Montana Tech: Perspectives of a Small Specialty School

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Abstract

Montana Tech is a small university comprising approximately 3000 students across three schools. In this paper, I will discuss the main challenges affecting accreditation of mineral processing related subjects.

Introduction and Background

Montana Tech is a small university located in Butte, Montana. Montana has a population of around one million, and is considered the heart of the Rocky Mountains, with two national parks. Butte has a population of 40 000 and historically was a mining district, with many head frames still visible. Butte is the home of Montana Tech, which is a small university comprising approximately 3000 students. There are three main schools; the College of Letters, Science and Professional Studies, the School of Mines and Engineering and Highlands College. The departments of Metallurgical and Materials Engineering and Mining Engineering form part of the School of Mines and Engineering.

The campus is in a region of great natural beauty and this poses some challenges for a mining-centred activities.

Within the School, there are 10 Masters programs, including Metallurgical/Mineral Processing Engineering and Mining Engineering. There are also two PhD programs; Materials Science (MatSci) and the Individual Interdisciplinary Program (IIP). In addition to this there is a 2 year “Vo-tech” program.

Each Department within the School of Mines and Engineering typically has 6 tenured faculty positions to manage the Batchelor (BS) and Master (MS) programs. Currently, the Metallurgical and Material Engineering Department is responsible for teaching the core courses in the MatSci PhD program, so it also has a visiting faculty/postdoc member of staff.

The Department of Metallurgical and Materials Engineering resides in the school of Mining Engineering. All students in mining engineering are required to take a DDmineral processing course.

Metallurgical and Materials Engineering has the following faculty members:

- Courtney Young (Dept Head): Mineral Processing
- Hsin-Hsuin Huang: Hydrometallurgy
- Jerome Downey: Pyrometallurgy
- Alan Meier: Brazing Metallurgy/Ceramic Materials
- KV Sudhakar: Physical Metallurgy/Biomaterials
- Bill Gleason: Welding Metallurgy/Casting/Polymers
- Avimanyu Das: Visiting Faculty/Mineral Processing

This is one more than the usual six faculty allowed per department. The extra “visiting” faculty member has been allowed because of a new PhD program.

In addition, there are three adjunct faculty members, and several supporting staff. The Department houses comprehensive laboratory facilities including environmental and hydrometallurgy labs, and materials synthesis and pyrometallurgy labs, in addition to mineral processing and materials characterization facilities.

Challenges

The discipline of mineral processing and extractive metallurgy has faced a number of challenges in recent years (i.e. since 1980s), including:

- NSF stops granting mineral processing and extractive metallurgy research

- Most universities eliminate Mining and Metallurgical Engineering programs
- Others (continue to) question why they have a "School of Mines"
- Survivors, circa 2000, such as CSM, SDSM&T and MT Tech:
    - Rename courses (e.g., Mineral Processing becomes Particulate Processing)
    - Change program names (e.g., Metallurgical & Materials Engineering)
    - Get creative with research (e.g., energy, recycling and waste/water treatment)

- Universities use research to meet bottom line and become "Pro-Material" advocates
- MT Tech MatSci PhD is created but includes minerals (and metals) as materials

In the USA, only 7 programs remain that teach Mineral Processing and Extractive Metallurgy and only 13 programs remain in Mining Engineering.

Furthermore, mineral processing and extractive metallurgy can reside in different departments around the world, including:

1. Metallurgical (and Materials) Engineering
2. Mining (and Minerals) Engineering
3. Chemical (and other Process) Engineering

All of these are reasonable homes for minerals processing, but each presents issues relating to delivery of curriculum. For example, programs in metallurgy/materials engineering schools will be particularly strong in materials science, programs in mining engineering departments are likely to be weak on chemistry. Chemical engineering programs will be weak in mineralogy and chemical engineers often struggle with comminution science.

This also presents corresponding challenges in the accreditation of courses by professional bodies.

Accreditation

Accreditation by Professional Bodies

There are several professional bodies that are govern the key disciplines associated with the departments that teach mineral processing.

The lead societies accrediting Materials (1), Metallurgical (2), Ceramics (3) and "Similarly Named Engineering Programs" are:

- (1,2)Materials and Metallurgical Engineering Programs: TMS
- (3)Ceramics Engineering Programs: ACerS

There are also several cooperating Societies for the same:

- (1)Materials Engineering Programs: ACerS, AIChE and ASME
- (2)Metallurgical Engineering Programs: SME
- (3)Ceramics Engineering Programs: TMS

This means there are a lot of different voices telling the head of department what to do.

By comparison, there is only one accrediting society for mining and similarly named engineering programs

- Lead Society: SME

And similarly, only one accrediting society for chemical, biochemical, biomolecular, and similarly named engineering programs

- Lead Society: AIChE

Required Engineering Student Outcomes

All engineering graduates are required by ABET of the Engineering Accreditation Commission, to demonstrate the following student outcomes:

The program must have documented student outcomes that prepare graduates to attain the program educational objectives. Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety,
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

In two years this will be reduced to a consolidated list:

1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4. An ability to communicate effectively with a range of audiences.
5 An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.

For students in Metallurgical & Materials Engineering, additional subject specific criteria are:

Metallurgical & Materials Engineering

These program criteria apply to engineering programs including "materials," "metallurgical," "ceramics," "glass," "polymer," "biomaterials," and similar modifiers in their titles.

1. Curriculum

The curriculum must prepare graduates to apply advanced science (such as chemistry, biology, and physics), computational techniques and engineering principles to materials systems implied by the program modifier, e.g., ceramics, metals, polymers, biomaterials, composite materials; to integrate the understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing, and performance related to material systems appropriate to the field; to apply and integrate knowledge from each of the above four elements of the field using experimental, computational, and statistical methods to solve materials problems including selection and design consistent with the program educational objectives.

2. Faculty

The faculty expertise for the professional area must encompass the four major elements in the field.

There are also subject specific criteria for students of Mining Engineering. A notable difference between this and the metallurgy criteria is the inclusion of clearly defined specific topic areas such as mine planning, rock mechanics and ventilation.

Mining Engineering

These program criteria apply to engineering programs that include "mining" or similar modifiers in their titles.

1. Curriculum

The program must prepare graduates to apply mathematics through differential equations, calculus-based physics, general chemistry, and probability and statistics as applied to mining engineering problem applications; to have fundamental knowledge in the geological sciences including characterization of mineral deposits, physical geology, structural or engineering geology, and mineral and rock identification and properties; to be proficient in statics, dynamics, strength of materials, fluid mechanics, thermodynamics, and electrical circuits; to be proficient in engineering topics related to both surface and underground mining, including: mining methods, planning and design, ground control and rock mechanics, health and safety, environmental issues, and ventilation; to be proficient in additional engineering topics such as rock fragmentation, materials handling, mineral or coal processing, mine surveying, and valuation and resource/reserve estimation as appropriate to the program objectives. The laboratory experience must prepare graduates to be proficient in geologic concepts, rock mechanics, mine ventilation, and other topics appropriate to the program objectives.

2. Faculty

Evidence must be provided that the program faculty understand professional engineering practice and maintain currency in their respective professional areas. Program faculty must have responsibility and authority to define, revise, implement, and achieve program objectives.

And for Chemical Engineering:

Chemical (and Biological) Engineering

These program criteria apply to engineering programs that include "chemical," "biochemical," "biomolecular," or similar modifiers in their titles.

1. Curriculum

The curriculum must provide a thorough grounding in the basic sciences including chemistry, physics, and/or biology, with some content at an advanced level, as appropriate to the objectives of the program. The curriculum must include the engineering application of these basic sciences to the design, analysis, and control of chemical, physical, and/or biological processes, including the hazards associated with these processes.

2. Faculty

Nothing Stated

With all of these outcome requirements, programs mineral processing and extractive metallurgy must be broad and diverse to include the necessary content. There is little space for inclusion of additional electives.

Additional Challenges

The minerals industry has attracted negative publicity over the last 30 years and this has impacted on Minerals Processing education. Some impacts:

- National Science Foundation (NSF) stops granting mineral processing and extractive metallurgy research
- Most universities eliminate Mining and Metallurgical Engineering programs
- Others (continue to) question why they have a "School of Mines"

The surviving schools of mines in the USA circa 2000 are the Colorado School of Mines, South Dakota School of Mines and Montana Tech. Universities use research to meet bottom line and become "Pro-Material" advocates. Other survival strategies used by the schools that are left include:

- Rename courses (e.g., Mineral Processing becomes Particulate Processing)
- Change program names (e.g., Metallurgical & Materials Engineering)
- Get creative with research (e.g., energy, recycling and waste/water treatment)

In summary, what does a school need to do to survive?

Accreditation requires input from constituents as part of assessment process, and program coordinators need to pay attention to all:

- **Industrial Advisory Boards –** must be proactive with Departments
- **Graduates –** must be hired permanently by Mining and Metallurgical Industries
- **Students –** must be hired as interns by Mining and Metallurgical Industries
- **Alumni –** must help keep IAB members up to date on technology
- **Faculty –** must work with constituents to keep up with changing industrial needs

In terms of the inputs from Faculty, this includes having hands-on courses (M&ME requires 14 labs of which 6 are in M&ME). Although this makes education expensive it delivers a much better outcome.

Having as many technical electives at graduate level as possible means that you will be prepared for a reduction in credit requirements, and also that you prepare students for Graduate School.

Finally, be innovative! Get industry in the classroom or bring the classroom to industry. Montana Tech has had great success with this including guest lectures, field trips (particularly early in program) and seminars and guest lectures (use long distance learning). Two highly successful examples are:

- Fire Assay – short course format that industry also takes
- Gold Processing – Newmont personnel offer expertise in 30% of course

Conclusions

Like many schools around the world, Montana Tech is under significant strain. However, the school is delivering a successful program and we believe our strategy is setting us up for survival in the long term.

References

1. www.abet.org