



June 21, 2017

Ruth V. Watkins
Senior Vice President for Academic Affairs
205 Park Bldg.
Campus

RE: Graduate Council Review
Department of Metallurgical Engineering

Dear Vice President Watkins:

Enclosed is the Graduate Council's review of the Department of Metallurgical Engineering. Included in this review packet are the report prepared by the Graduate Council, the Department Profile, and the Memorandum of Understanding resulting from the review wrap-up meeting.

After your approval, please forward this packet to President David Pershing for his review. It will then be sent to the Academic Senate to be placed on the information calendar for the next Senate meeting.

Sincerely,

David B. Kieda
Dean, The Graduate School

Encl.

XC: Manoranjan Misra, Chair, Department of Metallurgical Engineering
Darryl P. Butt, Dean, College of Mines and Earth Sciences

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The Graduate School - The University of Utah

GRADUATE COUNCIL REPORT TO THE SENIOR VICE PRESIDENT
FOR ACADEMIC AFFAIRS AND THE ACADEMIC SENATE

February 27, 2017

The Graduate Council has completed its review of the **Department of Metallurgical Engineering**.
The External Review Committee included:

J. Brent Hiskey, PhD
Associate Dean and Research Professor
Department of Mining and Geological Engineering
University of Arizona

Amit Misra, PhD
Professor and Chair
Department of Materials Science and Engineering
University of Michigan

Courtney Young, PhD
Prater Distinguished Professor of Metallurgical & Materials Engineering
Montana Tech University

The Internal Review Committee of the University of Utah included:

Milind Deo, PhD
Professor and Chair
Department of Chemical Engineering

Bruce K. Gale, PhD
Professor
Department of Mechanical Engineering

Orest G. Symko, PhD
Professor
Department of Physics and Astronomy

This report of the Graduate Council is based on the self-study submitted by the Department of Metallurgical Engineering, the reports of the external and internal review committees, and the Department Chair's and College Dean's combined response to the external and internal committee reports.

DEPARTMENT PROFILE

Program Overview

The mission of the Department of Metallurgical Engineering (hereinafter the "Department") is "to (i) educate and train professional metallurgical engineering undergraduate and graduate students with the broad technical knowledge, critical thinking abilities, communication skills, social consciousness, and integrity necessary to become outstanding engineers and scientists in industry and academia, (ii) engage in scholarly research activities in *physical metallurgy*, *extractive metallurgy*, *mineral separation*, and *advanced materials*, facilitating generation of new knowledge, (iii) disseminate newly acquired knowledge through timely publication of original research by faculty and students, and (iv) provide supporting service through consulting or other avenues to industry, government and the general public" (*self-study*). The Department offers three different types of graduate degrees (along with a Bachelor of Science): Master of Science, Master of Engineering, and PhD. Metallurgy and Mining instruction began in 1891 and the Department "continues this heritage as a true Metallurgical Engineering program" (*external review*). The Department offers an integrated curriculum that covers all three aspects of metallurgical engineering: mineral processing, chemical metallurgy, and physical metallurgy.

The program has seen several changes since the last review. The Department increased faculty size from 8 to 12 members, research funding increased from \$3.86M (2009) to \$6.15M (2016), and undergraduate student enrollment increased from 32 in 2009 to 68 in 2016. "An end result of these efforts has not only been a concomitant improvement in the amount, type, and quality of research being done, but also a marked enhancement of the student experience at all levels" (*external review*).

Faculty

Currently, the Department has 9 full-time tenured and 4 tenure-track faculty members. The faculty is supported by 13 adjunct faculty and 6 career-line (research) professors. The average faculty age is 55. The average adjunct faculty age is 61. There is currently one female faculty member. No faculty members are from underrepresented minority groups. The faculty consists of a balance of senior, mid-career, and junior professors. The Department has instituted a good mentoring philosophy whereby the junior faculty members are receiving advice and guidance from their senior counterparts but no formal mentoring assignments are given. Research productivity and research funding by the faculty is impressive. "With respect to research funding, the Department has been extremely productive with a total of \$27M awarded over the past 6 years from a variety of state and federal agencies, industry, and foundations" (*external review*). The number of archival journal publications, conference presentations, books and book chapters also reflect the effectiveness and productivity of the faculty.

Both the internal and external reviewers commented on the relatively low salaries of the faculty compared to their peers in other institutions as well as other departments within the College of Engineering. Both senior and junior faculty members have expressed frustration and resentment as a result of the salary inequity. Faculty members desire to be "compensated at a level commensurate with their productivity and

reputation and comparable to those in peer institutions and their peers in the College of Engineering" (*external review*). The need for more lab space is another topic mentioned by faculty members.

There are currently 19 career-line faculty, adjunct faculty and visiting faculty members who support the programs offered by the Department. One new female faculty member was recently hired. Her research interests are in physical metallurgy. Continued efforts to promote diversity and inclusion are being encouraged in the Department's recruitment and hiring activities.

Students

From 2010-2016 the enrollment for undergraduate students has nearly doubled. Graduate student enrollment was maintained in the range of 50-60. The student body represent 14 countries. In 2015-16, there were 14 female and 50 male undergraduate students, and 6 female and 45 male graduate students. Underrepresented minority students make up a small percentage of both undergraduate and graduate students, although Hispanic/Latino undergraduate students have increased from 0 at the beginning of the review period to 8 during the last two reported years. The Department has focused efforts on recruiting students. There is an extensive list of required and elective courses at both the graduate and undergraduate level. The Department added a new administrative staff member for undergraduate student academic advising, student outreach, etc. However, the external reviewers noted that the administrative staff feel underqualified as academic advisors and overburdened with the task.

The students are excited about their program. They enjoy the small class sizes (10-15 students/class), the scholarships, the student projects, faculty mentoring and the flexibility of the program. Students are encouraged to participate in conferences and present their research findings. Graduate students receive funding support from research grants and outside funding. Industrial sources offer support for student participation in conferences, etc.

Curriculum

The Department offers BS, MS, ME, and PhD degrees. The faculty are committed to all of the programs. The BS degree program is accredited (Fall 2015) by ABET, which listed numerous program strengths with the highest commendation being the low student to faculty ratio. The BS requires 103.5 credit hours of coursework. The program is not large, with a little over 30 graduates in the past 5 years. "ABET did have concerns about institutional support being inadequate to assure quality and continuity of the program regarding (1) low faculty salaries compared to peer institutions and the College of Engineering, and (2) no more than half-time support being available for a laboratory technician" (*external review*). The recent trend shows growth in the number of BS students.

The MS degree requires a minimum of 30 credit hours in graduate-level courses with 10 hours in thesis work. A thesis defense is required and must be approved by the student's supervisory committee. Twenty-nine students have completed this degree in the last 5 years. The number of students applying for the MS program is lower than in the past. "Students that received their BS degree in the Department and then moved on to the MS and PhD programs indicated a lack of additional courses for them to take beyond what they were offered for their BS degree" (*internal review*).

The ME degree requires a minimum of 30 credit hours, including 4-6 hours of engineering design. A final report and comprehensive oral exam and/or written exam is also required. All of the requirements for the MS degree, except for the thesis work, apply to the ME degree.

The requirements for the PhD degree include 33 hours of course work and 34 hours of research. Candidates must pass a qualifying exam and complete their work with a dissertation. In the past seven years, the Department has awarded 4 ME degrees, 43 MS degrees, and 51 PhD degrees.

Program Effectiveness and Outcomes Assessment

"Education objectives and outcomes assessments for the undergraduate portion of the program align with the criteria established by ABET for materials, metallurgical, ceramic and similarly named engineering programs" (*external review*). Full ABET accreditation was received in 2016. The next accreditation site visit is scheduled for 2021-2022. Current assessment tools include: course surveys, exit interviews, alumni surveys, employer surveys and internal and external reviews. By all assessment measures, the program is rated very good to excellent.

"The Department rates high in comparison to equivalent departments in the U.S. Its research reputation is higher than most and its quality of graduates is on a par with peer institutions" (*external review*). The Department tracks data on the job and employment success of its graduate students. Undergraduate students found good employment within about 3 months. This suggests that the Department is effective in preparing its students for the workforce. Overall, the Department appears highly effective.

Facilities and Resources

The classrooms, student spaces and offices appear to be adequate. With the completion of the new building for the College of Mines and Earth Sciences, more space for the Metallurgical Engineering program has been made available. However, the research program continues to grow rapidly and additional laboratory space and a laboratory manager will be needed to support the extensive research program and maintain the lab equipment. Continued integration with the sister Materials Science & Engineering Department in the College of Engineering might be helpful.

COMMENDATIONS

1. The Department is one of the top metallurgical engineering departments in the country.
2. The Department has seen substantial increases in research funding and expenditures.
3. Student satisfaction is high, resulting in increased enrollment. Most undergraduate students participate in research. Most graduate students submit publications.
4. Strong leadership and new faculty hires have helped diversify the curriculum and have resulted in great collegiality.

RECOMMENDATIONS

1. Reward high performance and address inequities between the faculty in the different colleges with adjustment to salaries and a research incentive mechanism.
2. Address the need for additional laboratory space to accommodate the rapid growth in research. A full-time qualified laboratory technician should be hired to maintain and support the laboratories.
3. Make improvements to the graduate program, including dedicating faculty time to advising, revamping the PhD qualifying exam, adding additional courses, and recruiting more aggressively.
4. Develop proactive recruitment strategies to increase women and underrepresented minorities among faculty and students.
5. Explore possible synergies and work to establish collaborative relationships with other departments that have similar research interests.

Submitted by the Ad Hoc Committee of the Graduate Council:

Bryan G. Trump (Chair)
Assistant Professor, School of Dentistry

Isabel Dulfano
Associate Professor, Department of World Languages & Cultures

Ryan E. Smith
Associate Professor, School of Architecture

Edward M. Barbanell (Undergraduate Council Representative)
Associate Dean, Undergraduate Studies

College Name
College of Mines & Earth Sciences

Department Name
Metallurgical Engineering

Program Name
All

Faculty Headcount

		2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
With Doctoral Degrees Including MFA and Other Terminal Degrees	Full Time Tenured Faculty	7	8	9	8	8	8	8
	Full Time Tenure Track	1			1	2	2	2
	Full Time Career Line/Adjunct Faculty	5	3	2	3	5	7	5
	Part Time Tenure/Tenure Track							
	Part Time Career Line/Adjunct Faculty	1	3	1	1			2
	Total	14	14	12	13	15	17	17
With Masters Degrees	Full Time Tenured Faculty	0	0	0	0	0	0	
	Full Time Tenure Track	0			0	0	0	
	Full Time Career Line/Adjunct Faculty	0	0	0	0	0	0	
	Part Time Tenure/Tenure Track							
	Part Time Career Line/Adjunct Faculty	0	0	0	0			
	Total	0	0	0	0	0	0	
With Bachelor Degrees	Full Time Tenured Faculty	0	0	0	0	0	0	
	Full Time Tenure Track	0			0	0	0	
	Full Time Career Line/Adjunct Faculty	0	0	0	0	0	0	
	Part Time Tenure/Tenure Track							
	Part Time Career Line/Adjunct Faculty	0	0	0	0			
	Total	0	0	0	0	0	0	
Total Headcount Faculty	Full Time Tenured Faculty	7	8	9	8	8	8	8
	Full Time Tenure Track	1			1	2	2	2
	Full Time Career Line/Adjunct Faculty	5	3	2	3	5	7	5
	Part Time Tenure/Tenure Track							
	Part Time Career Line/Adjunct Faculty	1	3	1	1			2
	Total	14	14	12	13	15	17	17

Cost Study

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Direct Instructional Expenditures	1,017,245	1,078,940	1,190,719	1,173,411	1,421,514	1,484,476	1,570,797
Cost Per Student FTE	15,897	15,953	17,506	16,168	18,066	17,040	18,456

FTE from Cost Study

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Full-Time Salaried	9	9	9	9	10	12	19
Part-Time or Auxiliary Faculty		0	0	0	0	0	3
Teaching Assistants		0					

Funding

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Total Grants	2,592,135	3,175,145	4,522,289	4,649,050	3,903,258	5,562,499	5,260,884
State Appropriated Funds	998,239	989,057	1,037,994	1,037,985	1,162,682	1,335,115	1,392,618
Teaching Grants	4,923	5,269	3,683	18,520	0	5,806	21,762
Special Legislative Appropriation*							
Differential Tuition*							

A.

Student Credit Hours and FTE

		2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
SCH	Lower Division	161.0	180.0	157.0	180.0	143.0	176.0	197.0
	Upper Division	351.0	355.0	532.0	618.0	687.5	909.0	849.5
	Basic Graduate	407.0	444.0	360.5	361.0	393.5	420.5	353.5
	Advanced Graduate	531.5	552.0	540.5	558.5	626.5	598.5	651.0
FTE	Lower Division	5.4	6.0	5.2	6.0	4.8	5.9	6.6
	Upper Division	11.7	11.8	17.7	20.6	22.9	30.3	28.3
	Basic Graduate	20.4	22.2	18.0	18.1	19.7	21.0	17.7
	Advanced Graduate	26.6	27.6	27.0	27.9	31.3	29.9	32.6
FTE/FTE	LD FTE per Total Faculty FTE	0.6	0.7	0.6	0.7	0.5	0.5	0.3
	UD FTE per Total Faculty FTE	1.3	1.3	2.0	2.3	2.3	2.5	1.3
	BG FTE per Total Faculty FTE	2.3	2.5	2.0	2.0	2.0	1.7	0.8
	AG FTE per Total Faculty FTE	3.0	3.1	3.0	3.1	3.1	2.5	1.5

Enrolled Majors

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Undergraduate Pre-Majors	15	20	11	15	5	3	1
Undergraduate Majors	17	15	31	31	42	62	67
Enrolled in Masters Program	18	17	14	12	18	17	19
Enrolled in Doctoral Program	34	39	35	34	35	35	32
Enrolled in First Professional Program							

Degrees Awarded

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Undergraduate Certificate							
Graduate Certificate							
Bachelors	5	7	7	3	4	6	13
Masters	9	3	7	5	10	7	7
Doctorate	3	7	5	11	9	9	6
First-Professional							



Memorandum of Understanding Department of Metallurgical Engineering Graduate Council Review 2016-17

This memorandum of understanding is a summary of decisions reached at a wrap-up meeting on May 30, 2017, and concludes the Graduate Council Review of the Department of Metallurgical Engineering. Ruth V. Watkins, Senior Vice President for Academic Affairs; Darryl P. Butt, Dean of the College of Mines and Earth Sciences; Manoranjan Misra, Chair of the Department of Metallurgical Engineering; David B. Kieda, Dean of The Graduate School; and Katharine S. Ullman, Associate Dean of the Graduate School, were present.

The discussion centered on but was not limited to the recommendations contained in the review summary report presented to the Graduate Council on February 27, 2017. The working group agreed to endorse the following actions:

Recommendation 1: Reward high performance and address inequities between the faculty in the different colleges with adjustment to salaries and a research incentive mechanism.

While a budget request has been made to boost salaries closer to averages reported by the American Association for Engineering Education, salary equity issues arose for a variety of reasons historically and fixing these will likely be a multi-year process. However, the Chair, Dean Butt, and SVP Watkins recognize the importance of this issue for the Department and aim to work together toward continuous improvement. Dean Butt is developing a proposal that will incentivize research and scholarly activity, and it is hoped that this can be used as part of a larger discussion to find guiding principles that could be applied in a broad manner on main campus. Finding the best solution will require financial oversight and input from Human Resources. SVP Watkins suggested getting this on the agenda for discussion at an upcoming Council of Academic Deans meeting.

Recommendation 2: Address the need for additional laboratory space to accommodate the rapid growth in research. A full-time qualified laboratory technician should be hired to maintain and support the laboratories.

Departmental growth has been fast and the need for research space is at a critical point. The Department is currently addressing this issue by leasing off-site facilities. An exciting plan to expand the Browning Building is underway: fundraising is on a good trajectory and meetings are planned with architects to hone the proposal and get an updated cost estimate. It may be possible to leverage the Department's robust research portfolio, and its potential for expanded core facilities, to get funds for a laboratory technician

from the Office of the Vice President for Research. Yet, a distinct area where the need for a technician is clear is in maintaining teaching laboratories. A past challenge has been that this has been budgeted as a part-time position, but hiring someone with the appropriate skill level is difficult on a part-time basis. Options discussed were sharing a technician between departments or splitting a technician's time between teaching and research laboratories. Whatever the model and exact sources of support, advertising the position nationally is advisable, as this may attract someone who is exceptionally skilled and well-suited to the position (an outcome for a similar position in Physics).

Recommendation 3: Make improvements to the graduate program, including dedicating faculty time to advising, revamping the PhD qualifying exam, adding additional courses, and recruiting more aggressively.

Several steps have already been taken to address this recommendation. A new graduate program committee was formed and has revamped the qualifying exam. It now has both written and oral components, which allows more complete assessment of student knowledge. External reviewers explicitly mentioned a problem with exam questions being recycled from previous years; revised procedures should be followed to ensure that students have the ability to think on their feet and understand topics deeply enough to approach an unforeseen question. The Director of Graduate Studies has taken on an expanded role in student advising, with the Department recognizing this important effort through additional compensation. The influx of faculty has been an opportunity to expand course offerings. Dean Butt is also working on a college-wide plan to offer a course for new graduate students that provides both a comprehensive orientation as well as training in leadership skills. SVP Watkins thought that the emphasis on professional issues in this systematic context would be very well received and highly useful. With regard to recruiting efforts, the Department has been increasing its presence at professional society meetings. Another specific initiative is an effort in the area of targeted international advertising. Tracking the outcome of recruiting efforts and student quality in the upcoming years to assess the success of these tactics will be important.

Recommendation 4: Develop proactive recruitment strategies to increase women and underrepresented minorities among faculty and students.

The Department, in partnership with central administration, has recently hired a female faculty member, and an upcoming recruitment effort for Fall 2018 is a chance to potentially hire an underrepresented minority faculty member. Chair Misra emphasized that it is not only important to find and hire diverse faculty, but also to provide mentorship to facilitate the success of these hires. SVP Watkins noted that there may be opportunities to bolster this in the future as a more centralized mentoring program on main campus is under consideration. The commitment to addressing this recommendation is underscored by prioritization of improving diversity in a recently completed college-wide strategic plan. At the student level, this entails "casting a wide net" and, to this end, open houses for prospective majors are being held.

Assessing the advising structure and curriculum to make the College attractive to diverse students was also highlighted in the Chair's written response. Dean Butt described a specific plan to bring in external experts to conduct workshops aimed at creating an inclusive culture. Preparation of an ADVANCE grant (an NSF mechanism aimed at increasing women in academic science and engineering) is also under discussion. These efforts seem very likely to cultivate positive changes that build on current success and eventually become self-reinforcing. Since increasing diversity at the faculty and student level is a goal that takes time to achieve, attention to actions that help in a short-term manner is also important. For instance, ensuring gender balance and diverse backgrounds of visiting speakers in the departmental seminar series increases the visibility of these role models, and may even be a chance to identify possible recruiting opportunities.

Recommendation 5: Explore possible synergies and work to establish collaborative relationships with other departments that have similar research interests.

The Department recognizes the value of collaboration across departments and recently established a joint graduate seminar with Materials Science and Engineering (MSE). Creative steps to broaden participation may need to be taken (such as alternating the location of the seminar between departments or serving refreshments). Building further collaboration in the arena of graduate student training -- ultimately in the form of a combined doctoral program -- seems a fruitful approach to take, as faculty in both MSE and Metallurgical Engineering, and potentially other departments, would gain visibility by coordinating. Such a shared approach would maintain the autonomy of departmental structure, while offering efficiency and synergy in terms of both advertising and curriculum development. A current effort to explore a joint course with MSE is a good step. Combining efforts at the level of training would help to build relationships and likely bring opportunities to jointly mentor students in ways that facilitate research collaboration. Dean Butt is hosting several social events aimed at bringing faculty together. This too is important, as it will allow bridges that form naturally to spur collaborative efforts from the ground up. Further thought and discussion should go into how to create and incentivize a joint training environment, as well as other avenues for synergy and collaboration in the future.

This memorandum of understanding is to be followed by regular letters of progress, upon request of the Graduate School, from the Chair of the Department of Metallurgical Engineering. Letters will be submitted until all of the actions described in the preceding paragraphs have been completed. In addition, a three-year follow-up meeting may be scheduled during AY 2019-20 to discuss progress made in addressing the review recommendations.

Ruth V. Watkins
Darryl P. Butt
Manoranjan Misra
David B. Kieda
Katharine S. Ullman



David B. Kieda
Dean, The Graduate School
June 21, 2017