

Mining Engineering Education Renewal (MEER) Project

Undergraduate Program Evaluation and Renewal (UPER)
Project Final Report



THE UNIVERSITY
OF BRITISH COLUMBIA



Circulated for Comment: May 6th, 2022

Issued: June 18th, 2022

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Executive Summary

Changing societal and mining industry needs prompted the need to teach UBC mining engineers differently. To address current challenges, course content would also need to adapt. To this end, the Mining Engineering and Education Renewal project was proposed by the Mining Engineering department faculty and subsequently approved for TLEF funding. The project, commencing in January 2019 was successfully completed at the end of March 2022.

During this time the project had to deal with the loss of the project manager and the outbreak and duration of the COVID-19 pandemic. The team restructured and made good use of the offered support from CTLT and CIS.

In spite of this the project team succeeded by borrowing some basic Agile techniques such as two-week development sprints and regular reporting. As a result, the work continued to completion and has since been awarded TLEF funding to implement the changed identified.

The report includes a breakdown of the impacts of the work as well as an additional section on some of the unexpected outcomes. A brief number of recommendations are made with the hope of passing on learning to any future team embarking on a similar enterprise.

Background

Technical

| | | | |
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| Faculty/Department: | Faculty of Applied Science | | |
| Degree Program: | Mining Engineering | | |
| Project Title: | Mining Engineering Education Renewal (MEER) | | |
| Principal Investigator/ Department Head: | Professor W Scott Dunbar | | |
| Other Applicants: | Andrea Arduini, Malcolm McLachlan, Jim Sibley, Davide Elmo | | |
| Report Submitted By: | Rets Sello, Jason Jarrett, Scott Dunbar, Jim Sibley, Carrie Hunter | | |
| Project Initiation Date: | 04/01/2019 | Project Completion Date: | 03/31/2022 |

Comment

Changes in the professional and academic world continue to create new challenges. For example, the use of highly networked sensors and the need to analyze the resulting data has created an important new analytics challenge for Mining Engineers in the workplace. As education conditions during the recent COVID outbreak amplified, standard didactic classroom delivery is no longer viewed as sufficient to ensure an adequate learning experience. Learning to incorporate best practices and new options such as experiential, interactive, and online components to improve learning is becoming essential to help graduates gain the necessary competencies to engage in the workplace.

Aim & Objectives

The aim of this project was to re-evaluate and renew the MINE Engineering undergraduate program. This aim will support the need to provide students with as many key and varied opportunities as possible to become a well-rounded engineer who has the tools and training to create innovative and sustainable changes in the mining industry.

To this end, the principal objectives for the MEER project included:

- Developing a new program vision
- Program learning outcomes
- Clear, well defined, and measurable learning outcomes which align with the overall program level outcomes and goals.

This work has been carried out with the intent of enabling UBC to be recognized as a world leader in mine engineering education by providing an engaging and flexible learning environment for students which fosters innovation, and the value of service to an inclusive society.

Approach and reflections

“No battle plan, survives contact with the enemy” Qt Helmuth von Moltke

The project had a very developed project management plan in Microsoft Project. The plan detailed exactly how the project should run. The project then met contact with the reality of daily life and the ‘to and fro’ of human life. For instance, the Project Leader left halfway through, and the remaining team members restructured the project to ensure the deliverables of the project could be met with the new decreased capacity. The core team began to reach out to get advice and support from designated APSC and CTLT representation. We reviewed the plan and decided to adopt an approach which could work similar to an “Agile” approach. This involved biweekly briefings and discussions with the stakeholder group identified in the project plan. These meetings set a pattern of very effective two-week sprints towards mini milestones. In addition, each week the core team met to review the progress, challenges, obstacles and learning points to take forwards at the next briefing.

Within a few weeks the team had approved a plan with the Project Investigator and the work continued unabated. By having the regular sprints towards objectives and making good use of the different support available the team were able to focus on defining what should a UBC Mining Engineer be.

The principal project challenge was developing the ‘buy-in’ from faculty. We had decided on a strategy of one-to-one engagement with faculty to develop a deeper understanding of their individual challenges and thereby present us with an opportunity to address some of them. This was easier planned than delivered, having to compete with faculty time during term and immediately after. Initially, the team faced resistance from a few faculty members, with perseverance, strategic communication, and patience however, the team were able to meet with everyone and gain a good understanding of their challenges. Prior to meeting faculty, the team prepared an extensive analysis of their courses which provided us with a framework to ask them questions to correct our models and have a common ground with which to begin this work.

In contrast, working together with Curriculum Development and the CTLT we were able to develop well responded to surveys and well attended and informed focus groups with students.

As we moved into the Analysis and Design phases of the work, we did so in the knowledge of the growing COVID-19 pandemic and subsequent international lockdown. The discipline of working to a sprint rhythm developed in year 1 proved very useful in moving our work from in person to online progress. In fact, remarkably, through having regular, focused meetings with the right support and advice on hand led to more effective work being achieved and explains in large part why the project was able to exceed in its expectations. Working from homes, across different continents, the teamwork and digital enablement of the internet enabled the team to adapt very well.

Impacts

| Predicted Impacts | | |
|---------------------------------|--|--|
| Who (include size/scope) | How | Plan for confirming, measuring, or evaluating |
| Students (165) | <ul style="list-style-type: none"> • Increased program satisfaction • Better knowledge, skills, and judgment capabilities for a better workplace preparedness • Mine engineers that can better respond to the increasingly complex world environment • Increased and diversified employability | <ul style="list-style-type: none"> • Students and Alumni surveys and focus groups for a few years of implementation |

| | | |
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| <p>UBC Mining Engineering Program</p> | <ul style="list-style-type: none"> • Newly defined program vision and Program Learning Outcomes help to maintain a consistent understanding of the program • Reliable guide for periodic, iterative on-going course redevelopments. • Maintained quality assurance even as teaching staff changes • Better trained graduates will enhance reputation for UBC and the department. | <ul style="list-style-type: none"> • Assess use of the Playbook by teaching staff • Monitor number of students who choose Mining Engineering each year |
| <p>Instructors</p> | <ul style="list-style-type: none"> • Revised course level outcomes that better define the intentions of the course and align with PLOs • Assessments and grading support • Removed redundancies will allow individual instructors to focus instructional time on what makes each course unique • A better understanding of how their course feeds into the whole program and how it relates with others | <ul style="list-style-type: none"> • Instructor feedback interviews |
| <p>Mining Industry, Indigenous and other Stake/Rightsholder Partners</p> | <p>Our renewed curriculum helps students embrace and value sustainability, inclusiveness, and innovation to positively change the interaction between the mining industry and global stakeholders.</p> | <ul style="list-style-type: none"> • Continuous stakeholder engagement and feedback loop |

Unanticipated outcomes

While most of the project subgoals were met, there were some additional outcomes achieved which were not listed in the original proposal or work plan, but which added significant value.

Securing an appropriate TLEF fund for the implementation of the MEER work through UIP was the most significant unanticipated outcome of the MEER project. This initial change to implement MINE 2 into the second-year experience is underway at the of this report being written.

The team are now developing along with MINE instructors from faculty, a *Playbook* which contains an exhaustively complete overview of the educational experience and includes all teaching materials, assignments, rubrics, marking guidelines, TA coaching notes, and classroom activity facilitation plans. This enables integrated teaching and collaborations within the teaching team, and also reduces gaps and redundancies identified in the MEER definition stage.

Successful working relationships were built with the teams and personnel of APSC. These interactions enabled the team to understand the large picture and thus focus our efforts on aligning our work with the strategic faculty plan. The connections with APSC also facilitated a better understanding of the overall graduate experiences. This approach motivated us to consider the need for smoother transitions of students between university and the workplace.

The team managed to obtain the 'buy in' of the mining engineering faculty to commit to the project and make the program changes identified. The team believe it was the one-on-one faculty engagement strategy which fostered a deeper understanding of their individual challenges, and thereby providing opportunities for the team to address them.

Future Support

The following points are areas of future support in place:

1. TLEF funding for activities to implement the MEER changes.
2. Stakeholder engagement support from the CTLT.
3. Continuous consultation and feedback loop with:
 - Indigenous partners
 - Industry
 - Students
4. CTLT support with evaluations on project performance and the impact of project activities using surveys and focus groups
5. APSC Center for Instructional Support (CIS) Office through Jim Sibley to provide support in the following areas:
 - Pedagogical advice
 - Course development
 - Assessments
 - Rubric designs etc
 - Building and maintaining the *Playbook*
 - Canvas help with MINE 2

Recommendations

Aside from the technical recommendations of the work, this section focusses on offering a brief set of recommendations for those perhaps considering undertaking a similar UPER initiative in the future. These include but are by no means limited to:

1. Define and develop an effective team. The project team needs to be constituted of committed and capable individuals. When specific skill sets are required, the team should be able to invite the appropriate expertise to support and build relationships with people who can guide and guide the project direction and sustain positive momentum.
2. Adopt a semi-loose tight structure of governance to enable the team to respond to uncertainty. The 'tight' aspect here refers to the need for a defined sense of accountability and reporting for team members as exemplified in the structured biweekly sprint briefings and weekly project team meetings.
3. Establish a flexible workplace. It is important to recognize that changing the means to achieve goals does not necessarily lead to changed goals. The MEER goals were exceeded, even with a changed workplace. Every sprint meeting provided an overview of the project work plan to help keep this picture in mind and better internalize how their individual work effects overall progress.
4. Allow for 'life' to happen. During the lifespan of the MEER project, many personal and professional changes occurred that could have shaken a less stable project. People left, moved, and dealt with significant life changes, yet the collaborative support continued, and the project activities went on.
5. Recognize there might be times of activity which require intense staff participation and sometimes, sparse activity when for an example a meeting has to be rearranged at the last moment.
6. Providing a common reference through simple visual tools. The practice of having a common deck of official UBC formatted slides to remind everyone of the aim, the goals and the overview of the project along with progress to date was very powerful and helpful in keeping everything on track.

Dissemination

A briefing for faculty initially planned for early May of 2022 was recently conducted on June 13 2022. At this meeting an update was provided on the outcomes of the MEER project, as outlined in this document.

Packaging the learning for students and sharing these with APSC and CTLT through chosen channels is planned. Core team member, Retsepile Sello, is currently working on her PhD in Mining Engineering curriculum design and intends to write a journal article on this later in 2022.

Next steps

With the support of the department, the project team were able to secure TLEF funding for the UPER Implementation Project (UIP) to integrate MINE 224, MINE 291 and MINE 292 courses into an integrated two term course to be called MINE 2. The current second year learning experience includes 3 separate mining courses which achieve their course level outcomes but could be strengthened to better serve the overall program level outcomes. A survey of students revealed 37.5% felt lost because of gaps in their learning when courses were taught in this silo manner.

This work breaks down these silos and integrates them around a stronger central narrative about mining engineering and who is a mining engineer.

Having gathered student data during MEER we will carry out post launch student surveys to compare how students view their learning after the MINE 2 experience with how they felt before.

Building on the learning and workflow associated with MINE 2, as well as information from the MEER project already gathered, the UIP team will be revisiting existing 3rd and 4th year courses to act on alignment opportunities to better achieve program level outcomes.

A consistent theme from the MEER stakeholder engagement was the need to integrate the entire mining story more strongly into the heart of the student learning experience. Case studies were often suggested as a means to highlight the complexity of mine development, operations and closure and the importance of how to engage and work with the communities in the areas where they operate. This is the focus of the changes planned for implementation in the 3rd and 4th years.

To construct case studies which foster an equitable participation and respecting diverse perspectives, the team will continue to work with their industry, community and indigenous partners. The indigenous strategy developed is informed by consultations with APSC Indigenous Engagement Committee and the UBC Faculty of Forestry, also an extractive industry faculty with extensive experience of indigenous engagement.

The teams strategy will be to continue to work with the Indigenous Peoples and Mining Instructor, consult with their Indigenous partners with a goal of listening,

implementing what is learned and seeking feedback in a cyclic iterative process. The team will also revisit course content to include Indigenous knowledge and community engagement strategies. The revised program will provide students with the opportunity to learn and practice stakeholder mapping, public participation processes and other concepts related to Indigenous knowledge.

Concluding remarks

The project team collectively felt it was an absolute joy to work on the MEER project, made only greater with the opportunity to implement the changes identified.

The team created a positive working environment of learning and growth for all members alike.

The team are deeply indebted to the offices of the CTLT and CIS, their financial and practical hands-on help was very important. The early engagement with Carrie Hunter and Nausheen Shafiq proved to be a very valuable decision and made a decisive improvement in our ability to get unbiased and useful feedback from students and faculty alike.

The team were very privileged to maintain the attention and support of Jim Sibley from the CIS, whose advice from the early days of designing and writing the proposal for the project to advising on the construction of the Playbook. Jim's advice and dogged determination was gratefully received and highly valued and remains so in his ongoing support of UIP.

The commitment and help the team received continuously throughout the project from Project Investigator, Scott Dunbar, ensured work remained aligned with the departments mandate and vision throughout the three-year project. Scott's timely and patient interventions helped overcome initial inertia and maintain momentum with faculty.

After working with many stakeholder groups, the team were able to establish a definition for a UBC Mining Engineer and communicate this in terms of program learning outcomes and solid steps for improvement. Multiple industry partners from four different continents, various companies, agencies, and positions, provided a diverse perspective of what it means to be a mining engineer. In the same manner, environmental and indigenous partners helped to further 'round out' and inform the teams understanding of what they expect from the mining engineers of the future.

The team believe implementing the changes identified will enhance students educational experiences and present them various career opportunities, in various fields and capacities, anywhere in the world.

Bibliography

These are some resources we found useful during the MEER project.

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Appendices

| | Goal | Met | Partially met | Not met or removed | Reason (if “not met or removed”) |
|---|--|-----|---------------|--------------------|---|
| 1 | A website will be developed and maintained throughout the project | | | √ | A website was started, but later not maintained due to lack of capacity. We chose to manage data and progress on UBC SharePoint instead |
| 2 | Define ‘what should a UBC Mining Engineer be | √ | | | |
| 3 | Consult with various stakeholder groups including, faculty, current students, recent alumni, other alumni, environmental proponents, indigenous groups, the BC Ministries of Mines, and Environment, and industry representatives. | √ | | | |
| 4 | Develop survey topics to distribute to the greater Mining Engineering student population | √ | | | |

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| 5 | Employ graphic recording (i.e., outsidethelines.ca) to the resultant process to deliver a visual feedback to the stakeholder. | √ | | | Changed out feedback process from graphic recording to delivering findings reports to consulted stakeholders |
| 6 | Survey recent alumni for their perspectives on key competencies and effective teaching methods to improve student learning | √ | | | |
| 7 | Survey older alumni and industry representatives for their perspectives on key competencies required for a UBC Mining Engineer. | √ | | | |

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| 8 | A small focus group consisting of invited representatives from 1-2 NGO environmental groups will be conducted to consult and identify key competencies for mining engineers that environmental groups feel that would foster better relations and understanding between mining engineers/mining companies and environmental proponents. | √ | | | Chose o do individual interviews, instead of a focus group, with environmental NGO representatives |
| 9 | Consult with the Ministries of Mines, and Environment to ensure that our program fulfills the needs of government regulators. | √ | | | Consulted with our project PI, Andrea, once she moved from UBC to a position with the Ministry |
| 10 | Consultation with the Faculty of Forestry on best practices and development of a consultation plan for Indigenous Groups | √ | | | |

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| 11 | Meetings with Faculty of the Mining Engineering Department will take place each term (3 per year) to keep faculty up to date on the project progress, validation of share vision, and to generate discussion and direction to the project. | | √ | | We did individual interviews with all faculty members, and then one faculty update in a meeting |
| 12 | Review of current courses, and mapping of learning outcomes and competencies for each core MINE course and supporting 2 nd year core courses | √ | | | |
| 13 | Identifying which competencies are assessed, at which level of achievement, and in which courses. A total of 36 courses will be reviewed. | √ | | | |
| 14 | Interviewing other Applied Science departments (Mechanical, Civil, Electrical, and APSC 100/101) who have gone through the program renewal process. | √ | | | |

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| 15 | Evaluation of program goals and outcomes at nine Mining Engineering schools across Canada. | √ | | | |
| 16 | Development of a new program vision, program level learning outcomes, and clear, well defined, and measurable course learning outcomes. | | √ | | New program vision and PLOs were defined. We reviewed MINE course level outcomes, but only focused on redefining 2 nd year course level outcomes, not all MINE |
| 17 | A new curriculum map will be developed filling identified gaps in the current program and applying newly identified competencies. | | √ | | Defined what new curriculum would look like, but left a new curriculum map to be drawn later, once the identified necessary changes are made |
| 18 | Construct both the vertical and horizontal alignment of course outcomes to program level outcomes. | √ | | | |
| 19 | Identifying and completing the concrete steps towards implementation | √ | | | |