary of all conclusions deriving from outcome assessment, actions taken if warranted, and the results of such actions. The always contain reviews of two major elements: 1) the curriculum as it pertains to student performance and 2) the assessment process so as to focus on effective and efficient methods.

Contents

Review Summary (a)

2010

Previous Curriculum Action Review Summary

Mean student performance improved from 2008 to 2009, while the variation between instruments was considerably reduced.

Curriculum Review Summary

Math 373 was removed and not considered as an assessment tool for 2010.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N		

Previous Assessment Process Action Review Summary

As previously, all student assessments for the local exam were the same. They were all very good, but with no variation. This may indicate some changes in questions or how the scores are apportioned is needed.

• No results were returned for MATH 373.

•MATH 373 has ceased being a useful assessment tool since SMH no longer controls the related instruments.

• Scores have stabilized so the extra faculty training is likely having an effect

Assessment Process Review Summary

MATH 373 has been removed. Significant variability in 2010 was observed. However, much of the variability can be related to less number of students taking the FE Exam. So the watch has been removed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N		

2011

Previous Curriculum Action Review Summary

Math 373 was removed and not considered as an assessment tool for 2010.

Curriculum Review Summary

The outcome review scores were consistent with the previous year and therefore no action is needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N		

Previous Assessment Process Action Review Summary

MATH 373 has been removed. Significant variability in 2010 was observed. However, much of the variability can be related to less number of students taking the FE Exam. So the watch has been removed.

Assessment Process Review Summary

The variability in 2011 has been decreased when compared to previous year. Therefore no action is needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N		

Review Summary (a) (cont'd)

2012

Previous Curriculum Action Review Summary

The outcome review scores were consistent with the previous year and therefore no action is needed.

Curriculum Review Summary

The outcome review scores were consistent with the previous year. Therefore no action is needed

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N		

Previous Assessment Process Action Review Summary

The variability in 2011 has been decreased when compared to previous year. Therefore no action is needed.

Assessment Process Review Summary

The variability has been decreased when compared to 2011. Much of the variability can be related to number of students taking the FE Exam.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N		

2013

Previous Curriculum Action Review Summary

The outcome review scores were consistent with the previous year. Therefore no action is needed

Curriculum Review Summary

The outcome review scores were consistent with 2012; therefore, no action is needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

The variability has been decreased when compared to 2011. Much of the variability can be related to number of students taking the FE Exam.

Assessment Process Review Summary

The average of 3.50 was the same as the previous year. There seems to be a trend downwards; however, one reviewer scored student performance particularly low in one course. It is recommended that a watch be placed on this item to determine if the low ratings remain reviewer specific and if so then seek more uniform assesment methods.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	Instrument Scoring Variability	Determine if the the MET 330 instrument yields low scores in 2015.

Review Summary (a) (cont'd)

2014

Previous Curriculum Action Review Summary

The outcome review scores were consistent with 2012; therefore, no action is needed.

Curriculum Review Summary

The average score has dropped to 3.3 from 3.50. This drop is reflected in the non-subjective Exit exam scores, too. Therefore, it appears to be a real decrease unrelated to reviewer subjectness. Some Action is needed to determine the cause of this decrease. One item that should be reviewed is average class GPA.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
A	Improve Exit Exam adminstration	Administer Exit exam in a more formal setting so as to demonstrate its importance to the students.

Previous Assessment Process Action Review Summary

The average of 3.50 was the same as the previous year. There seems to be a trend downwards; however, one reviewer scored student performance particularly low in one course. It is recommended that a watch be placed on this item to determine if the low ratings remain reviewer specific and if so then seek more uniform assesment methods.

Assessment Process Review Summary

Continue the Watch from 2013 per 2-year cohort system.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	Instrument Scoring Variability	MET 330 exam reviews appear lower. This may be because of new faculty teaching MET 330. Watch for consistency of MET 330

2015

Previous Curriculum Action Review Summary

The average score has dropped to 3.3 from 3.50. This drop is reflected in the non-subjective Exit exam scores, too. Therefore, it appears to be a real decrease unrelated to reviewer subjectness. Some Action is needed to determine the cause of this decrease. One item that should be reviewed is average class GPA.

Curriculum Review Summary

The average score has remained low and is reflected in the non-subjective decreasing Senior Exit Exam scores from 2010 to 2015: 4.67, 4.71, 4.60, 3.78, 3.55, 3.67. It seems very unlikely this drop is the result of variations in student learning but rather because something has changed in the assessment methodology. Therefore, action is focused on assessment processes. Otherwise, a review of basic (Freshman & Sophomore)science and math instruction will be needed but only if other programs note the same decrease.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Low a) watch	If there is no improvement in a) assessments, a review of instructional methods is needed.

Previous Assessment Process Action Review Summary

Continue the Watch from 2013 per 2-year cohort system.

Assessment Process Review Summary

The results from MET 330 remain significantly lower than from other instruments. Conduct training and review on a) Metrics for faculty members.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
A	Metrics Training and Review	Conduct a comparative review of a) outcome metrics and procedures.
A	Increase Senior Exam Prestige	Move the exit exam to earlier in the semester and have the Dept Head administer the testing.

Review Summary (b)

2010

Previous Curriculum Action Review Summary

• Both FE Exam and MET 465 Local Exam are showing Outcome (b) Design and Conduct experiments needs to be improved.

Curriculum Review Summary

Trends appear consistent at a relatively high level. No action needed

Code	Curriculum Action Title	Curriculum Action Brief Description
N	No action needed	

Previous Assessment Process Action Review Summary

• Again a small number of instruments are used. There was heavy reliance in the past on MATH 373. Assessment for Outcome (b) needs to be introduced in other courses to substitute for MATH 373.

Assessment Process Review Summary

Trends look good. Design and conduct experiments assessment in Local Exam appears to be effective.

Code	Assessment Process Action Title	Assessment Process Action Brief Description
N	No action needed	

2011

Previous Curriculum Action Review Summary

Trends appear consistent at a relatively high level. No action needed

Curriculum Review Summary

Trend seems good. Action was called for to introduce DOE activities into 310L - follow up?

Code	Curriculum Action Title	Curriculum Action Brief Description
N	No action	
C	Comment	Were DOE instruments implemented in 310L?

Previous Assessment Process Action Review Summary

Trends look good. Design and conduct experiments assessment in Local Exam appears to be effective.

Assessment Process Review Summary

Process seems good with several instruments used including Labs, Senior Survey, Exit Exams and FE Exam

Code	Assessment Process Action Title	Assessment Process Action Brief Description
N	No Action	

Review Summary (b) (cont'd)

2012

Previous Curriculum Action Review Summary

Trend seems good. Action was called for to introduce DOE activities into 310L - follow up?

Curriculum Review Summary

DOE activities in courses seem to be effective. Students seem to be doing fine on conducting experiments. Improvement may be needed in global interpretation of data.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Watch global interpretation	Watch student ability to globally interpret data.

Previous Assessment Process Action Review Summary

Process seems good with several instruments used including Labs, Senior Survey, Exit Exams and FE Exam

Assessment Process Review Summary

Trends seem okay. Local exam and FE are giving much lower scores than course instruments. This needs to be watched to see if trend continues. Also, this result may be skewed by small number of students taking FE exam.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	Watch FE Exam	Small number of students taking FE. Does local exam continue to give much lower rating?

2013

Previous Curriculum Action Review Summary

DOE activities in courses seem to be effective. Students seem to be doing fine on conducting experiments. Improvement may be needed in global interpretation of data.

Curriculum Review Summary

Specific activities were introduced into MET 310L. Results are essentially unchanged. There is no continued evidence of difficulty on global data interpretation so the Watch is removed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Watch global interpretation	Watch student ability to globally interpret data.

Previous Assessment Process Action Review Summary

Trends seem okay. Local exam and FE are giving much lower scores than course instruments. This needs to be watched to see if trend continues. Also, this result may be skewed by small number of students taking FE exam.

Assessment Process Review Summary

No students took the FE Exam so it should be suspended. Students seem to be doing more poorly on the Local (Senior Exit) Exam. This should be Watched.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
A	Suspend using the FE Exam	Unless three or more students take the FE Exam, it is not effective. Discontinue
W	Local Exam Performance	The Local Exam administration needs to be watched to determine if the exam is being taken seriously by students.

Review Summary (b) (cont'd)

2014

Previous Curriculum Action Review Summary

Specific activities were introduced into MET 310L. Results are essentially unchanged. There is no continued evidence of difficulty on global data interpretation so the Watch is removed.

Curriculum Review Summary

Good student performance. No action

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

No students took the FE Exam so it should be suspended. Students seem to be doing more poorly on the Local (Senior Exit) Exam. This should be Watched.

Assessment Process Review Summary

Instruments seem to be functioning as expected. Students are doing well.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

2015

Previous Curriculum Action Review Summary

Good student performance. No action

Curriculum Review Summary

Scores were some what low in MET 330 But consistent with that reviewer's norms. No Action Needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

Instruments seem to be functioning as expected. Students are doing well.

Assessment Process Review Summary

See if contniued assessment procedure reviews even out scores.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
A	Scoring Metric Review	Review Scoring procedures and use of Metrics with faculty

Review Summary (c)

2010

Previous Curriculum Action Review Summary

• Student performance mirrored that of 2009, which itself was at a high level.

• No recommended Curricular Actions are necessary for 2010.

Curriculum Review Summary

Students continue to do well. No action needed.

Code	Curriculum Action Title	Curriculum Action Brief Description
N	No Action	

Previous Assessment Process Action Review Summary

• Students continued to perform well with on this outcome.

• The tools used to assess this outcome are varied and robust.

• No recommended Assessment Process Actions needed for 2010.

Assessment Process Review Summary

Several instruments used including design reports, presentations, and senior survey. Process seems adequate.

Code	Assessment Process Action Title	Assessment Process Action Brief Description
N	No action	

2011

Previous Curriculum Action Review Summary

Students continue to do well. No action needed.

Curriculum Review Summary

Performance seems to decrease substantially in 2011. Results should be watched for trends.

Code	Curriculum Action Title	Curriculum Action Brief Description
W	Watch Trend	Watch performance for seletion of materials.

Previous Assessment Process Action Review Summary

Several instruments used including design reports, presentations, and senior survey. Process seems adequate.

Assessment Process Review Summary

Process appears adequate

Code	Assessment Process Action Title	Assessment Process Action Brief Description
N	No action	

Review Summary (c) (cont'd)

2012

Previous Curriculum Action Review Summary

Performance seems to decrease substantially in 2011. Results should be watched for trends.

Curriculum Review Summary

Negative trend in performance continues. Emphasis of materials selection and processes is needed. Possible courses include Met 232, 332, 321, 440 and design sequence.

Code	***Curriculum Action Title***	***Curriculum Action Brief Description***
A	Emphasize matls/proc selection	Emphasize materials process and selection in MET 321, 332 and Design sequence.

Previous Assessment Process Action Review Summary

Process appears adequate

Assessment Process Review Summary

Process seems adequate. Should instuments be introduced into specific classes that emphasize materials process/selection

Code	***Assessment Process Action Title***	***Assessment Process Action Brief Description***
C	Comment	Should instruments be introduced in specific courses?

2013

Previous Curriculum Action Review Summary

Negative trend in performance continues. Emphasis of materials selection and processes is needed. Possible courses include Met 232, 332, 321, 440 and design sequence.

Curriculum Review Summary

Code

Previous Assessment Process Action Review Summary

Process seems adequate. Should instuments be introduced into specific classes that emphasize materials process/selection

Assessment Process Review Summary

Code

Review Summary (c) (cont'd)

2014

Previous Curriculum Action Review Summary

Curriculum Review Summary

Student performance continues to improve under the new design curriculum. No Action needed

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

Assessment Process Review Summary

Process continues to function well.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

2015

Previous Curriculum Action Review Summary

Student performance continues to improve under the new design curriculum. No Action needed

Curriculum Review Summary

Student performance continues to improve under the new design curriculum. No Action needed

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

Process continues to function well.

Assessment Process Review Summary

Process continues to function well. No Acxtion needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (d)

2010

Previous Curriculum Action Review Summary

The assessment results increased slightly during this review period indicating there was a normalization of the outcome assessment from previous cohorts and the new faculty.

Curriculum Review Summary

There was no appreciable change in year over year assessment results during this period. No action required. Signifigant decline in assessment results as compared to previous years. The decline is assessment results are attributed directly to changes in the assessment process itself. No action required.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
Signifigant d	No Action	

Previous Assessment Process Action Review Summary

In the future additional teaming and conflict resolution issues will be addressed in the design courses by either faculty in the department or by faculty from other departments.

Assessment Process Review Summary

No action at this time. Continue to watch "working well with others".

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	Working well with others	additional materials to be taught in design courses.

2011

Previous Curriculum Action Review Summary

There was no appreciable change in year over year assessment results during this period. No action required. Signifigant decline in assessment results as compared to previous years. The decline is assessment results are attributed directly to changes in the assessment process itself. No action required.

Curriculum Review Summary

Significant decline in assessment results as compared to previous years. The decline is assessment results are attributed directly to changes in the assessment process itself. No action required.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

No action at this time. Continue to watch "working well with others".

Assessment Process Review Summary

A significant drop in assessment results was observed in 2011. This decline is attributed to; (1) the lack of student self-evaluation results, and (2) the use of local exam results as an instrument for assessing "interactive skills". Both of these changes had a pronounced affect on assessment results. Continue to watch "working well with others".

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	Working well with others	New material added to design courses and self evaluation removed.

Review Summary (d) (cont'd)

2012

Previous Curriculum Action Review Summary

Significant decline in assessment results as compared to previous years. The decline is assessment results are attributed directly to changes in the assessment process itself. No action required.

Curriculum Review Summary

Assessment results showed a marked improvement in 2012. This is primarily due to changes in the assessment process. No action required.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	no action required.	

Previous Assessment Process Action Review Summary

A significant drop in assessment results was observed in 2011. This decline is attributed to; (1) the lack of student self-evaluation results, and (2) the use of local exam results as an instrument for assessing "interactive skills". Both of these changes had a pronounced affect on assessment results. Continue to watch "working well with others".

Assessment Process Review Summary

A significant improvement in assessment results was observed in 2012. This improvement is attributed to discontinuing the use of local exam results as an instrument for assessing "interactive skills", thus reverting to the same process as used in 2010. Continue to watch "working well with others".

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	working well with others	New material added to design courses and use of local exam instrument modified.

2013

Previous Curriculum Action Review Summary

Assessment results showed a marked improvement in 2012. This is primarily due to changes in the assessment process. No action required.

Curriculum Review Summary

There was a significant decrease in performance this year as determined from the assessment of design reports. Students demostrated excellent knowlegde of team skills on the Local Exam and very favorable self-reporting by survey. Low report assessment may be a hold over from the 2012-13 design year so no action should be taken until at least after the 2013 results (for 2013 spring design reports) are available.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Low report performance	See if faculty assessment of team performance improves with new curriculum.

Previous Assessment Process Action Review Summary

A significant improvement in assessment results was observed in 2012. This improvement is attributed to discontinuing the use of local exam results as an instrument for assessing "interactive skills", thus reverting to the same process as used in 2010. Continue to watch "working well with others".

Assessment Process Review Summary

The system may be a bit too depedant on one subjective assessment (faculty evaluation of design reports). Perhaps as students gain a better understanding of new expectations, performance will improve on final design reports. This is being watched under curriculum.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (d) (cont'd)

2014

Previous Curriculum Action Review Summary

There was a significant decrease in performance this year as determined from the assessment of design reports. Students demostrated excellent knowlegde of team skills on the Local Exam and very favorable self-reporting by survey. Low report assessment may be a hold over from the 2012-13 design year so no action should be taken until at least after the 2013 results (for 2013 spring design reports) are available.

Curriculum Review Summary

There has been marginal improvement in team performance with overall scores impacted greatly by faculty assessment of the final design reports. The current Watch should be continued to see if students adapt to the more rigorous grading standards and expectations undoubtedly reflected in the faculty assessments of performance.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Low report performance	See if faculty assessment of team performance improves with new curriculum as students adapt to higher standards.

Previous Assessment Process Action Review Summary

The system may be a bit too depedant on one subjective assessment (faculty evaluation of design reports). Perhaps as students gain a better understanding of new expectations, performance will improve on final design reports. This is being watched under curriculum.

Assessment Process Review Summary

Continue as in 2013 watching to see if students adjust to new additional rigor in curriculum under curriculum above.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

2015

Previous Curriculum Action Review Summary

There has been marginal improvement in team performance with overall scores impacted greatly by faculty assessment of the final design reports. The current Watch should be continued to see if students adapt to the more rigorous grading standards and expectations undoubtedly reflected in the faculty assessments of performance.

Curriculum Review Summary

Students have improved their performance, which indicates the implimentation of higher standards has been integrated into the students expectations.. No action is needed. All watches discontinued.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

Continue as in 2013 watching to see if students adjust to new additional rigor in curriculum under curriculum above.

Assessment Process Review Summary

Working well. No action

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (e)

2010

Previous Curriculum Action Review Summary

• Student performance seems satisfactory.

Curriculum Review Summary

Code

Previous Assessment Process Action Review Summary

• It is noted that the Senior Survey indicates that the students are confident in their abilities to solve engineering problems; however, Local Exam results indicate a different picture. This may indicate students are not doing as well as they think.

Assessment Process Review Summary

Code

2011

Previous Curriculum Action Review Summary

Curriculum Review Summary

Student performance showed a slight decrease during this period compared to 2010. However, results are consistent with those for 2009 where the same instruments were used. Thus, no action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No action required.	

Previous Assessment Process Action Review Summary

Assessment Process Review Summary

Senior survey remains higher than local. Watch continued. FE exam has only 1 assessment during this period. Watch continued. Consider removing this assessment or looking for method to increase number of students taking FE exam.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	Local Exam vs Senior Survey	Senior Survey results higher than local exam results. Continue to watch this discrepancy.
W	Limited number of FE exams	Watch the number of FE exams.

2012

Review Summary (e) (cont'd)

2012

Previous Curriculum Action Review Summary

Student performance showed a slight decrease during this period compared to 2010. However, results are consistent with those for 2009 where the same instruments were used. Thus, no action needed.

Curriculum Review Summary

Student performance showed significant drop compared to 2010 (where the same instruments were used). Decline is student performance is likely associated with the addition of new faculty to the program. Add watch on overall outcome performance to see if this persists.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Low scores	Decline in student performance observed from 2010 to 2012. Continue to watch to see if performance persists.

Previous Assessment Process Action Review Summary

Senior survey remains higher than local. Watch continued. FE exam has only 1 assessment during this period. Watch continued. Consider removing this assessment or looking for method to increase number of students taking FE exam.

Assessment Process Review Summary

Senior survey and local exam results are much closer during this period. Watch continued. FE exam had 9 assessments during this period. Continue to watch the number of assessments to determine if removal of instrument is needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	Local Exam vs Senior Survey	Senior Survey results higher than local exam results. Continue to watch this discrepancy.
W	Limited number of FE exams	Watch the number of FE exams.

2013

Previous Curriculum Action Review Summary

Student performance showed significant drop compared to 2010 (where the same instruments were used). Decline is student performance is likely associated with the addition of new faculty to the program. Add watch on overall outcome performance to see if this persists.

Curriculum Review Summary

Student performance has increased enough to question the significannce of the 2012 decrease in performance. Watch will continue.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Low Performance Watch	Determine if the current rebound in scores is permanent or if there is an odd/even year oscillation.

Previous Assessment Process Action Review Summary

Senior survey and local exam results are much closer during this period. Watch continued. FE exam had 9 assessments during this period. Continue to watch the number of assessments to determine if removal of instrument is needed.

Assessment Process Review Summary

FE Exam has been removed from inventory because too few students were taking it.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (e) (cont'd)

2014

Previous Curriculum Action Review Summary

Student performance has increased enough to question the significannce of the 2012 decrease in performance. Watch will continue.

Curriculum Review Summary

Student performance has decreased not unlike two years ago. If this were an effect of the cohort system it should have persisted from earlier years but opposite phase high values were observed in 2010 and earlier years. Consequently, this is unlikely the result of the cohort system. For the time being it must be considered a probable noise pattern, but the low values warrant a Watch of student performance.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Determine direction of performance	See if oscillating student performance is improving or declining.

Previous Assessment Process Action Review Summary

FE Exam has been removed from inventory because too few students were taking it.

Assessment Process Review Summary

The system no longer uses the FE Exam owing to low participatioon in the exam. The remaining instruments seem to be performing adequately.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

2015

Previous Curriculum Action Review Summary

Student performance has decreased not unlike two years ago. If this were an effect of the cohort system it should have persisted from earlier years but opposite phase high values were observed in 2010 and earlier years. Consequently, this is unlikely the result of the cohort system. For the time being it must be considered a probable noise pattern, but the low values warrant a Watch of student performance.

Curriculum Review Summary

Student performance returned to substantially higher levels (3.77 from 3.29). The watch is continued.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Determine direction of performance	See if oscillating student performance is improving or declining.

Previous Assessment Process Action Review Summary

The system no longer uses the FE Exam owing to low participatioon in the exam. The remaining instruments seem to be performing adequately.

Assessment Process Review Summary

No action is needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (f)

2010

Previous Curriculum Action Review Summary

For 2009, the curriculum in MET 465 (Design Reports) seems to have underemphasized ethics. However, the other methods indicate good performance in Outcome (f).

Curriculum Review Summary

The curriculum results show a significant improvement over 2009. More importantly, the curriculum in MET 465 (Design Reports), which raised some concern in 2009, has been greatly improved.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No action needed.	

Previous Assessment Process Action Review Summary

The Assessment Process shows that Outcome (f) is adequately covered by the current instruments, once the issue with the design reports is dealt with.

Assessment Process Review Summary

One instrument was added (MET 310) to evaluate Outcome (f). Noting that the number of students taking the FE Exam is still lowest as compared to the number of students in other instruments, it is a valuable addition to the instruments used to evaluate Outcome (f).

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No action needed.	

2011

Previous Curriculum Action Review Summary

The curriculum results show a significant improvement over 2009. More importantly, the curriculum in MET 465 (Design Reports), which raised some concern in 2009, has been greatly improved.

Curriculum Review Summary

There has been a considerable improvement of curriculum results over 2010. However, the results correspond to considerably less number of students as compared to 2010. While the total number of assessments for 2010 was 72 using 5 instruments, the total number of assessments was only 28 using 4 instruments.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No action needed.	

Previous Assessment Process Action Review Summary

One instrument was added (MET 310) to evaluate Outcome (f). Noting that the number of students taking the FE Exam is still lowest as compared to the number of students in other instruments, it is a valuable addition to the instruments used to evaluate Outcome (f).

Assessment Process Review Summary

MET 310 was not considered as an instrument to evaluate Outcome (f), most probably because it is offered every other year. Not only the number of students taking the FE Exam is still lowest as compared to the number of students in other instruments, it has decreased even more contributing only one assessment.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	FE Exam numbers	The number of students taking FE Exam is small.

Review Summary (f) (cont'd)

2012

Previous Curriculum Action Review Summary

There has been a considerable improvement of curriculum results over 2010. However, the results correspond to considerably less number of students as compared to 2010. While the total number of assessments for 2010 was 72 using 5 instruments, the total number of assessments was only 28 using 4 instruments.

Curriculum Review Summary

There has been a considerable decline in curriculum results compared to all previous years except 2001 and 2003. The students have scored less on almost all of the instruments, while the number of assessments is comparable to 2011.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Low Performance in all Instruments.	Watch to see if lower scores persist in all instruments.

Previous Assessment Process Action Review Summary

MET 310 was not considered as an instrument to evaluate Outcome (f), most probably because it is offered every other year. Not only the number of students taking the FE Exam is still lowest as compared to the number of students in other instruments, it has decreased even more contributing only one assessment.

Assessment Process Review Summary

The number of students taking the FE Exam has considerably increased, but the scores are low.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
A	Inclusion of ethical responsibilities and	Add ethical instruction on responsibilities and practices to MET310

2013

Previous Curriculum Action Review Summary

There has been a considerable decline in curriculum results compared to all previous years except 2001 and 2003. The students have scored less on almost all of the instruments, while the number of assessments is comparable to 2011.

Curriculum Review Summary

The average of scores increased from 3.52 to 3.87. It appears that the introduction of new design projects and standards has re-energized the students. The previous Watch is discontinued.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

The number of students taking the FE Exam has considerably increased, but the scores are low.

Assessment Process Review Summary

The FE Exam is no longer used since too few students are taking it to be meaningful. No Action is needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	Inclusion of ethical responsibilities and practices in MET310	Ethical responsibilities and practices should be introduced in MET310 in 2014

Review Summary (f) (cont'd)

2014

Previous Curriculum Action Review Summary

The average of scores increased from 3.52 to 3.87. It appears that the introduction of new design projects and standards has re-energized the students. The previous Watch is discontinued.

Curriculum Review Summary

The average of scores remained steady (3.87 to 3.85). It appears that the introduction of new design projects and standards continues to re-energized the students. There is no need for action as the new curriculum with higher performance standards is implemented.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	Ethical responsibilities and practices was included and emphasized in MET 310.	The action which was called for to introduce ethical responsibilities and practices has been implemented.

Previous Assessment Process Action Review Summary

The FE Exam is no longer used since too few students are taking it to be meaningful. No Action is needed.

Assessment Process Review Summary

The system is performing well. No Action needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
C	Add Ethics to MET 310	Ethics instruction was added to MET 310

2015

Previous Curriculum Action Review Summary

The average of scores remained steady (3.87 to 3.85). It appears that the introduction of new design projects and standards continues to re-energized the students. There is no need for action as the new curriculum with higher performance standards is implemented.

Curriculum Review Summary

Student performance continues to rise (3.85 to 4.48). No Action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

The system is performing well. No Action needed.

Assessment Process Review Summary

The system continues to perform well. No Action needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (g)

2010

Previous Curriculum Action Review Summary

• Overall quality of senior design reports appear to decrease from previous year's quality. This finding bears watching into the next assessment cycle as the capstone report often serves as a bell weather for overall program communication skills.

Curriculum Review Summary

The assessment instruments (7) ranged from an average of 3.53 to 4.76 with the lowest the metric involving slide presentation clarity and the highest metric for written content. The lowest metric was for slide clarity: the highest for written content. The average performance remains unchanged considering uncertainty. Watch for changes because of faculty turnover.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Faculty Turnover Effect on Writing	Watch for changes in communication accomplishment because of faculty turnover.

Previous Assessment Process Action Review Summary

The assessment instruments used were adequate and varied. Five different assessors were used and a total of seven instruments in total, making the assessment process very robust.

Assessment Process Review Summary

There are a total of seven assessment instruments. They appear to be providing good feedback on student performance. The oral design report should be remove from the assessment inventory since it is no longer presented.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
A	Remove Oral Design Report	Remove Oral Design Report from Inventory - no longer presented

2011

Previous Curriculum Action Review Summary

The assessment instruments (7) ranged from an average of 3.53 to 4.76 with the lowest the metric involving slide presentation clarity and the highest metric for written content. The lowest metric was for slide clarity: the highest for written content. The average performance remains unchanged considering uncertainty. Watch for changes because of faculty turnover.

Curriculum Review Summary

The performance on communication as measured by the overall average decreased significantly from 2010: 4.07 to 3.42. The average for each metric decreased and were very consistent: 3.49, 3.32, and 3.44. Clearly writing skills have declined fro some reason. This requires some Action to determine the reason for the decline.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
A	Declining Communication Skills	Determine why communication skills are declining and remedy the decline

Previous Assessment Process Action Review Summary

There are a total of seven assessment instruments. They appear to be providing good feedback on student performance. The oral design report should be remove from the assessment inventory since it is no longer presented.

Assessment Process Review Summary

The assessment instruments used were adequate and varied. Seven instruments were used, making the assessment process very robust.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	No Action Needed

Review Summary (g) (cont'd)

2012

Previous Curriculum Action Review Summary

The performance on communication as measured by the overall average decreased significantly from 2010: 4.07 to 3.42. The average for each metric decreased and were very consistent: 3.49, 3.32, and 3.44. Clearly writing skills have declined fro some reason. This requires some Action to determine the reason for the decline.

Curriculum Review Summary

During 2012 the faculty met to discuss writing standards and communication standards in general. The discussion has ranged from writing styles expected of engineering students, common syntax errors, and formatting requirements that should be adopted by the department. Both junior and senior faculty made presentations to students attended by all faculty so the department can form cohesive standards. This needs to continue as additional new faculty join the department. Beginning with the next design sequence (F2012), students will be required to provide monthly oral reports. This should improve their presentation skills- especially slide preparation.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
C	Declining Communication Skills	Determine why communication skills are declining and remedy the decline.
A	Monthly Design Oral Reports	Require design teams to provide monthly updates beginning F2012.

Previous Assessment Process Action Review Summary

The assessment instruments used were adequate and varied. Seven instruments were used, making the assessment process very robust.

Assessment Process Review Summary

The assessment instruments used were adequate and varied. Seven instruments were used, making the assessment process very robust.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	No Action Needed

2013

Previous Curriculum Action Review Summary

During 2012 the faculty met to discuss writing standards and communication standards in general. The discussion has ranged from writing styles expected of engineering students, common syntax errors, and formatting requirements that should be adopted by the department. Both junior and senior faculty made presentations to students attended by all faculty so the department can form cohesive standards. This needs to continue as additional new faculty join the department. Beginning with the next design sequence (F2012), students will be required to provide monthly oral reports. This should improve their presentation skills- especially slide preparation.

Curriculum Review Summary

The student performance has improved from 3.35 to 3.57 under the curricular changes instituted. Evidence shows as students adjust to new expectations that performance under those expectations will continue to rise. Action item was implemented. No further action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

The assessment instruments used were adequate and varied. Seven instruments were used, making the assessment process very robust.

Assessment Process Review Summary

The seven assessment instruments used were adequate and varied. No hanges are needed at the present time.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (g) (cont'd)

2014

Previous Curriculum Action Review Summary

The student performance has improved from 3.35 to 3.57 under the curricular changes instituted. Evidence shows as students adjust to new expectations that performance under those expectations will continue to rise. Action item was implemented. No further action needed.

Curriculum Review Summary

Student performance continues to rise, from 3.57 to 3.83, under the more consistent communication curriculum implemented fully last year. No action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

The seven assessment instruments used were adequate and varied. No hanges are needed at the present time.

Assessment Process Review Summary

No Changes needed. The instruments perform well and incorporate a range of assessment methods.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

2015

Previous Curriculum Action Review Summary

Student performance continues to rise, from 3.57 to 3.83, under the more consistent communication curriculum implemented fully last year. No action needed.

Curriculum Review Summary

Student performance continues to rise, from 3.83 to 4.00, under the more consistent communication curriculum implemented fully last year. This is the second year in a row that an increase has occurred. Faculty noted that they had seen an increase in overall quality of student communication (lab reports, presentations etc.). No action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

No Changes needed. The instruments perform well and incorporate a range of assessment methods.

Assessment Process Review Summary

The instruments conti nue to perform well and encompass range of assessment methods. No Changes needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Changes	

Review Summary (h)

2010

Previous Curriculum Action Review Summary

As the scores have been increasing the curriculum seems to be better addressing Outcome (h).

Curriculum Review Summary

The student performance remains unchanged at approximately 4. The previous action to cure low student performance has remained successful, so the action is dismissed. No additional action is required.

Code	***Curriculum Action Title***	***Curriculum Action Brief Description***
N	No Action	No action is required

Previous Assessment Process Action Review Summary

Student performance improved indicating that the watch does not need continuation.

• Little variation was observed in the mean assessments in both 2008 and 2009, so a watch may be needed to determine if this is a short term fluke or if the instruments used are a little too blunt.

Assessment Process Review Summary

The previously watched variation in instruments and metrics has remained minimal so the watch action is dismissed. No action required.

Code	***Assessment Process Action Title***	***Assessment Process Action Brief Description***
N	No Action	No action is required

2011

Previous Curriculum Action Review Summary

The student performance remains unchanged at approximately 4. The previous action to cure low student performance has remained successful, so the action is dismissed. No additional action is required.

Curriculum Review Summary

Student performance has shown a continual slight decline. Watch to see if 2011 is an aberation or permanent decline.

Code	***Curriculum Action Title***	***Curriculum Action Brief Description***
W	Watch for failure to improve	Watch to see if student performance continues to decline.

Previous Assessment Process Action Review Summary

The previously watched variation in instruments and metrics has remained minimal so the watch action is dismissed. No action required.

Assessment Process Review Summary

The process appears to be working well. No action is needed.

Code	***Assessment Process Action Title***	***Assessment Process Action Brief Description***
N	No Action	No action is required.

Review Summary (h) (cont'd)

2012

Previous Curriculum Action Review Summary

Student performance has shown a continual slight decline. Watch to see if 2011 is an aberation or permanent decline.

Curriculum Review Summary

All metrics and instruments show a large decline in student performance. Design reports are much lower perhaps reflecting higher expectations and a weak class cohort.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
A	Rapid Decline in G-S Context	Correct the decline in Global-Scocietal Context understanding.

Previous Assessment Process Action Review Summary

The process appears to be working well. No action is needed.

Assessment Process Review Summary

The instruments and metrics appear to have identified a significant decrease in performance so are deemed to be working as designed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

2013

Previous Curriculum Action Review Summary

All metrics and instruments show a large decline in student performance. Design reports are much lower perhaps reflecting higher expectations and a weak class cohort.

Curriculum Review Summary

The Global Societal Instructional Module was relocated in the curriculum to the combined Junior-Senior Design Sequence, and a dedicated design lecture was given by Dr. Howard on this topic. The former assures every student will see the topic twice, and the later that the students will be able to see the topic put into action during the presentation. The Instructional Module was also updated, and will be annually, to add content so as to improve student interest and engagement.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
W	Watch (h) Performance	Watch (h) performance to see if students continue to improve.

Previous Assessment Process Action Review Summary

The instruments and metrics appear to have identified a significant decrease in performance so are deemed to be working as designed.

Assessment Process Review Summary

The instruments seem to be reporting well. No Change needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Change	

Review Summary (h) (cont'd)

2014

Previous Curriculum Action Review Summary

The Global Societal Instructional Module was relocated in the curriculum to the combined Junior-Senior Design Sequence, and a dedicated design lecture was given by Dr. Howard on this topic. The former assures every student will see the topic twice, and the later that the students will be able to see the topic put into action during the presentation. The Instructional Module was also updated, and will be annually, to add content so as to improve student interest and engagement.

Curriculum Review Summary

The perfomance was down from 3.51 to 3.09. Additional requirements on the topic need to be added to the Design Reports. This can occur by requiring a specific section of the Deisign Reports to cover this topic.

Code	***Curriculum Action Title***	***Curriculum Action Brief Description***
A	Design Report Global Context	Add more Global-Societal Context requirements into Design Reports.

Previous Assessment Process Action Review Summary

The instruments seem to be reporting well. No Change needed.

Assessment Process Review Summary

No change needed

Code	***Assessment Process Action Title***	***Assessment Process Action Brief Description***

2015

Previous Curriculum Action Review Summary

The perfomance was down from 3.51 to 3.09. Additional requirements on the topic need to be added to the Design Reports. This can occur by requiring a specific section of the Deisign Reports to cover this topic.

Curriculum Review Summary

Student performance increased from 3.09 to 3.37. After some discussion the faculty decided to add more content to MET 321 and MET 310 to further bolster this topic.

Code	***Curriculum Action Title***	***Curriculum Action Brief Description***
A	Increased Global/Societal content	Add content on Outcome (h) to MET 321 and Met 310.

Previous Assessment Process Action Review Summary

No change needed

Assessment Process Review Summary

No Change needed in assessment system

Code	***Assessment Process Action Title***	***Assessment Process Action Brief Description***
N	No Change	

Review Summary (i)

2010

Previous Curriculum Action Review Summary

The assessment results for this instrument remain high.

Curriculum Review Summary

Scores were down slightly, but no action is deemed to be required at the current time.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

Nothing to report.

Assessment Process Review Summary

A variety of instruments were used and these instruments appear to be sufficien for the task.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action Required	

2011

Previous Curriculum Action Review Summary

Scores were down slightly, but no action is deemed to be required at the current time.

Curriculum Review Summary

Outcome scores very high, with small variation, may want to keep an eye on this trend for persistence

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No action required	

Previous Assessment Process Action Review Summary

A variety of instruments were used and these instruments appear to be sufficien for the task.

Assessment Process Review Summary

If scores remain high with little variation may want to consider more instruments

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No action required	

Review Summary (i) (cont'd)

2012

Previous Curriculum Action Review Summary

Outcome scores very high, with small variation, may want to keep an eye on this trend for persistence

Curriculum Review Summary

Students continue to perform well but there appears to be several tenths of a point noise in the assessmsnents.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

If scores remain high with little variation may want to consider more instruments

Assessment Process Review Summary

Students continue to perform well but there appears to be several tenths of a point noise in the assessmsnents. No action needed unless additionall decline is encountered.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

2013

Previous Curriculum Action Review Summary

Students continue to perform well but there appears to be several tenths of a point noise in the assessmsnents.

Curriculum Review Summary

Student performance returned to previous odd year norms (3.65 to 4.29). No Action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

Students continue to perform well but there appears to be several tenths of a point noise in the assessmsnents. No action needed unless additionall decline is encountered.

Assessment Process Review Summary

The system seems to have some oscillation in the average but the range results generally overlap indicating little overall difference between years. No action needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (i) (cont'd)

2014

Previous Curriculum Action Review Summary

Student performance returned to previous odd year norms (3.65 to 4.29). No Action needed.

Curriculum Review Summary

This year's performance is consistent with the general previous performance. No action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No action	

Previous Assessment Process Action Review Summary

The system seems to have some oscillation in the average but the range results generally overlap indicating little overall difference between years. No action needed.

Assessment Process Review Summary

A Watch is issued to determine if the oscillaton is related to the assessment process and, if so, why.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	Oscillation	Watch to see if the oscillations continues with high performance for odd years and low for even years.

2015

Previous Curriculum Action Review Summary

This year's performance is consistent with the general previous performance. No action needed.

Curriculum Review Summary

This year the students performed at a value of 4.05. No Action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

A Watch is issued to determine if the oscillaton is related to the assessment process and, if so, why.

Assessment Process Review Summary

Overall performance is very good, but there seems to be an aspect of the system that is returning oscillating values, although the oscillation is somewhat weak. The individual instruments are generally consistent within anyone year except that the MET 465 Senior Survey often is higher than the other instruments. Continue the Watch.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	Watch oscillation	Continue to Watch to see if the oscillations continues with high performance for odd years and low for even years.

Review Summary (j)

2010

Previous Curriculum Action Review Summary

• It was found that the student scores from the instruments used during the assessment cycle were on average reasonably high (average 3.92).

• Overall, the student performance on this outcome appears adequate.

Curriculum Review Summary

Scores up, but there was little variation

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No action required	

Previous Assessment Process Action Review Summary

• Unlike the previous assessment period triangulation assessment occurred.

• An additional instrument to the assessment "toolbox" would help make the Assessment Process for this Outcome more robust.

Assessment Process Review Summary

The low variation in scores suggests more instruments are needed, but given the 2-year course cycle, another year watching is warranted

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
W	Consider expanding instrument inventory	low variation possibly due to only 2 instruments

2011

Previous Curriculum Action Review Summary

Scores up, but there was little variation

Curriculum Review Summary

Continued high scores with low variation

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No action required	

Previous Assessment Process Action Review Summary

The low variation in scores suggests more instruments are needed, but given the 2-year course cycle, another year watching is warranted

Assessment Process Review Summary

Low variation with few instruments

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
A	Add MET 310 Writing Assignment	The current global issues writing assignment also has a contemporary issues component that may make a good additional instrument.

Review Summary (j) (cont'd)

2012

Previous Curriculum Action Review Summary

Continued high scores with low variation

Curriculum Review Summary

Students continue to perform well. No action Needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

Low variation with few instruments

Assessment Process Review Summary

All instruments are performing well. No Action Needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action Needed	

2013

Previous Curriculum Action Review Summary

Students continue to perform well. No action Needed.

Curriculum Review Summary

Student performance was 4.25 during 2013. No action Needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

All instruments are performing well. No Action Needed.

Assessment Process Review Summary

All instruments are performing well. No Action Needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (j) (cont'd)

2014

Previous Curriculum Action Review Summary

Student performance was 4.25 during 2013. No action Needed.

Curriculum Review Summary

There may be some even-odd year oscillation but both years indicate high performance. No Action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

All instruments are performing well. No Action Needed.

Assessment Process Review Summary

All instruments are performing well. There is good consistency between the assessments that make up the process for Outcome j. No Action needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

2015

Previous Curriculum Action Review Summary

There may be some even-odd year oscillation but both years indicate high performance. No Action needed.

Curriculum Review Summary

Student performance continued to be good. No Action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

All instruments are performing well. There is good consistency between the assessments that make up the process for Outcome j. No Action needed.

Assessment Process Review Summary

All instruments are performing well. No Action needed.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (k)

2010

Previous Curriculum Action Review Summary

The assessment results for this instrument increased slightly compared to 2008.

Curriculum Review Summary

The outcome review scores decreased slightly compraed to previous year and therefore no action was needed

Code	Curriculum Action Title	Curriculum Action Brief Description
N	No action required	

Previous Assessment Process Action Review Summary

Need to find another assessment instrument for Math-373 since a faculty member from the MET department is not teaching it. Assessment information from other MET courses or labs needs to be added to this instrument.

Assessment Process Review Summary

Math-373 was replaced by MET 422 for 2010. However, this course was only offered in even years and there is a need to find alternate assesment method to replace Math-373 for odd years.

Code	Assessment Process Action Title	Assessment Process Action Brief Description
A	Assessment for Math 373	Find other assesment methods to replace Math-373 for next year

2011

Previous Curriculum Action Review Summary

The outcome review scores decreased slightly compraed to previous year and therefore no action was needed

Curriculum Review Summary

The outcome review scores were consistent with the previous year and no action was needed.

Code	Curriculum Action Title	Curriculum Action Brief Description
N	No Action Required	

Previous Assessment Process Action Review Summary

Math-373 was replaced by MET 422 for 2010. However, this course was only offered in even years and there is a need to find alternate assesment method to replace Math-373 for odd years.

Assessment Process Review Summary

MET 321 will be offered in odd years and this will replace Math-373. Therefore, MET 422 will be used as an assement method for even years and MET 321 will be used for odd years.

Code	Assessment Process Action Title	Assessment Process Action Brief Description
N	No action required	

Review Summary (k) (cont'd)

2012

Previous Curriculum Action Review Summary

The outcome review scores were consistent with the previous year and no action was needed.

Curriculum Review Summary

No action needed as the review scores were consistent with the previous years.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No action required	

Previous Assessment Process Action Review Summary

MET 321 will be offered in odd years and this will replace Math-373. Therefore, MET 422 will be used as an assement method for even years and MET 321 will be used for odd years.

Assessment Process Review Summary

Dr Howard returned to teaching MATH 373 spring 2012 so MATH 373 will remain in the inventory.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No action required	

2013

Previous Curriculum Action Review Summary

No action needed as the review scores were consistent with the previous years.

Curriculum Review Summary

Student perfromance increased from 3.88 to 4.22. No Action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

Dr Howard returned to teaching MATH 373 spring 2012 so MATH 373 will remain in the inventory.

Assessment Process Review Summary

The instruments appear to be working well. There is good consistency and multiple methods of assessment.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

Review Summary (k) (cont'd)

2014

Previous Curriculum Action Review Summary

Student perfromance increased from 3.88 to 4.22. No Action needed.

Curriculum Review Summary

Student perfromance increased from 3.88 to 4.22. No Action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

The instruments appear to be working well. There is good consistency and multiple methods of assessment.

Assessment Process Review Summary

The instruments appear to be working well. There is good consistency and multiple methods of assessment.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
N	No Action	

2015

Previous Curriculum Action Review Summary

Student perfromance increased from 3.88 to 4.22. No Action needed.

Curriculum Review Summary

Student performance remains over 4. No Action needed.

Code	*Curriculum Action Title*	*Curriculum Action Brief Description*
N	No Action	

Previous Assessment Process Action Review Summary

The instruments appear to be working well. There is good consistency and multiple methods of assessment.

Assessment Process Review Summary

Dr. Howard is not going to teach MATH 373 in 2016 so instruments will need to shift to MET 422 and MET 321: Action Item.

Code	*Assessment Process Action Title*	*Assessment Process Action Brief Description*
A	Shift from MATH 373	Assessment instrumennts will need to shift from MATH 373 to MET 422 and MET 321

Part VI

Alumni Survey Summary

Contents

Table E-VI-1 Alumni Survey Report for 2002-08 graduates

How much does your current employment involve metallurgical engineering?	Number
Frequently	33
Sometimes	8
Rarely	8
Never	2
Employer's Primary Business	Number
Primary Metals	9
Manufacturing	14
Electronic materials	4
Recycling, Enviroment	1
Material use, performance, or properties	9
Education	3
Other engineering	1
Other	7
Which of the following skills do you use in your work? (Check all that apply.)	Number
Report Writing	42
Oral Presentations	42
Team Interactions	44
Technical Computations	38
Advanced Engineering Tools and Equipment	36
Design	29
How do you serve your profession or local community? (Check all that apply.)	Number
Member of one or more Professional Societies	5
Service on Professional Boards or Societies	27
Community Volunteer	22
Attend Community Activities	27
Other Service	10

Numbers represent number of responses out of 51 respondents. Survey return was 51/54.

Table E-VI-2 Alumni Survey Report for 2002-08 graduates (cont'd)

Single Response Survey Questions

Item	Very High	High	Low	Very Low
To what extent do you feel that your job meets societal needs through science and tec	32	15	3	
How satisfied are you with the overall effectiveness and value of your SDSM&T Met E	26	25		
How satisfied are you with your ability to use analytical methods and solve engineering	26	25		
How important in your position is the use of analytical methods to solve engineering pr	25	19	4	2
How satisfied are you with your ability to use computational methods and solve engine	20	26	5	
How important in your position is the use of computational methods to solve engineeri	15	19	12	4
How satisfied are you with your ability to use math, science, and engineering principles	26	24	1	
How important in your position is the use of math, science, and engineering principles	28	13	8	1
How satisfied are you with your ability to make engineering decisions?	27	22	1	
How important in your position is the making of engineering decisions?	30	10	9	1
How satisfied are you with your ability to design engineering systems?	8	32	11	
How important in your position is the design of engineering systems?	12	12	16	9
How satisfied are you with your ability to work in teams?	32	18	1	
How important in your position is working in teams?	34	11	3	2
How satisfied are you with your ability to use communication skills?	31	20		
How important in your position is the use of communication skills?	41	8		1
How satisfied are you with your ability to use instruments and measurement tools?	26	22	2	
How important in your position is the use of instruments and measurement tools?	25	15	8	2
How satisfied are you with your ability to anticipate the societal impacts of your work?	13	32	5	
How important in your position is the anticipation of societal impacts?	20	13	14	3
How satisfied are you with your ability to recognize the potential environmental impact	11	35	5	
How important in your position is the recognition of potential environmental impacts?	23	14	10	3

Table E-VI-2 Alumni Survey Report for 2010-16 graduates

How much does your current employment involve metallurgical engineering?	Number
Frequently	27
Sometimes	8
Rarely	3
Never	2
Employer's Primary Business	Number
Primary Metals	11
Manufacturing	17
Electronic materials	0
Recycling, Environment	1
Material use, performance, or properties	0
Education	4
Other engineering	3
Other	4
Which of the following skills do you use in your work? (Check all that apply.)	Number
Report Writing	29
Oral Presentations	32
Team Interactions	35
Technical Computations	29
Advanced Engineering Tools and Equipment	19
Design	18
How do you serve your profession or local community? (Check all that apply.)	Number
Member of one or more Professional Societies	23
Service on Professional Boards or Societies	2
Community Volunteer	18
Attend Community Activities	17
Other Service	8
No Public Service	5

Numbers represent number of responses out of 51 respondents. Survey return was 41/63.

Table E-VI-2 Alumni Survey Report for 2010-2016S graduates (cont'd)

Single Response Survey Questions				
Item	Very High	High	Low	Very Low
To what extent do you feel that your job meets societal needs through science and technology?	24	12	4	
How satisfied are you with the overall effectiveness and value of your SDSM&T Met Eng education?	32	7	2	
How satisfied are you with your ability to use analytical methods and solve engineering problems?	24	17		
How important in your position is the use of analytical methods to solve engineering problems?	14	17	8	1
How satisfied are you with your ability to use computational methods and solve engineering problems?	12	28	1	
How important in your position is the use of computational methods to solve engineering problems?	6	18	15	1
How satisfied are you with your ability to use math, science, and engineering principles?	27	14		
How important in your position is the use of math, science, and engineering principles?	20	15	5	
How satisfied are you with your ability to make engineering decisions?	25	16		
How important in your position is the making of engineering decisions?	17	18	4	1
How satisfied are you with your ability to design engineering systems?	7	30	3	
How important in your position is the design of engineering systems?	7	13	14	6
How satisfied are you with your ability to work in teams?	23	15	2	
How important in your position is working in teams?	28	8	3	1
How satisfied are you with your ability to use communication skills?	22	18		
How important in your position is the use of communication skills?	32	6	2	
How satisfied are you with your ability to use instruments and measurement tools?	23	17		
How important in your position is the use of instruments and measurement tools?	17	13	8	2
How satisfied are you with your ability to anticipate the societal impacts of your work?	16	25		
How important in your position is the anticipation of societal impacts?	14	11	12	3
How satisfied are you with your ability to recognize the potential environmental impact of your work?	12	29		
How important in your position is the recognition of potential environmental impacts?	18	12	8	2

Part VII

Advisory Board Reports

Contents

Table E-VII-1 Advisory Board Report for 2009-10

Report from

The Advisory Board
For the Department of Materials and Metallurgical Engineering
At
SDSM&T

Review Date: October 16, 2009

Team Members Participating (in person, by phone, or in later correspondence):

Everett Bloom	Oak Ridge National Laboratory - Retired
Wendy Craig	MacSteel
Chris Misterek	John Deere
Ray Peterson	Aleris International
Shane Vernon	Nucor Steel
Shawn Veurink	RPM and Associates
Richard Wensel	Micron Technology

SUMMARY

The faculty and staff of the Materials and Metallurgical Engineering Department at the South Dakota School of Mines and Technology (SDSM&T) have made outstanding progress in addressing fundamental issues impacting the department since our last on-site Advisory Board Review. In particular they have skillfully navigated the transitional period of three faculty retirements (out of five positions) during a period when the school administration did not seem particularly interested in sustaining the department. They have increased the number of students in the department and they have dramatically increased their outside research funding. All actions have improved the strength of the department and benefited the larger goals of the school.

The Department continues to produce quality students who are well accepted by industry and academia, both regionally and nationally. The future concerns for the Department to address include planning for and executing the transition of a retiring faculty with the concurrent hiring of a qualified replacement, providing opportunities for a full spectrum of materials science curricula, and increasing the faculty level by at least one member. The addition of one more faculty member could help increase the breadth of class offerings and allow faculty members the opportunity to continue to seek more outside research funding opportunities.

The B.S. Metallurgical Degree Program educational objectives remain current and appropriate. Alumni surveys and feedback from board members on the program's alumni performance in the

workplace indicate that the objectives are being met and that no specific changes in curriculum beyond the suggestions below are needed.

Observations by the AB Regarding The Department of Materials and Metallurgical Engineering

Strengths:

1. The faculty of Materials and Metallurgical Engineering Department has taken a strongly proactive approach to improving the department. They addressed most of the major concerns of the AB in our last on site review in 2002 (several teleconferences have been held in the interim). Two of the five faculty positions are partially endowed with the possibility of becoming fully endowed. Self assessment rates by recent alumni (for ABET) were extremely high and the overall impression by alumni was that they were well prepared for their careers. The new Samurai Sword Senior Project was laid out in a manner so that all students contributed in different ways to a single goal, much like a company would operate. Students were able to succeed or fail in their own areas and learn from the experience. The faculty also creatively modified the class schedule such that class sizes could be increased through combining grade levels. The larger classes produced a stronger and more dynamic teaching environment.

2. Strong progress in undergraduate student enrollment has been made resulting in the highest levels of enrollment in 18 years. This is not an accident, but the result of active involvement by the faculty members. They have added programs and activities to increase student involvement with the department and the materials profession, thereby engendering more student interest. Some of these programs and activities include:
   - A weekly blacksmithing workshop that is entertaining, but still ties back into the students' education by linking processing paths to microstructure and properties.
   - A Samurai sword Senior Design Project covering all areas of metallurgy.
   - Integrating the artistic side of Materials Science with the industrial side. Examples include blacksmithing, glass blowing, jewelry crafting, and copper working.
   - Extra efforts to attract and retain non-traditional students to the metallurgy field (women and minorities) through the WIME program and an NSF REU.
   - Outreach to scientifically oriented high school students with the ASM Materials Camp.

3. The five teaching and one research faculty members are currently responsible for bringing in over \$6.7M of external research funding (17 total awards). This equates to \$1.3M per faculty member – at or near the top for any department within SDSM&T. They are supervising approximately 15 Masters students and approximately 10 PhD students. Development and expansion of MS / PhD programs has helped to bring in external funding as well as new equipment.

4. As already mentioned the enrollment numbers for students in the Materials and Metallurgical Engineering Department are at all time highs. In addition to the active student recruitment program, the Department has developed a strong scholarship program so that over two-thirds of the undergraduate students receive some form of scholarship

5. stipend. The graduating seniors experience a high placement rate in many types of industries and research facilities both regionally and nationally. Additionally a significant portion of the students progress on to graduate level programs (1 in 3 goes on) with approximately 40 % enrolling outside of SDSM&T. The graduating students are of a high caliber and are in demand due to strong technical backgrounds and good work ethics.

Opportunities and Concerns:

1. The Department continues to have a focus on traditional metallurgy. This is both strength and a weakness. Very few schools still produce students who can go into a traditional metallurgical operation and not require significant on the job training. On the hand, the world of Materials Science is much larger than it used to be (ceramics, biomaterials, polymers, electronic materials, composites, etc.) and training in other areas might open doors for the students. Perhaps one or two survey classes could be a partial remedy.

2. Dr. Howard is nearing retirement. It is critical that the proper replacement be found for him and that this transition proceeds as smoothly as possible.

3. As the number of research projects within the Department has increased, the need for project management tools has become critical. Examples of information that need to be collected and tracked for the multiple projects includes: PI and researcher hours, purchases and expenses, and progress to goals. Outside assistance has been offered.

4. Some class space, laboratories, and offices need infrastructure upgrades and repair to meet current standards. There have been some new additions of equipment to the Departmental laboratories in recent years, but not a lot of change. While expensive and difficult to do, the faculty and school need to ensure that laboratories are current so the students can be adequately prepared for future jobs or additional training at research universities.

5.

6. The Department should find more opportunities for students to work in summer or co-op jobs to gain experience. This is an area where alumni and other contacts could be used beneficially.

7. Faculty numbers are still low for the number of enrolled students and the level of research funding being performed. Many MSE departments have student to faculty ratios of about 12 : 1. This department is 16 : 1. With five faculty members, the department is always just one step away from a dilemma should a member be lost. Adding another faculty member with the correct skill set could also be a method to broaden the department’s range of abilities and class offerings.

Table E-VII-2 Advisory Board Report for 2013-14

Advisory Board Analysis for Department of Metallurgical Engineering

Date: June 3, 2014

Background

The Advisory Board for the Metallurgical Engineering Department of South Dakota School of Mines and Technology met telephonically with the faculty in December, 2013. Department Chair Michael West and his faculty members presented a departmental review. Also students were given an opportunity to speak to the AB. Based on these inputs, each of the AB members created a SWOT (Strengths – Weaknesses – Opportunities - Threats) chart. All inputs were compiled and grouped by topical area or theme to help identify successes and opportunities.

Conclusions

The AB members are pleased to see the addition of two new faculty members to the department which brings the total teaching staff up to seven professors. This action helped to address one of the major concerns the AB identified in its last departmental review.

With the addition of the new faculty members it should be possible to both increase the number of class offerings and increase the undergraduate enrollment while maintaining the close student – faculty interaction cited by so many as an important part of the Met E culture. With expanded faculty numbers it may be possible to move away from the 2-year rotating class schedule which limits student's opportunities in many ways. To increase undergraduate enrollment will require continued exploration of new and varied recruiting techniques. Increasing student enrollment will strengthen the department's position within the university and help to secure funding for needed laboratory upgrades and building improvements or replacements.

The AB believes it is important for the department to continue to nurture the strong relations it has with industry including placement of its students in industrial positions. While it is exciting to develop new class content, it is also important to maintain strengths in the niche markets that the Met E department has traditionally served. Stronger relationships with industry could improve outside funding for laboratories and facilities as well as scholarships. Placement of graduates has been virtually 100% for the last few years indicating outside approval of your primary product – new engineers.

The Metallurgical Engineering Department will need to address near term issues including:
a.) replacement of aging buildings and laboratories so that thee students remain relevant to the changing job market, b.) investigation of increasing undergraduate enrollment size, c.) possible changes to the two-year rotating class schedule, and d.) determination of future curricula (traditional focus versus new and more speculative area of research).

Recommendations

The AB feels that the Metallurgical Engineering Department should develop specific short and long term goals to increase the department's strength and health. Example goals could include raising the undergraduate enrollment to 100 students and replacement of the aging Minerals Industry Building. Based on these large goals, individual actions and activities could be reviewed and assessed for their impact to meet these overall goals.

SWOT Analysis for Department of Metallurgical Engineering

Responder: Combined Responses

Strengths	Weaknesses
1. Student – Faculty Ratio (Low student to professor ratio, Student : Teacher ratio; Student/Faculty ratio is small, so interaction between the two is good; Expanded faculty; excellent student/professor ratio; Small class size – Instructor/Student interaction) 2. Strong Student - Faculty Interactions Possible (Strong faculty – student interaction; Student/Faculty ratio is small, so interaction between the two is good; Engaged faculty; Small class size – Instructor/Student interaction) 3. Increased Faculty Headcount (Seven member department now; New faculty to bring in new research and courses; Expanded faculty; excellent student/professor ratio) 4. Ability to attract students with scholarships (Better than school average scholarships; Ability to give scholarships) 5. Graduating students are in demand (Strong job placement (100%) with good salaries; Excellent dollar value and job placement, this is true for SDSM&T in general; Reputation – on campus & in industry) 6. Maintained focus in traditional Metallurgy curriculum and found a niche (1 of 7 MetE undergraduate programs in US; Course work in extractive and physical met; Ferrous Metallurgy; Reputation – on campus & in industry) 7. Other (Increased enrollment; Summer Materials Camp; Senior Design Project has been revamped to work more closely with industry; Ability to obtain research grants)	1. Current two-year class schedule is viewed negatively (Two year rotating class schedule; Poor class schedule options for Coop Students; 2 year curriculum hinders ability for coops; Two-year cohort program) 2. Age and wear on laboratory equipment and Minerals Engineering Building (Old labs and obsolete equipment; Aging Lab Facilities in Met Dept.; Aging building – facilities do not compare well to some other schools; Mineral Industries Building; Limited lab equipment) 3. While above historically low levels, current level of undergraduate enrollment are worrying (Already at full capacity of MET Dept.; Cannot keep up with growth goals without increasing undergrad capacity; Still weak on female enrollment; Low enrollment leads to fewer resources allocated to the dept.) 4. Other (Extractive metallurgy elective selection seems light; Number of faculty; Lots of plans and activities – unclear strategy [research, faculty, curriculum, and capital plan aligned with to-be-determined department goals]; Clear Department goals for future [in support of university strategy.]; Need clear “WIG’s (wildly important goals)”)

Opportunities	Threats
1. Growing the department offers possibilities for improvement (Increase number of classes or size of classes with increased faculty; Develop new courses; Growth potential in Metallurgical Enrollment) 2. Maintain or enhance relationship with industry (Continue to create a niche for supplying engineers to key metallurgical industries; Continue to develop industry and interdisciplinary design projects; Increase Industrial support/funding; Use industrial efforts to promote school/department; Poll industry to determine their needs when designing new laboratory facilities; Poll industry to determine their needs when designing new laboratory facilities) 3. Continue to test techniques to improve student recruiting (Glassblowing club – Growth of this group could help attract more female (or male) students that are more "artsy"; Expand Foundry. Attract more hands on students. Build on science/art link; Increase brand awareness, aka: recruiting; Capitalize on strong research support – increase undergrad/graduate enrollment; Undergraduate center for Manufacturing / Metal working / Entrepreneurship; Utilize the REU sites on campus. (strategic printing, foundry)) 4. Other (Collaboration with other fields such as BME and NSNE fields; Planned Maintenance of Laboratory Equipment; University leadership thinks highly of the department… and is supportive of capital projects. Leverage this and make sure the department grows in the appropriate direction)	1. Students are annoyed and alienated by 2 year rotating schedule. This schedule limits their ability to participate in co-op programs or deviate from a regimented schedule without impacting their graduation date. 2. Outdated facilities negatively impact student training and faculty research (The labs and building are becoming small and outdated; Need to identify resources for capital updates) 3. Changing curriculum away from traditional Metallurgy program to Material Science (Curriculum becomes too materials based and loses focus on metallurgy; There continues to be a push away from Metallurgical to Materials department - following this trend could alienate many employers; Industry hiring trends vs. curriculum focus areas and research experience; Serving industry vs. serving research dollars - Are these aligned / supporting each other?) 4. While the number of faculty positions has grown, the department is still small in relation to other departments on campus which could cause funding and perception problems (department is still small compared to others on campus; "Best kept secret on campus" – more than a running joke – this may be a significant threat to the MetE dept.) 5. MES program is in jeopardy (No base support for MES program; No dedicated faculty/staff for MES program) 6. Increasing student enrollment could lead to growth pains (Increase in enrollment could outpace facility growth; Job placement as enrollment increases to planned levels

SWOT Analysis for Department of Metallurgical Engineering

All Responses – No combining of answers

Strengths	Weaknesses
1. Strong faculty – student interaction. 2. Seven member department now. 3. Increased enrollment. 4. Better than school average scholarships. 5. Strong job placement (100%) with good salaries. 6. Low student to professor ratio. 7. New facility to bring in new research and courses. 8. Ability to give scholarships. 9. Summer Materials Camp 10. Student : Teacher ratio 11. Excellent dollar value and job placement, this is true for SDSM&T in general. 12. Student/Faculty ratio is small, so interaction between the two is good. 13. Senior Design Project has been revamped to work more closely with industry. 14. Reputation – on campus & in industry 15. Ability to obtain research grants 16. Expanded faculty; excellent student/professor ratio 17. 1 of 7 MetE undergraduate programs in US 18. Engaged faculty 19. Ferrous Metallurgy 20. Small class size – Instructor/Student interaction 21. Course work in extractive and physical met	1. Two year rotating class schedule. 2. Poor class schedule options for Coop Students. 3. Old labs and obsolete equipment. 4. 2 yr curriculum hinders ability for coops. 5. Extractive metallurgy elective selection seems light. 6. Aging Lab Facilities in Met Dept. 7. Aging building – facilities do not compare well to some other schools. 8. Already at full capacity of MET Dept. Cannot keep up with growth goals without increasing undergrad capacity. 9. Still weak on female enrollment 10. Low enrollment leads to fewer resources allocated to the dept. 11. Two-year cohort program. 12. Lots of plans and activities – unclear strategy (research, faculty, curriculum, and capital plan aligned with to-be-determined department goals) 13. Clear Department goals for future (in support of university strategy.) Need clear “WIG’s” 14. Mineral Industries Building 15. Number of faculty 16. Limited lab equipment

Opportunities	Threats
1. Increase number of classes or size of classes with increased faculty. 2. Continue to create a niche for supplying engineers to key metallurgical industries. 3. Develop new courses. 4. Continue to develop industry and interdisciplinary design projects. 5. Poll industry to determine their needs when designing new laboratory facilities. 6. Glassblowing club – Growth of this group could help attract more female (or male)student that are more “artsy” 7. Growth potential in Metallurgical Enrollment 8. Expand Foundry. Attract more hands on students. Build on science/art link. 9. Industrial efforts to promote school/department. 10. Increase Industrial support/funding 11. Increase brand awareness, aka: recruiting 12. Collaboration with other fields such as BME and NSNE fields. 13. Utilizing the REU sites on campus. (strategic printing, foundry). 14. Capitalize on strong research support – increase undergrad/graduate enrollment 15. University leadership thinks highly of the department… and is supportive of capital projects. Leverage this and make sure the dept grows in the appropriate direction. 16. Undergraduate center for ‘Metalworking, Manufacturing, and Entrepreneurship’ 17. Mfg/Metallworking/Entrepreneurship 18. Planned Maintenance of Laboratory Equipment	1. Alienate students with 2 year rotating schedule. 2. Need to identify resources for capital updates. 3. Increase in enrollment out paces facility growth. 4. Curriculum becomes too materials based and loses focus on metallurgy. 5. MS&T offer’s Materials Camp at no cost to the student. 6. There continues to be a push away from Metallurgical to Materials dept. Following this trend could alienate many employers. 7. The labs and building are becoming small and outdated. 8. Dept is still small compared to others on campus. 9. Industry hiring trends vs. curriculum focus areas and research experience 10. “Best kept secret on campus” – more than a running joke – this may be a significant threat to the MetE dept. 11. Serving industry vs. serving research dollars. Are these aligned / supporting each other? 12. No base support for MES program 13. No dedicated faculty/staff for MES program 14. Job placement as enrollment increases to planned levels.

<u>Advisory Board Members:</u>

Wendy Craig
Chris Misterek
Ray Peterson
Terry Rasmussen

Lisa Schlink
John Walenta
Rich Wensel

Table E-VII-3 Advisory Board Report for 2015-16

Date:	4/21/2015
Attendees:	Ray Peterson (Real Alloy), Wayne Douglas, (Barrick), Terry Rasmussen (Nucor Steel), Lisa Schlink (Freeport McMoRan), Shaun Veurink (RPM), John Walenta (Caterpillar)
Attended on conference call:	Wendy Craig (Gerdau Steel), Andy Johnson, GE (retired)*
Absent with regrets:	Rich Wensel (Micron), David Gildemeister (ALCOA), Chris Misterek (John Deere)

Summary

The Metallurgical Engineering Department has made significant progress in rectifying problems identified over the last few years. Examples of progress made include:

- Increased Enrollment to over 100 students with larger Freshman and Sophomore Classes
- More Faculty
- Significant progress in updating the lab areas
- Significant effort in increasing diversity in enrollment
- Having 65% of student enrollment from out of state
- 100 % placement of students into employment or graduate school
- Strong research activities by all professors
- Development of new classes and exploring opportunities for sharing video classes with Montana Tech
- Strong ABET reviews

Observations

Curriculum: The number of lab sections has been increased to accommodate the higher number of students. The curriculum standards are being raised in increase the quality of education/students. The advisory board believes this will lead to stronger graduates.

The department continues to maintain a good balance between research and teaching using the two-year cohort model. The department has identified optimal coop times starting Spring of Sophomore and Junior years. Some flexibility on Coop options is still recommended and may be accomplished through distance learning. Utilization of remote access to classes was discussed as one possibility of adding flexibility to coops. Flexibility on Lab Classes was discussed. If a class corresponded to the coop, and the coop company was able to supply equivalent experience, that could help. The difficulty in making this work is recognized, however, we recommend that this be considered further.

The department continues to improve the design sequence by partnering with industry on nearly all design projects. Projects in the last sequence were well represented in all three areas of metallurgical engineering – extractive, process, and physical.

The board is pleased to see the plans to continue the Culture and Attitude scholarship program for Women in Engineering. This could lead to the development of new curricula to support women in engineering.

Recruiting and retention: Department enrollment continues to grow. 2014 found enrollment at 105 students, which was a significant increase from 2013. The 2015 class was the largest freshman class ever. The department continues to do a good job with recruiting and retention activities.

The ASM Summer camp for high school students continues to provide a portion of the Freshmen enrollment. With the loss of the campus residential summer camp program, the ASM camp will be scaled back to local residents, but provided at little or no cost. This option keeps the program going, but does miss out on a lot of potential students. Many former campers came from out of state and have come to SDSM&T as students. This may result in reductions in enrollment in the MET department. During the first summer of implementation, many students still came from out of state but this trend should be watched to make sure the camp is reaching a broader geographic base of students.

Other outreach programs and internships and visit programs are still in place and should be continued. Blacksmithing continues to be a draw to the department and provides a fun way for students to be involved in a group program, that also helps them learn metallurgy. The Blacksmithing Club has grown to one of the largest student organizations on campus. The department is also re-introducing foundry activities.

Mentor programs continue to grow nationwide as a way to retain students and help them succeed. It is imperative that students be encouraged to succeed. It is good to see implementation of MET peer mentors by the university as well as WISE (Women in Science and Engineering) mentors.

The Go To Mines event in October brings in high school students interested in attending Mines. Next year, Industry will be invited to attend and talk to student and parents about the opportunities for engineers in industry. This could be a great recruiting opportunity for the school and for industry. The department has recently teamed with industry during the Go to Mines day as a way to show career pathways. This model could be replicated with other departments on campus.

SDSM&T enrollment is now over 50% out-of-state students. Out of State students are attending for a variety of reasons, one being the cost of education. It’s interesting to note that 1 in 4 out-of-state students finds their first job after graduation in the state of South Dakota.
To maintain and grow the department, the department needs to continue to grow the available discretionary funds to have $100-150K in departmental scholarships available. The scholarship level needs to increase going forward. Endowments are the preferred method of scholarship provision. While the board agrees that endowments are ideal, pay as you go scholarships may be easier for some companies/people to provide and should be encouraged as well. This may include partnerships with new industry partners.

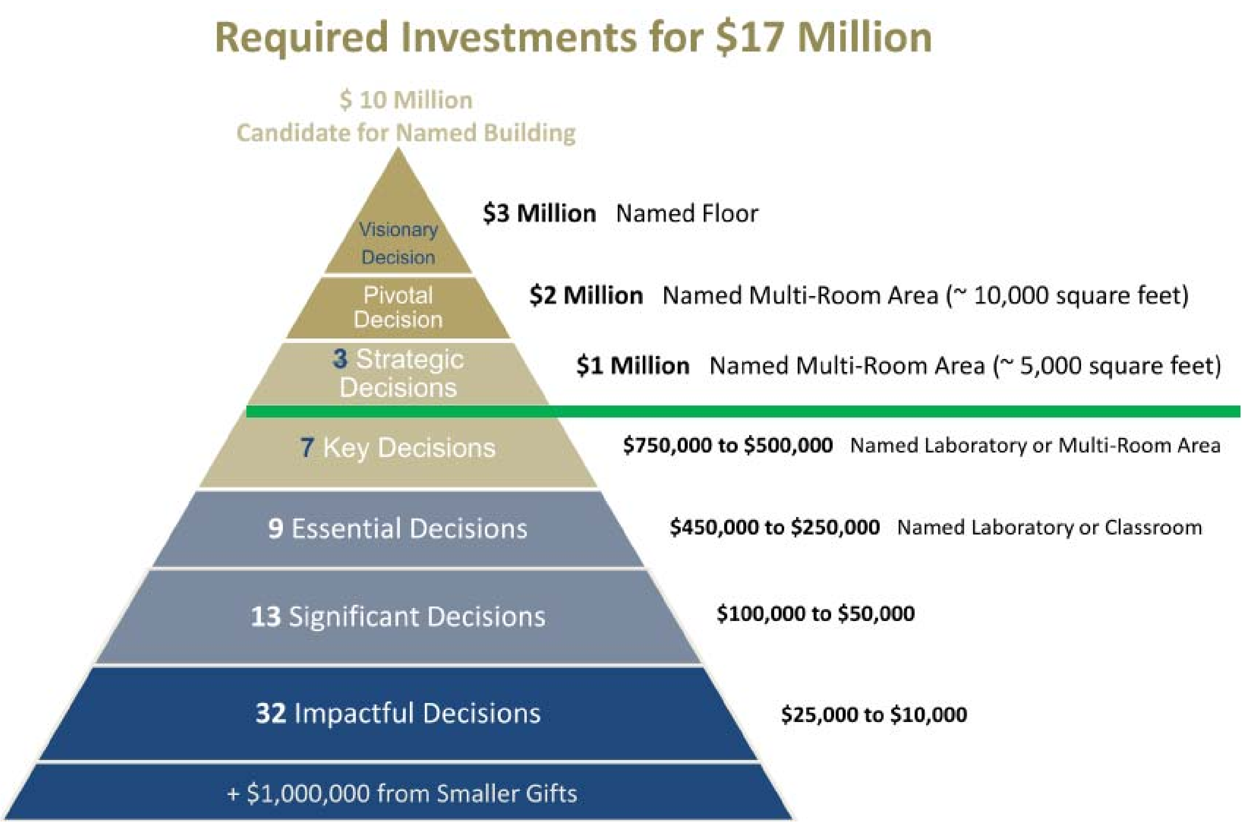
Student placement: Student placement is down slightly due to the sag in the economy. However several new employers have been present on campus. Increased representation of hiring companies is a key element in maintaining and growing the department/school. The department should develop a strategy to engage new partners to broaden the portfolio of companies that come to recruit. The department has done a good job to engage new companies through the design sequence as a way to provide new opportunities for student placement.

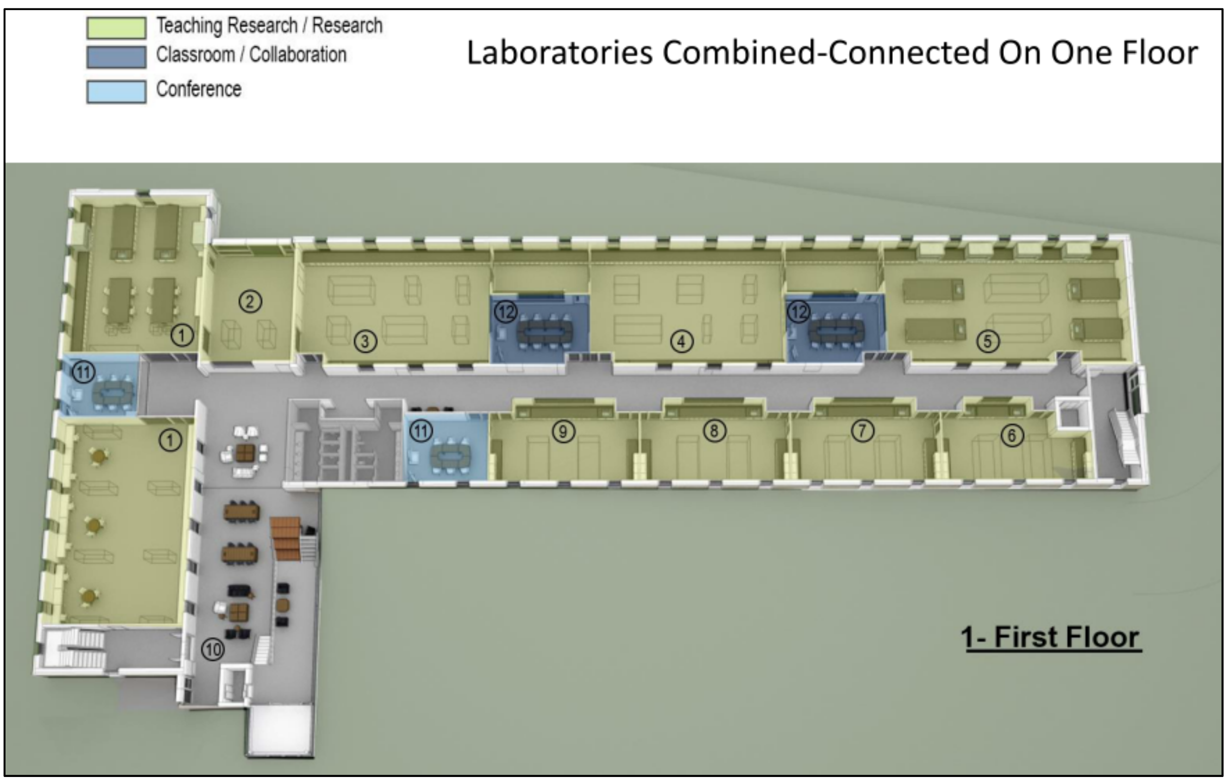
ABET accreditation: The plan for presentation to ABET for accreditation is well mapped out. The board was briefed on the metallurgical engineering department's continuous improvement process. We find that the constituents are complete and appropriate. The student educational outcomes are clearly stated. In general, the documentation that was set up for ABET is appropriate and covered the topics and requirements set by ABET. One note is that safety and leadership are not mentioned specifically as topics directly. These are important requirements as students are entering industry.

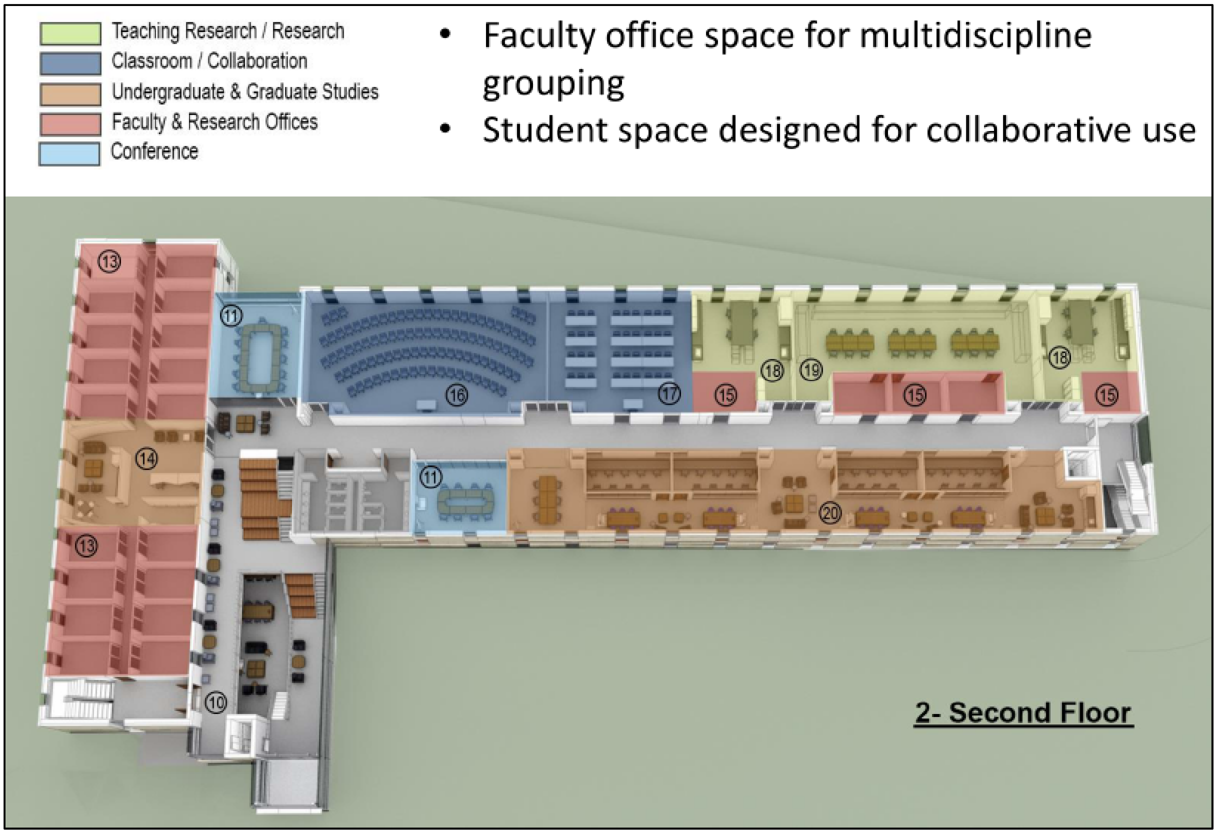
Current facilities: A tour of labs presented a significant improvement in the housekeeping and organization of the laboratories. Updating of lab equipment is still needed, however the improvement is encouraging. The grad student office renovation provides a much improved facility. Some areas were noted to still be going through improvement, such as the Blacksmithing/Foundry area and Hydrometallurgy Lab. There is a critical need for additional space throughout the MI building given the growth in enrollment of the department particularly in the undergraduate labs. The department has done started work to try to consolidate labs to efficiently use space but more improvement is needed in general housekeeping. The Foundry building also needs additional space added if casting activities are to be reintroduced.

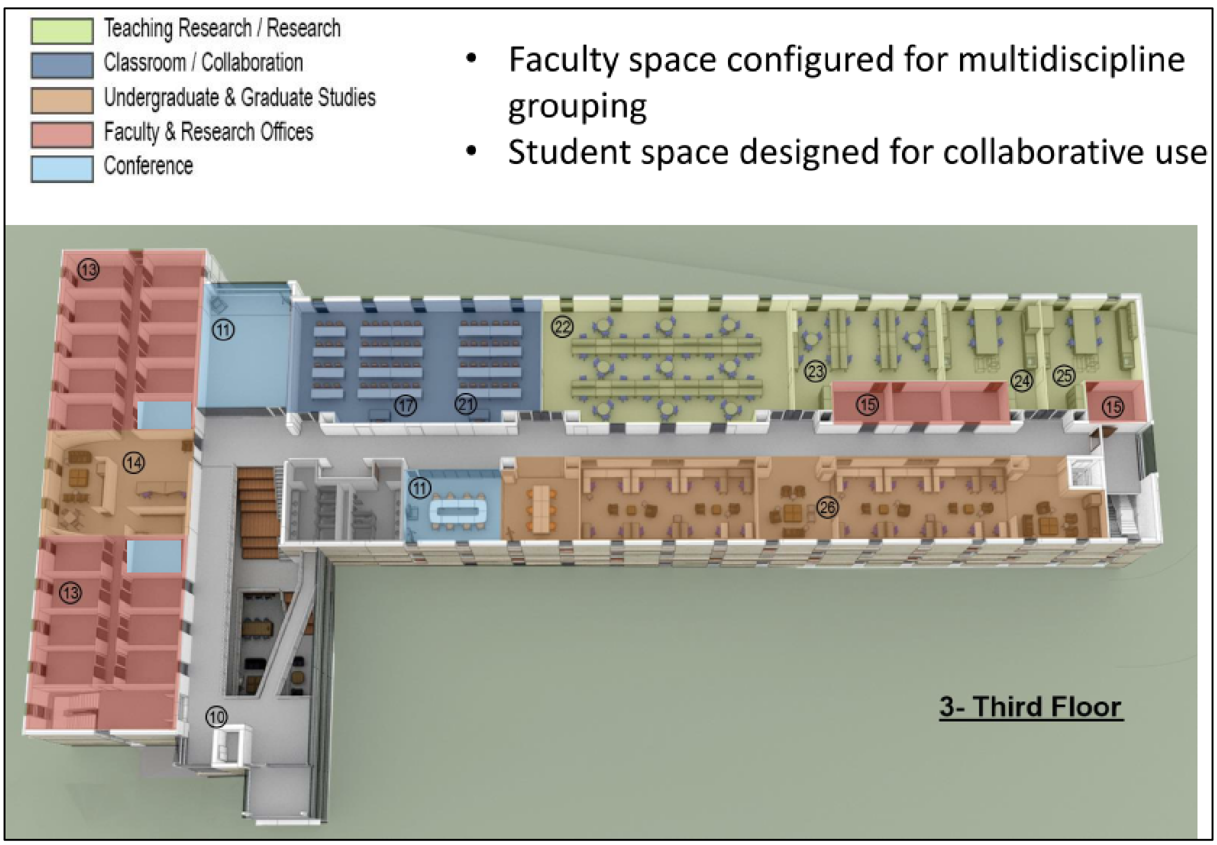
MI Building initiative: The current Mineral Industries Building (MI) is in desperate need of renovation in order to provide more space and better classroom and lab space. The renovation of the current building will cost approximately 60% of what a new facility would cost. Proposed layouts are attached below. The possibility of the USGS attaching a new 15,000 sq. ft. section to the building on the South side was presented. This additional space would be used by the USGS, but some of the Federal funds provided would help with the renovation of the rest of the building. The USGS addition is still being discussed and is not finalized. The relocation of the Atmospheric Sciences department will provide some of the additional space needed by the MI departments (Metallurgy, Geology, Mining).

Only $1.5M is currently designated to be used for the renovation. That money was donated by unnamed companies that hire many of the MI graduates. More donations are needed to reach the goal. <u>All board members are encouraged to help raise the needed funds in any way they can.</u> Dr. Heather Wilson stated she will continue fundraising until the entire $17M is raised.


Required Investments for $17 Million
$ 10 Million
Candidate for Named Building
Visionary Decision
$3 Million Named Floor
Pivotal Decision
$2 Million Named Multi-Room Area (~ 10,000 square feet)
3 Strategic Decisions
$1 Million Named Multi-Room Area (~ 5,000 square feet)
7 Key Decisions
$750,000 to $500,000 Named Laboratory or Multi-Room Area
9 Essential Decisions
$450,000 to $250,000 Named Laboratory or Classroom
13 Significant Decisions
$100,000 to $50,000
32 Impactful Decisions
$25,000 to $10,000
+ $1,000,000 from Smaller Gifts


Teaching Research / Research
Classroom / Collaboration
Conference
Laboratories Combined-Connected On One Floor
1- First Floor


Teaching Research / Research
Classroom / Collaboration
Undergraduate & Graduate Studies
Faculty & Research Offices
Conference
• Faculty office space for multidiscipline grouping
• Student space designed for collaborative use
2- Second Floor


Teaching Research / Research
Classroom / Collaboration
Undergraduate & Graduate Studies
Faculty & Research Offices
Conference
• Faculty space configured for multidiscipline grouping
• Student space designed for collaborative use
3- Third Floor

Recommendations

The board recommends that the department continue to strengthen high quality curriculum and develop new industry partnerships. It was recommended that the following sub-committees of the advisory board be established to help with future needs of the department.

- **Safety & Housekeeping –** Veurink, Rasmussen
  Monthly audits, work with faculty and students to bring up to industry expectations
- **Scholarship** - Douglas
  Need to coordinate with Foundation
- **MI Building Initiative –** Rasmussen

Coordinate with other AB's from Mineral Industry Departments

- **Personal Skills Building –** Wensel, Gildemeister
  Potentially coordinate with ongoing professional development activities on campus
- **Industrial Advisory Board Expansion**
  Increase membership up to 20. Improve industry-faculty-student contact/mentoring. Increase funding opportunities. Increase commitment to the department/school

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Appendix F - Glossary of Terms

Continuous Improvement Terms used by the Bachelor of Science in Metallurgical Engineering Degree Program at SDSM&T

Action Statement
refers to a written and distributed statement prescribing program faculty members to change outcome assessment procedures, instructional content or procedures, curriculum, extracurricular activities and opportunities, or objective evaluation procedures with the intent of improving program quality.

Assessment
Assessment under this criterion is one or more processes that identify, collect, and prepare data to evaluate the achievement of a program outcome or a program educational objective.

Assessment Summary
is a Microsoft Excel document consisting of a Table and a Chart onto which all Program Outcomes results are organized for one academic year.

Assessment Triangulation
is the use of three assessment methods to obtain a more meaningful assessment than possible from any one assessment method.

Course Objectives
are statements about the broad educational goals of a course.

Course Outcomes
are statements that describe what students are expected to know, attitudes they are expected to hold, and what they are able to do as a result of taking a course

Evaluation
is one or more processes for interpreting the data and evidence accumulated through assessment practices.

Goal
The terms “goal” and “objectives” are used interchangeably.

Grand Summary
is a Microsoft Excel document that shows the assessment results for all outcomes over all years, any one outcome over time, or all outcomes for any selected year.

Instrument
is the collection of a specific document, one per student or team, used to assess a Program Outcome. Examples of the specific document may be a completed homework assignment or an

exam, faculty member-completed oral presentation assessment form, or students' standardized exam results.

Instrument Inventory
is the collection of all instruments used to assess all Program Outcomes.

Metrics
refers to the system of Performance Criteria used to arrive at numerical measures of student satisfaction of Program Outcomes.

Performance Criteria
are measurable attributes that define each of the educational outcomes.

Program Educational Objectives
are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

Program Outcomes
are statements that describe what students are expected to know, attitudes they are expected to hold, and what they are able to do by the time of graduation. (Achievement of program outcomes should indicate the student is equipped to achieve the Program Educational Objectives.)
For ABET-accredited programs, outcomes must embrace the 11 (a) through (k) requirements of ABET Criterion 3

Outcome Review
is a Microsoft Excel worksheet onto which a designated Met Eng faculty member documents his critical review of a selected Program Outcome for a specified academic year and includes actions needed.

Outcome Review Summary
is a Microsoft Excel worksheet that contains a complete sequential history of the evaluation, actions, and results for one outcome review for all years.

Outcome Summary
is a Microsoft Excel table document for a specified Program Outcome onto which the all the Score Card assessment results for the specified outcome are summarized and tabulated for one calendar year.

Quality Function Deployment Matrix
refers to map of outcomes to established functions, such as courses, student advisement, career fairs, field trips that influence the degree to which one or more program outcomes are achieved.

Score Card
is a Microsoft Excel table document on which the Program Outcome assessment results for one instrument are recorded. These are typically completed by one designated faculty assessor.

Signature attesting to compliance

By signing below, I attest to the following:

That the BS Metallurgical Engineering program has conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET's *Criteria for Accrediting Applied Science Programs* to include the General Criteria and any applicable Program Criteria, and the ABET *Accreditation Policy and Procedure Manual.*

Demitris Kouris
Dean's Name (As indicated on the RFE)

Signature Date

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