Montana Tech: Annual Program Review

Department: Graduate School

Program: All On Campus Programs

Dean: Beverly Karplus Hartline, Ph.D.

Year Under Review: 2014-15

Submitted: June 1, 2016

Assessment Committee Review: Summer 2016
Program Review

Department: Graduate School
Degree: All On-Campus Certificates, M.S., and Ph.D. Programs

Introduction

From the Catalog: “The Graduate School provides opportunities for advanced study and research in science, engineering, and technical communication. It aims to foster a community of faculty and students motivated by a shared commitment to blending theory with practice to advance research, scholarship, and applications that meet the changing needs of society and contribute to the responsible and sustainable development and use of natural resources.”

Montana Tech’s AY2014-15 graduate programs (Table 1) concentrate in engineering, technology, and science, building on expertise in the institution’s mission areas and bachelor’s degree fields. These programs serve the same employment sectors and employers as the undergraduate programs. The Graduate School and its programs are continually evaluating the quality, curriculum, currency, and learning experiences of the courses and programs, along with the graduate-school processes and policies, modifying as needed to keep up-to-date and optimize their overall effectiveness and value. Three recent examples are provided at the end of this introduction. This program review is the first formally documented, collective Program Review for on-campus graduate programs.

<table>
<thead>
<tr>
<th>Graduate Programs</th>
<th>Metallurgical/Mining Process Engr MS</th>
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<td>Environmental Engineering MS</td>
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<td>Geoscience MS</td>
<td>Master Project Engr Mgt: Distance</td>
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<td>#Health Care Informatics Certificate</td>
<td>Materials Science Ph.D.</td>
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<td>Interdisciplinary Studies MS</td>
<td>Restoration Certificate</td>
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<tr>
<td>Industrial Hygiene MS</td>
<td>Tech Communication MS</td>
</tr>
<tr>
<td>#IH Distance Prof Track MS</td>
<td># Distance</td>
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Until May 2013, the university was only authorized to offer master’s-degree and certificate programs at the graduate level. In an historic decision for Montana Tech, the Board of Regents approved Montana Tech to award a Ph.D. in materials science in an innovative program offered in collaboration with the University of Montana in Missoula and Montana State University in Bozeman. The first four doctoral students entered Montana Tech in August 2014. The Restoration Certificate core courses were not offered until AY2015/16. During AY2015/16 a graduate certificate in Computational Science was approved, and it will be initiated in AY2016/17. Three of the programs (MSIH Professional Track, Master of Project Engineering Management, and Health Care Informatics Certificate) are available as distance programs, marked with a # in Table 1. All other programs are offered on campus only, with a small but growing number of courses being available in hybrid mode simultaneously to on-campus and distant students. As a general trend, over the past decade graduate enrollment (Figure 1) and completions (Figure 2) at Montana Tech are increasing, though significant year-to-year swings are common.

Figure 1. Graduate Head Count Enrollment: Fall 2004 through Fall 2014

Figure 2. Graduate Completions: AY2004-05 through AY2014-15
The majority of Tech graduate students are non-traditional in age and have at least a few years of career experience. Many also have family responsibilities and continue working professionally, while they advance their education. Although some start their graduate education at Tech intending the M.S. as a stepping stone toward a doctorate elsewhere, the majority enroll in our master's and certificate programs for career advancement, greater earning power, or to change careers. Some discover in the course of graduate study that they wish to continue for a Ph.D. Thus, prospective students, who apply to Montana Tech, know what program interests them, and they are not choosing Montana Tech or the program on the basis of published program objectives or student outcomes. Their primary decision factors tend to be location, program reputation, specific faculty they desire to work with, specialty areas, and financial factors (cost and the potential for financial support). These students “vote with their feet” and would leave, if their program was not serving their needs and expectations. Retention rates are high, providing circumstantial evidence that the students judge that the programs are high quality and meet their needs.

The Year 3 Peer Evaluation Report prepared for NWCCU was informed by Montana Tech’s Year 3 Self Study and a distance-mode team visit. The Report includes the following statement: “Evidence was not found that graduate degree programs publish student learning outcomes in the catalog. The graduate learning outcomes could not be located initially nor in follow-up inquiry.” (page 12, Standard 2.C.2). The Peer Evaluation Report was received in late spring 2014. After receiving the Report, the Graduate Dean shared this observation with the Graduate Council membership with a request for the Council to establish clear expectations about graduate programs and published learning outcomes. Considerable discussion ensued during several Graduate Council meetings in AY2014/15, and faculty representatives gathered input from colleagues in their departments. Two alternative approaches were formulated and considered: A. to require graduate programs to specify and publish outcomes; or B. to encourage programs to do so. The final discussion and vote took place at the February 27, 2015 Graduate Council meeting, resulting in the decision to encourage but not require graduate programs to specify their outcomes. Each program deciding to have published outcomes would document the outcomes in its catalog entry and on its program web page. In parallel, the Graduate School with input from programs and faculty worked on preparing a summary of the de facto common, overarching graduate program objectives and graduate student outcomes that Montana Tech’s graduate programs address, even though they had not been written down previously. The primary sources for this information were the descriptions of programs in the Catalog and on the website, other material, if any, published by the programs, and the syllabi of 500-level courses. This effort, after iteration with Graduate Council members, produced the program objectives and student outcomes used in this program review. Note, however, that neither the objectives nor the student outcomes had been published prior to the academic year (2014-15), which is the subject of this review.

In AY2015/16 each department prepared Annual Program Reviews for AY2014/15, due in January. The Graduate Dean read the program reviews from departments which have graduate programs. It turned out that these documents focused overwhelmingly on the undergraduate degree programs, which dominate the department’s enrollment, and in several cases are accredited by professional organizations, such as ABET. Program reviews were prepared for the distance graduate programs, however.

With on-campus graduate programs for the most part NOT included in departmental program reviews, the Graduate School in Spring 2016 consulted with the Graduate Council about how to proceed. The Graduate Council decided to ask the Graduate School to draft ONE program review covering all on-campus graduate programs. This approach is reasonable, because the programs individually are small, and collectively comparable to a mid-sized undergraduate department. Table 2 shows the graduate enrollment for each program for Fall 2014 and completions for AY2014/15. For on-campus programs, the total head-count enrollment was 113 (~60% of graduate enrollment), and the completions totaled 40 (~70% of graduate completions). Taken together, the on-campus graduate programs would rank 8th in enrollment at Montana Tech. The SIZE of the graduate programs collectively, in combination with the fact that they do not have individualized program objectives or student outcomes makes this approach of preparing one combined program review more reasonable than preparing 11 separate program reviews, each covering a program with a small number of students. A benefit of one combined program review is that it enables cross-fertilization of effective practices and cross-program learning from each other.
Three Recent Examples of Continuous Assessment and Improvement for Graduate Programs

A. Montana Tech requires all students doing research, regardless of the source of funds, to have Responsible Conduct of Research (RCR) training. This requirement affects the vast majority of on-campus graduate students. Originally sessions were offered once or twice per semester. Students and faculty complained that this was too late, as students would start planning or doing their research before having the training. The solution was to include the RCR session in the new-grad-student orientation, offered during the first week the students are on campus, and at the beginning of the summer term. Participant feedback collected from each RCR session is reviewed and used to improve subsequent sessions, and the complaints about timing have stopped.

B. The Master of Project Engineering Management (MPEM) program requires students to complete 12 credits of electives. Although students with any engineering background and in any industry sector can enroll in the MPEM, most of the electives are in energy, management, and environmental areas. Prospective and enrolled MPEM students have contacted the graduate school to find out if electives would be available in areas of their interest. Thus the graduate school has encouraged and supported faculty in other degree programs—especially those which serve students in far-flung regions (e.g. oil and gas production, mining)—to retool 500-level courses to be available to both on-campus and distance students.

C. Quality writing is sufficiently important that Montana Tech has long required all on-campus graduate students to pass a 1-credit graduate writing seminar. This seminar had been offered in two formats: 1-hour-per-week throughout the term and as an intensive weekend (Th/Fr evening, Sat, Sun) workshop. Students vastly favored and enrolled in the weekend version. However, this format does not allow for instruction and development of basic writing competencies, and many students and their thesis/project committees were struggling with multiple review cycles for the final thesis or project report, because of poor writing. The Graduate School, in consultation with the Graduate Council, the Writing Program Director, the cognizant dean, and the instructors of both courses, stopped offering the semester-long version of the seminar and established a writing-proficiency pre-requisite for the weekend version: GRE analytical writing score of at least 4.0 or B or better grade in an upper division undergraduate writing course. A new graduate writing proficiency course has been developed and taught once as a “Special Topic” (graded P/F, where the P requires B or better performance) also satisfies the prerequisite. Students without adequate writing proficiency are required meet the prerequisite before being allowed to enroll in the graduate writing seminar. It is too soon to know whether this approach has improved graduate thesis writing.
**Program Educational Objectives:** Program educational objectives are broad statements that describe what graduates are expected to attain within a few years of graduation. Program educational objectives are based on the needs of the program’s constituencies.

Montana Tech’s graduate degree and certificate programs assist students in achieving the following accomplishments within a few years of graduation:

1. Professional advancement in their careers. This objective includes “retooling” for a new profession and becoming established in that profession.
2. Recognition by their employers as bringing, applying, and integrating valuable, advanced, state-of-the-art knowledge, skills, and understanding that contributes significantly to the organization.
3. Success in keeping up-to-date professionally, thereby contributing to meeting the changing needs of society in the field and for the organization.

**Student Outcomes:** Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program.

Graduate Programs at Montana Tech assist students to acquire and master deep knowledge and advanced professional skills in degree fields aligned with Montana Tech’s mission. Graduate programs may either formulate and document their own program-specific student outcomes, subject to review and endorsement by the Graduate Council or adopt a subset of the Graduate School’s student outcomes. Master’s degree programs and certificate programs must address at least four of the outcomes, while doctoral programs must address all five.

Students completing graduate degrees and certificates at Montana Tech will:

1. Acquire up-to-date, advanced knowledge, skills, and understanding in the degree area, as needed to meet the changing needs of society.
2. Blend theory with practice to integrate, problem solve, and apply advanced knowledge, skills and understanding in the degree area.
3. Develop skills in communicating technical and complex material orally, in writing, and using various media for a broad range of audiences.
4. Demonstrate leadership skills and ethical principles applicable to the discipline and profession. Where applicable, this outcome includes the ability to enable the responsible and sustainable development and use of natural resources, including the protection and/or restoration of the environment.
5. Make a significant and original contribution to advance knowledge in the discipline, the tools of discovery, or a major application.
Student Outcomes

Outcome (1): Acquire up-to-date, advanced knowledge, skills, and understanding in the degree area, as needed to meet the changing needs of society.

Performance Criteria:
(a) Strategies: M.S. and Ph.D. curricula and courses; assignments; master's theses, projects, and exams; requirement for students to have cumulative GPA of at least 3.0 to complete degree. Graduate Council review of proposed new courses and programs requires complete syllabus for all new courses, with outcomes, topic details, textbook(s), grading approach.
(b) Assessment Instrument(s): Curricula and syllabi; exams and quizzes; qualifying and comprehensive exams; thesis/project defense presentations.
(c) Source of Assessment: Courses; comprehensive exam (if available); MS theses or projects; Ph.D. dissertations; defenses.
(d) Time of data collection: During courses; end of terms; defenses; occasional retrospective sampling.
(e) Person/group responsible for ensuring collection of assessment data: Program faculty and chairs; Graduate School.
(f) Person/group responsible for evaluating results: Program faculty and chairs, deans, Graduate School.
(g) Summary of how data collected as well as the information obtained from the data: Data from courses is collected by the faculty teaching the course, and used in grading. Syllabi of ~95% of 500-level courses offered during AY2014/15 were reviewed by the graduate dean: 100% of 500-level courses cover advanced knowledge, skills, and understanding in the degree area. Less than 5% of 500-level course syllabi lack detailed topic information; ~10% lack course outcomes; ~20% lack information about grading and/or student deliverables. Note that ABET guidance regarding syllabi discourages including grading information. Many faculty teach also in ABET-accredited B.S. programs and have chosen to prepare syllabi consistent with ABET guidance for all their courses.
(h) Based on the findings, actions taken: Feedback provided to chairs and faculty about vague syllabi. Departments regularly discuss courses, student performance, and readiness for subsequent courses and projects. Common issues and 'best practices' discussed at Graduate Council, with possible improvements to policies or procedures.
(i) Second-Cycle Results: N/A

Outcome (2): Blend theory with practice to integrate, problem solve, and apply advanced knowledge, skills and understanding in the degree area.

Performance Criteria:
(a) Strategies: Curriculum, courses, course projects, team projects, master's projects, master's theses, Ph.D. dissertations
(b) Assessment Instrument(s): Project/thesis/dissertation proposals, defenses and documents; project reports for courses; 500-level course syllabi; seminar presentations.
(c) Source of Assessment: Courses, comprehensive exams, defenses
(d) **Time of data collection:** During courses, end of term, defenses, occasional retrospective sampling.

(e) **Person/group responsible for ensuring collection of assessment data:** Program faculty and chairs; Graduate School.

(f) **Person/group responsible for evaluating results:** Program faculty and chairs, deans, Graduate School.

(g) **Summary of how data collected as well as the information obtained from the data:** Data from courses is collected by the faculty teaching the course, and used in grading. Syllabi of >95% of 500-level courses offered during AY2014/15 were reviewed by the graduate dean: 100% of 500-level courses cover integration, problem-solving, and application in real-world or real-world-like situations, with students required to practice and demonstrate these skills in graded labs, projects, and/or papers.

(h) **Based on the findings, actions taken:** Feedback provided to chairs and faculty about vague syllabi. Departments discuss courses, student performance, and readiness for subsequent courses and projects. Common issues and ‘best practices’ discussed at Graduate Council, with possible improvements to policies or procedures.

(i) **Second-Cycle Results:** N/A

**Outcome (3): Develop skills in communicating technical and complex material orally, in writing, and using various media for a broad range of audiences.**

**Performance Criteria:**

(a) **Strategies:** Required seminars: Graduate Writing Seminar (TC5160 or TC5150), and discipline seminars (ENGR5940 or TC5946). Written assignments, oral reports, and presentations in several graduate courses; assignments; master’s theses, projects, and exams; Ph.D. dissertations; Research Proposals for thesis/dissertation; oral defenses of theses, dissertations, and projects; written assignments.

(b) **Assessment Instrument(s):** Project/thesis/dissertation proposals, defenses and documents; project reports for courses; 500-level course syllabi; seminar presentations.

(c) **Source of Assessment:** Required seminars, reports, master’s theses, master’s projects, courses, comprehensive exams, dissertations, defenses, and other oral exams.

(d) **Time of data collection:** During courses, defenses, oral exams, thesis/dissertation final review, occasional retrospective sampling

(e) **Person/group responsible for ensuring collection of assessment data:** Program faculty and chairs; thesis/dissertation committee members & chairs; e-thesis coordinator, Graduate School.

(f) **Person/group responsible for evaluating results:** Program faculty and chairs, deans, thesis/dissertation committees, e-thesis coordinator, Graduate School.

(g) **Summary of how data collected as well as the information obtained from the data:** Written and oral assignments are collected and graded by the faculty teaching the course. Syllabi of >95% of 500-level courses offered during AY2014/15 were reviewed by the graduate dean: syllabi of 50% of 500-level courses document significant communication products (literature search, reports, and/or class presentations) by students. The Graduate writing seminar requires 12 written assignments. Engineering and TC seminars require each student to make a
presentation, answer questions, AND ask questions of other students re their presentations. Students tend to be reticent about asking questions of peers, so seminar instructor implemented a new practice: after a student presentation, the first questions must come from other students, and students are required to ask some questions over the course of the term.

(h) Based on the findings, actions taken: Feedback to students and revision of theses, dissertations and reports by students if poorly written or formatted is required by the committee and/or by e-thesis coordinator. Several poorly written theses requiring multiple rewrites resulted in an additional prerequisite for the graduate writing seminar (which does not teach grammar/mechanics): see Example C in Introduction (p. 3). Common issues, such as poor writing, and ‘best practices’ are discussed at Graduate Council, with improvements to policies or procedures, such as establishing a writing-proficiency pre-requisite for the graduate writing seminar.

(i) Second-Cycle Results: NA

Outcome (4): Demonstrate leadership skills and ethical principles applicable to the discipline and profession. Where applicable, this outcome includes the ability to enable the responsible and sustainable development and use of natural resources, including the protection and/or restoration of the environment.

Performance Criteria:

(a) Strategies: Integration of regulatory matters, societal contexts, professional standards and ethics, and societal issues into course curricula; mandatory Responsible Conduct of Research (RCR) workshop including some case studies; student presentations in courses; inclusion of graduate student on various departmental and university committees; interaction with program’s Industry Advisory Board; industry/professional internships.

(b) Assessment Instrument(s): Some assigned papers and presentations in some courses; participant feedback on RCR workshop; dissertations and theses (especially the context/background section); defenses.

(c) Source of Assessment: Courses, exams, papers, theses, dissertations, and defenses.

(d) Time of data collection: During courses, end of term, defenses.

(e) Person/group responsible for ensuring collection of assessment data: Program faculty and chairs; Research Office; Graduate School.

(f) Person/group responsible for evaluating results: Program faculty and chairs, deans, Graduate School.

(g) Summary of how data collected as well as the information obtained from the data: Data from courses is collected by the faculty teaching the course, and used in grading. Syllabi of >95% of 500-level courses offered during AY2014/15 were reviewed by the graduate dean: ~45% of 500-level course syllabi cover leadership and/or ethical topics &/or assignments. RCR workshop emphasizes ethics and taking responsibility/leadership. Case studies require students to grapple with and propose appropriate action in realistic situations, then report, and their choices consistently match ethical norms.

(h) Based on the findings, actions taken: Common issues and ‘best practices’ discussed at Graduate Council, with possible improvements to policies or procedures. Not all
students were taking the Responsible Conduct of Research workshop prior to commencing research, so the RCR workshop was incorporated into the orientation program for new grad students, which is mandatory and held at the start of each semester.

(i) Second-Cycle Results: N/A

Outcome (5): Make a significant and original contribution to advance knowledge in the discipline, the tools of discovery, or a major application.

Performance Criteria:

(a) Strategies: Master's projects, master's theses, especially Ph.D. dissertations; research methods courses; mandatory RCR workshop.

(b) Assessment Instrument(s): Project/thesis/dissertation proposals, defenses and documents; peer-reviewed manuscripts; presentations at major professional conferences.

(c) Source of Assessment: Theses, M.S. projects, dissertations, and defenses


(e) Person/group responsible for ensuring collection of assessment data: Advisor; thesis and dissertation committee for each student, including a member from outside the department/program; chairs; deans; E-thesis Coordinator; Graduate School.

(f) Person/group responsible for evaluating results: Program faculty and chairs, deans, Graduate School.

(g) Summary of how data collected as well as the information obtained from the data: Advisors and thesis/project/dissertation committees typically meet with students before, mid, and nearing research project completion. They review and provide feedback on thesis/project/dissertation drafts and research methods and interpretation. The Committee decides when the thesis/dissertation is ready for successful defense and allows the defense to be scheduled. At the public oral defense, audience members and committee members question the student. After the conclusion of the public part of the defense, the committee questions the student in a closed session. Based on the written document, the presentation, and the response to questions, the Committee determines whether to accept the thesis/dissertation/project. Peer-reviewed publications may constitute part of the thesis/dissertation or may substitute for it at the M.S. level as a “publishable paper.” Many students present their research at national or international professional conferences, and every year a few are recognized with “best paper” or “best poster” awards. Data and analysis from several theses become published in peer-reviewed journals, co-authored by the student and advisor. Publishable-paper M.S. documents are not always finalized and submitted/published in a professional journal in a timely manner, but the student has graduated and departed. Regularly several students were late in submitting and defending their theses and then very slow in finalizing their thesis/project report with the E-thesis coordinator for submission to the ProQuest repository and/or Montana Tech's Digital Commons.

(h) Based on the findings, actions taken: The Graduate Council approved tightening deadlines, requiring drafts near mid-term and defenses to be held on or prior to the last day of class in a term. Deadlines for final submission have also been moved up. Students who miss the deadlines must register for another thesis/dissertation credit in the next term, and their graduation date would slip. Exceptions require a formal “petition to the graduate dean.”

(i) Second-Cycle Results: N/A
Information Required by our NWCCU Year Three Report (YTR)

CORE THEME 1: Education and Knowledge

As found under Objective 1, Indicator of Achievement E in YTR: Describe direct measures of student knowledge (e.g., Licensing Exams, Capstone Course, Senior Projects).

- Master's theses completed, presented/defended and approved
- Master's thesis proposals (some programs)
- Master's project reports completed, presented/defended, and approved
- Presentations and publications in peer-reviewed journals and conferences
- Comprehensive, qualifying, and candidacy examinations passed (oral and/or written)
- Future: Ph.D. qualifying exams; Ph.D. dissertations completed and approved.

As found under Objective 2, Indicator of Achievement A in YTR: What extracurricular educational opportunities (and participation rate) are available to students in your program? (e.g., Undergraduate Research Program (URP), Seminar Activities, Conference Attendance, Guest Lectures, and Field Trips)

Graduate students have the opportunity to:

1. Present posters or demonstrations at Montana Tech's annual TechXPo (April)
2. Join and be active members of professional societies in their discipline area(s), including student chapters
3. Attend professional conferences as speakers, presenters, and/or observers.
4. Take leadership roles in student chapters of professional societies
5. Participate in student government (ASMT)
6. Attend on-campus seminars and colloquia and network with these distinguished visiting speakers
7. Mentor and assist faculty in supervising undergraduate research and senior projects
8. Gain teaching and leadership experience and reinforce their own learning by serving as Graduate Teaching Assistants or Graduate Research Assistants (about 60 students were GTAs, and about 40 were GRAs (some students had both types of support)).
9. Attend free on-campus workshops on and apply for external fellowships, such as the NSF National Graduate Research Fellowships: about 20 attended.
10. Attend some professional development sessions that are offered for faculty, such as principal investigator training, human subjects research, etc.
11. Gain professional experience by participating in research, GIS, and documentation projects of the Montana Bureau of Mines and Geology (MBMG)

As found under Objective 3, Indicator of Achievement A in YTR: In what ways does your program prepare graduates for a successful career in addition to curricular preparation? (e.g., Internships, professional exam preparation, specialized training in software, and IAB feedback)

On-campus career fair in September and February, accompanied by topical workshops presented by employer representatives, who are in many cases Tech alumni
- Special software and industry training
- Internships with industry or with government labs and agencies
- Work and field experiences with the MBMG on their various projects
- Graduate research and teaching assistantships (GRA, GTA)
Professional society participation, leadership, and presentations
Writing seminar
Discipline seminar featuring discussions with peers and faculty and presentations of their work to an audience
Professional exam preparation sessions and career services guidance, also available to undergraduates
Annual or semiannual Departmental Industrial Advisory Board (IAB) meetings. The IAB provides feedback to the department on curriculum and interacts extensively with its graduate students.

Geophysical Engineering students are exposed to over $20 M in industry-standard geophysics software including Petrel, Kingdom Suite, VISTA, OMNI, Matlab, RES3D and ProMAX.

The Fire Assay short course offered by the Metallurgy department in August enrolls both MS students and working professionals in metallurgy and mineral processing. The course includes field trips to mines and mineral processing operations and a hands-on exercise at a commercial facility. Students “rub shoulders” with professionals in the mining industry and government agencies, who also take the course.

Students with non-engineering undergraduate degrees desiring M.S. degrees in engineering fields must take engineering fundamental courses as required in the BS program, as well as core undergraduate courses the engineering specialty, which might take a semester to 2 years as “post-baccalaureate” students. These students usually also get involved in research in their M.S. area before being fully admitted to the Graduate School.
**CORE THEME 2: Student Achievement**

As found under Objective 3, Indicator of Achievement A in YTR: What academic distinction opportunities are available to your students and what distinctions have been achieved over the last year? (e.g., Merit Scholarships, distinction based on GPA (e.g., Deans List), and team competitions.)

**Internal Recognition of Student Achievement**

Graduate students achieving a cumulative GPA of 4.0 for the degree/certificate program are recognized with Highest Honors.

Full-time graduate students (enrolled in at least 9 credits) achieving a term GPA of 4.0 are recognized on the Dean's List. Table 3 shows the student performance during academic year 2014-15 for on-campus programs, which had 40 total graduates/completions. An additional 14 graduates (~35%) had cumulative GPA’s of at least 3.8.

**Table 3. Academic Honors (GPA=4.0) by Degree Program: Term and at Completion**

<table>
<thead>
<tr>
<th>Program</th>
<th>Dean's List Fall 2014</th>
<th>Dean's List Spring 2015</th>
<th>GPA 4.0 Graduates</th>
<th>% with Highest Honors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elect. Engineering</td>
<td>1</td>
<td>2</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Environment'l Engineering</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>General Engineering</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>33%</td>
</tr>
<tr>
<td>Geoscience</td>
<td>6</td>
<td>10</td>
<td>1</td>
<td>7%</td>
</tr>
<tr>
<td>Health Care Inform. Certif.</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Industrial Hygiene</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Interdisciplinary M.S.</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Metallurgy/Min'l Proc.Eng.</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Mining Engineering</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Petroleum Engineering</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>33%</td>
</tr>
<tr>
<td>Tech. Communication</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22</strong></td>
<td><strong>25</strong></td>
<td><strong>3</strong></td>
<td><strong>8%</strong></td>
</tr>
</tbody>
</table>

**Examples of External Recognition of Student Achievement**

In 2014-15, four students had Sloan Indigenous Graduate Fellowships to pursue their master's degrees at Tech.

One geoscience/geophysical engineering M.S. student received a Tobacco Root Geological Society Scholarship.

Four of four (100%) of Materials Science Ph.D. students passed their qualifying exams, after completing the core course sequence during their first year in the program (2014-15).

Several students were recognized for Best Poster, Best Paper, Best Technical Illustration, etc. at major professional conferences.
Graduate program faculty members are each affiliated with a home department. Information about faculty teaching and other activities is included in the departmental program reviews.
CORE THEME 1: Education and Knowledge
Program Evaluation

Objective 1, Indicator of Achievement C: Strengths:
On-campus graduate programs are small, distinctive and effectively integrate theory with practice, with graduate students collaborating closely as colleagues with faculty. Montana Tech remains one of very few universities in the United States, which offers graduate degrees in the full complement of extractive natural resources fields, from exploration to planning and development, to resource extraction and processing, to environmental restoration and sustainability for oil, gas, minerals, and metals.

Three of Tech’s M.S. programs are recognized by the Western Interstate Commission for Higher Education (WICHE) as eligible for the Western Regional Graduate Exchange Program (WRGP): Geoscience M.S., Metallurgical and Mineral Processing Engineering M.S., and Technical Communication.

Enrollment overall is growing, externally funded research is growing, time-to-degree is reasonable (~2 years for many full-time students), and retention from term to term is high. Master’s theses and projects are high quality and often lead to peer-reviewed publications or award-winning conference presentations. Collaborations across departments and programs are common, allowing students to get a broad and interdisciplinary background, which is an advantage as they enter into or continue careers.

Faculty are knowledgeable, current, passionate about their specialty, and dedicated to students and to Montana Tech. Several are research active and successful in acquiring external funding. New faculty hires in departments with graduate programs share these attributes and are working on setting up their research efforts, obtaining external funding, and engaging graduate students.

Because of the low number of research-active faculty in each program area (typically 4-6), the research opportunities in each degree program are focused, and in several cases have achieved national/international reputations beyond what might be expected of an institution the size of Montana Tech. For example, the geoscience/geophysical engineering program focuses on field methods and exploration and maintains an extensive collection of field equipment used by graduate students in their thesis projects. The metallurgical engineering M.S. and the materials science Ph.D. program benefit from the funded projects and research infrastructure associated with the Regent-approved Center for Advanced Mineral Metallurgical (& Materials) Processing (CAMP). The Electrical Engineering M.S. focuses on high power, grid-scale control and stability in general and in the context of increasing amounts of intermittent/renewable supply sources. And the geosciences benefit from collaboration among three departments and with the on-campus Montana Bureau of Mines and Geology (MBMG).

Service as GTAs gives graduate students valuable professional experience and reduces some of the faculty workload associated with the high teaching assignment (typically three courses per semester for research-active faculty; four for others), allowing the faculty more time to pursue research and supervise master’s students.

Developing graduate programs, ensuring their quality, and increasing graduate enrollment are strategic priorities for the university and its leadership. The new collaborative Ph.D. in materials science has brought doctoral students to campus, along with additional external research funding in this interdisciplinary field, which is also benefiting M.S. students in several materials-science related programs by supporting their thesis research.
Objective 1, Indicator of Achievement D: How will the program maintain the strengths?

Investment in faculty is key to maintaining the level of activity and quality of research. In 2014/15, led by the Provost, the campus piloted a “faculty development initiative,” making minigrants available to faculty, with projects selected for funding on the basis of review of research proposals. The program was repeated in 2015/16 and the intention is to continue it. In terms of departmental standards, finalized in 2014-15, research productivity is an important factor in all departments with graduate programs; and research track record and potential in areas that could engage students is one of the qualifications that new faculty hires must meet.

With respect to enrollment, balanced and manageable growth is being pursued by recruiting students, retaining them to completion, increasing distance offerings, and increasing the emphasis on non-thesis options for M.S. degrees. Interest is growing in establishing “master of engineering” curricula without the thesis/project requirement, to make quality graduate programs from Montana Tech available to more students while still being manageable by the faculty. Without doctoral programs, thesis M.S. programs and students are key to maintaining and increasing Tech’s research productivity.

The Research Office offers assistance to faculty—especially those early in their career—to produce competitive and fundable proposals. These services will continue to be publicized to departments. The Office also helps connect faculty with promising funding sources for their projects.

Considerable attention is being paid and must continue to be paid to acquiring and maintaining research instrumentation and equipment needed by graduate students to perform forefront research. The need for technical instrumentation support is recognized and a couple of strategies are being implemented or considered to optimize the performance and availability of the campus’ research infrastructure.

“Five Year” B.S./M.S. pathways allow undergraduates interested in graduate study to work in parallel on both degrees from the middle of their third year, if they are strong students with high GPAs. The students are officially undergraduates, but they might have completed 15 or more graduate credits by the time they earn their B.S., and they might be well underway on their thesis research, making it possible to finish the M.S. within another year or less. This option is attractive to some students, who then enter the workforce with a few summers of internship experiences plus a master’s degree.

Objective 1, Indicator of Achievement C: Weaknesses:

Educating undergraduate students is Montana Tech’s primary mission. The number of faculty in each department is low, teaching responsibilities are high, and for the most part, the pay scale is not competitive with peer institutions. When new faculty candidates learn the salary scale, many drop out of the pool. In other cases, they decline to apply, because they desire to work at an institution where they can mentor Ph.D. students, with the resultant higher research productivity.

With high teaching loads, high undergraduate advising loads, and a commitment to providing graduate students with excellent educational experiences, many departments sharply limit the number of graduate students to only a few (see Table 2). This keeps the research supervision in balance with the available faculty time. However, few faculty and low graduate-student numbers limit the number of graduate-level (500-level) electives that can be offered each semester and year, which diminishes the range of topics students can learn about in courses. Moreover, since there are few graduate students, graduate courses would have low enrollment, thus several are offered as hybrid graduate/upper-division undergraduate courses. In these cases, the course has two course numbers, and there are additional expectations and requirements for the graduate students. When enrollment in 500-level courses is low, there is limited
opportunity for peer learning and the vibrant discussions, insights, and viewpoints that make graduate courses enriching for both faculty and students.

Dearth of Ph.D. programs and students reduces the competitiveness of research proposals written by faculty to obtain external research funding, because reviewers believe that Ph.D. students are key to the ability to succeed with a demanding, cutting-edge project.

Where departments lack technical support staff, the maintenance, reliability, and availability of research instrumentation can be compromised. Yet these instruments are essential for graduate student projects. When key instruments are out of service, the completion of a master’s or Ph.D. project can be delayed by a semester or more, the student might have to locate and seek access to the needed instrument(s) at some other university, or the quality of the work would suffer by not being able to make measurements using the broken instrument(s). The lack of technical support staff puts the burden of keeping instrumentation operational on faculty members, who must find time to do the maintenance, troubleshooting, and repairing.

Some departments do not have adequate desk/cubicle/office space for their graduate students (especially as enrollments grow), handicapping the students in terms of having a place to study and collaborate on campus, when they are not in class or lab.

Many programs serve natural resource sectors for which jobs are located where the exploration/extraction/processing is—often far from cities and universities. The M.S. programs for professionals enroll such students, and the MPEM (master of project engineering management) program requires 12 credits of electives. Electives available by distance are not yet offered by most of the programs.

Objective 1, Indicator of Achievement D: How will the program address the weaknesses?
Continued attention to developing and investing in faculty and the required research infrastructure is critical. More grant funding with funded support for faculty release time can help, but only if there are qualified people available in Butte to teach the courses. One strategy being pursued is to hire post-docs who work 50/50 on research and teaching during the academic year and 100% on research during the summer. Providing teaching/research postdocs can give these individuals valuable experience to make them competitive for a faculty position in a year or two, while contributing to Tech’s course offerings, research, and student mentoring. Thus, a position announcement for post-docs is posted on Montana Tech’s jobs web site.

The use of Ph.D. students as adjunct instructors of record for undergraduate courses on topics where they have expertise can also help fill in for released faculty, while giving these students excellent professional experience and supportive mentoring as new faculty.

Increased attention needs to be paid to keeping all research instrumentation operational. CAMP staff perform these types of services for many instruments in materials and metallurgy labs, including SEMs and X-ray instruments. Strategies are being pursued to get similar support for the shared instrumentation in the Chemistry/Biology Building.

The completion of the new laboratory building (NRRB), currently under construction, will free up some space in existing buildings when certain activities and labs move into new space in spring 2017.
Consideration of grad student space needs will be included in the space discussions and prioritization for how the freed-up space will be allocated.

With the hiring in February 2016 of a Distance Learning Director, more assistance and attention can be paid to helping faculty develop or convert courses for distance or hybrid delivery. In addition, professional development for faculty is being provided on educational design and pedagogical matters. Having courses available in this mode could attract students working in isolated locations to pursue a graduate degree or at least take advantage of topical graduate courses to grow professionally.

Three possible Ph.D. programs have been placed on the program planning document maintained by the Office of the Commissioner of Higher Education for possible development in 2017-19: engineering (with some natural resources concentrations), geosciences, and sustainable engineering (including energy). This listing is a mandatory first step toward implementation. To actually develop them and have them approved by the Regents will require both policy/political efforts and academic ones, because a reorganization of the Montana University System in the mid-1990s assigns only to the two “flagship” campuses the authority to offer doctoral degrees. However, currently Montana Tech is unique among Schools of Mines in having NO Ph.D.-granting authority (except for the recently established collaborative Materials Science program). The lack of Ph.D.-granting authority in combination with the high priority placed on preventing duplication within the MUS means that Ph.D. programs cannot be offered in Montana in Montana Tech’s natural-resource/extraction engineering mission areas, even though these fields are economically vital to the “Treasure State.”

Other actions leading to program improvement (e.g., develop a new course):

- Distance options are being developed for specific courses (e.g. PET504) and being considered for entire programs (e.g. M.S.T.C.). Petroleum engineering and restoration are areas with potentially high demand from students who cannot relocate to Butte for various reasons.
- Additional graduate electives useful for Materials Science Ph.D. students at Tech, MSU, and U.M., as well as for students in various M.S. programs are being prepared for synchronous distance delivery, the same way the core courses for MatSci Ph.D. are offered.
- Enhanced integration between academic departments with graduate programs and the MBMG is also in the works. Certain MBMG researchers with appropriate credentials would be given affiliate faculty status in the appropriate graduate program/department, therefore being able to serve as thesis advisors. This would help enable more graduate students to be supervised effectively and to work on real-world problems of interest to the MBMG.
Glossary of Terms:

**Student Outcome:** Program outcomes describe what students are expected to know and able to do by the time of graduation. These relate to the knowledge, skills, and behaviors that students acquire as they progress through the program.

**Performance criteria:** Performance criteria are measurable statements and indicate the specific characteristics students should exhibit in order to demonstrate desired attainment of the learning outcomes.

**Strategies:** The courses or activities that are designed to provide opportunities for students to learn, practice, demonstrate and/or get feedback on their performance on the performance criteria. This identifies how the curriculum is aligned with the projected outcome.

**Assessment Method:** The assessment instrument(s) that are used to assess student learning. (examples: Student Evaluation of Courses, Capstone Course/Project, SSI Survey, Graduate Survey, Alumni Survey, Employer Survey, Exit or Licensing Exam, Advisory Board, Specialized Accreditation, Internship, Curriculum review, Evaluation of Faculty, pre-post exams, seminar, and URP projects

**Source of assessment:** The course or other setting in which the assessment data will be collected. For program assessment it is not necessary—or even desirable—to collect data from every course or setting in which the performance criteria are addressed, nor are data needed from every student. Sampling strategies can be used where appropriate.

**Time of data collection:** Identifies when the assessment data will be collected.

**Assessment Coordinator:** The person responsible for being sure that the assessment data are collected.

**Evaluation of Results:** The person/group responsible for determining the meaning of the assessment results and making recommendations for action.

**Results:** Report of the data collection and analysis process.

**Actions:** Based on the findings, the actions taken which have been recommended to improve student performance.

**Second Cycle Results:** The results based on assessment after taking action on earlier recommendations.