

University and Industry Collaboration in Canadian Mining Education

by

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Abstract

For many years Canada has been at the forefront of mining engineering education, research, and technology development. Canadian universities have been the foundation for developing the individuals and companies that have maintained a global reputation for quality and responsibility. However, various stresses on the Canadian mining education system currently appear to place at risk the quality of the educational experience, limit the ability of mining departments to adapt to industry, while overall jeopardizing the sustainability of mining education.

This study identifies the absence of an industry strategy to nurture the sustainability of Canada's mining educational excellence. The thesis is based on a qualitative research program that examined the perspectives of a range of industry and academic experts. It attempts to contribute to invigorated collaboration between industry and universities to better address the future human resources challenges and ensure the sustainability of Canadian mining leadership.

Data collected through a series of structured interviews was organized into six themes leading to the conclusion that the challenges threatening the university contribution to mining engineering leadership in Canada can be mitigated through strategic university and industry collaboration.

It concludes that industry leadership needs to become proactively involved in collaboration with schools to sustain Canada's mining education health and quality. Its leadership needs to be more aware of the critical state of Canadian mining engineering education system. Industry needs to influence mining schools to pool resources and expertise and to work collaboratively together rather than in isolation. Companies need to accelerate the development of future leaders through offering consistent summer student and co-op hiring. Lastly, it is recommended

that industry needs to prioritize mentorship and facilitate the timely transfer of knowledge from senior engineers to junior engineers.

This thesis contends that Canadian mining engineering education is at a critical juncture. The mining industry is experiencing a new era of globalization and expectations of sustainable development. Continuing to simply stay the course places Canada's competitiveness as a leader in mining at risk. The research concludes by observing that a new vision and strategy for industry-university collaboration, energised by government, should be a priority short term goal.

Preface

This research was approved by the University of British Columbia's Office of Research Services Behavioural Research Ethics Board in June of 2013. The certificate number for this research is H13-01397.

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List of Abbreviations and Definitions

Co-operative Education (Co-op): a program which enables students to alternate periods of academic study with periods of work experience in positions related to their field of study.

Economic Cycles: the fluctuation of the economy between periods of expansion (growth) and contraction (recession).

Highly Qualified People (HQP): individuals who have obtained a minimum of a Bachelor's degree from an educational institute.

Industry Expert: individuals with experience with and knowledge of mining and the human resources side of the mining industry (ie. attraction, recruitment, training, and/or development).

Mining industry: refers to organizations or individuals that work on some aspect of the mining lifecycle, includes: exploration; extraction and processing of minerals and metals; closure and reclamation of mining lands; and organizations or individuals which support these activities through consultation or other service offerings.

Mining Industry Human Resources Council (MiHR): national sector council for the Canadian minerals and metals industry. The council is funded in part by the Government of Canada's Sector Council Program.

Mining School, Institute, and/or Department: refers to a post-secondary academic unit that educates undergraduate and/or graduate students in mining.

University and Industry Partnership: an arrangement where parties agree to cooperate to advance their mutual interest.

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I would like to express my sincere appreciation to Brock Roadhouse, New Gold Inc., and Mitacs for facilitating and supporting my research. This openness to partnership is an example of the essence of what this thesis is about. I would like to thank Jenny Reilly, Neil McLean, and UBC for supporting my professional development and facilitating a study leave that enabled me to complete my data collection. I would also like to thank Patrick Blaeser for assisting with the tables and figures as well as the rest of my current and former coworkers who worked tirelessly during my absences and supported my master's ambitions from the very beginning. Lastly, I would like to thank all of the students I worked with over the years. They are the reason for this research in the first place. They have had an immense impact on my career goals and I hope that I have had some positive impact on the direction of their careers.

Dedications

To Akiko, for supporting me, believing in me, and persevering with me, with patience and love.

1 Introduction

The human resources challenge is one of the greatest threats to the global mining industry. The 2014 edition of the Ernst & Young report on the top ten business risks facing the mining industry ranks 'Skills Shortage' as the combined top risk over the course of the past seven years (Ernst & Young, 2014). Mining and the extractive industries are grappling with an overwhelmingly aging workforce, a scarcity of the middle management demographic to replace them, and insufficient capacity to produce enough skilled workers to meet projected hiring demand. In the US alone 50% of the workforce will be retired by 2029 (Society for Mining Metallurgy & Exploration, 2014). Closer to home, 20% of the workforce in Canada is eligible to retire in the next two to four years (Mining Industry Human Resources Council, 2013). This situation is exacerbated by other industries such as the emerging BC oil and gas industry facing similar HR challenges (Heemsbergen, 2010).

The dearth of middle management aged workers is due in large part to an extended period of time from the 1970's to the 1990's when the public perception of mining was low and companies did little to attract new people to the industry leading to low university enrolment. Subsequently, many mining schools around the world closed down due to a lack of support from industry and government; consequently the remaining schools today lack the capacity to produce new graduates at the rate required. Figure 1 below summarizes the roles of Universities, Industry, and Government in relation to the past, present, and future of the mining industry human resources challenge.



Figure 1: Current Issues in Mining

The technical and complex nature of the extractive industries has created the need for knowledge workers. These Highly Qualified People (HQP) possess a combination of technical, business, and social skills that are developed over time through a combination of post-secondary education and real world experience. From high school graduation it can take more than a decade to develop into HQP. The generation gap of HQP in the global mining industry is of significant concern considering the investment of time and resources required to develop these individuals.

Universities play a key role in the development of HQP; however, many of the remaining mining oriented universities are facing a shortage of teaching resources and limited capacity. Mining companies have a limited history of collaborating with universities in a variety of ways and there is much opportunity for growth in this area.

Working at the University of British Columbia Co-operative Education Program for the past eight years, six of them as a coordinator assigned to the resource industries, led the author to the development of a significant resource of anecdotal evidence of the successes and shortcomings of the current and past collaboration efforts between industry and universities.

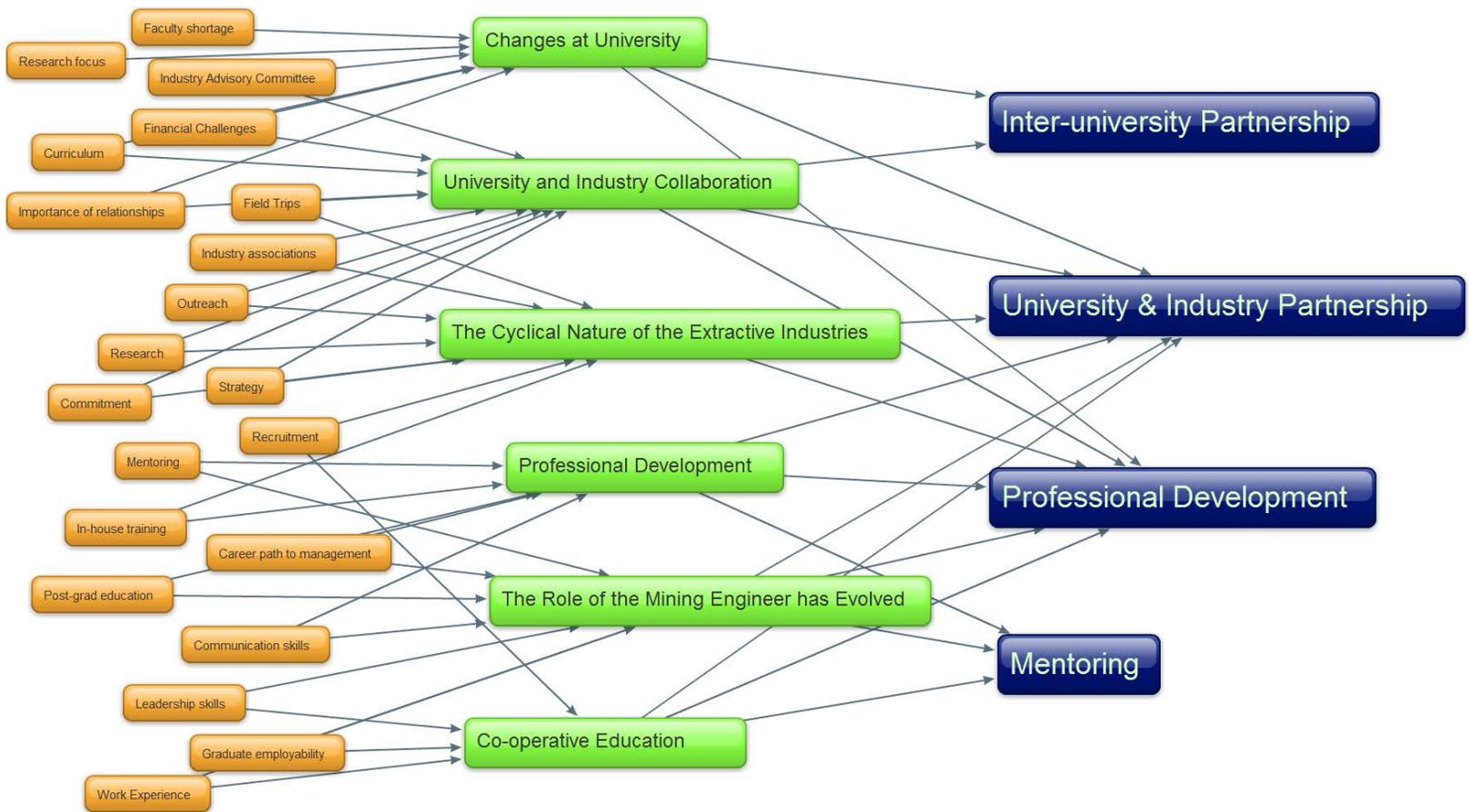
Qualitative data was collected through a series of structured interviews with industry experts. Analysis of the data identified twenty-one reoccurring themes that were then organized into six major themes, becoming the foundation of this study. This research brings to light many of the problems faced by each of the stakeholders and identifies possible solutions to addressing them. The thesis concludes by reviewing the four components of a strategy for collaboration between industry and universities to ensure sustainability to prepare future generations of HQP. Figure 2 provides an illustration of the sub-themes, themes, and recommendations of this research.

Figure 2: Data Analysis

Sub-themes

Themes

Recommendations



2 Methodology

2.1 Research Approach

Prior to formal data collection beginning in the summer of 2013, when the researcher was granted a four month study leave by his UBC employer, data on this research topic had been collected informally over the course of four years. A qualitative research methodology was chosen because of the potential detail and depth that could be achieved and that the power and complexity of the individual experience that could be used to provide a more compelling and authentic resource. Under the guidance of a consultant a structured interview comprised of nine open-ended questions was designed to elicit feedback that would form the foundation of the study. Upon receiving approval from the UBC Behavioural Research Ethics Board the structured interviews were conducted over a period of four months. In order to establish an industry partner for this study and to access funding for the research activities the researchers applied for the Mitacs Accelerate research internship. New Gold Inc. agreed to participate in the internship and provided office space, access to its employees, and insight into the culture and environment of a Canadian mining company. During the four month internship the majority of the literature review was completed as well as most of the interviews. Attendance at the World Mining Conference held in Montreal provided access to interviewees from outside of BC as well as outside of Canada. A progress report of the research conducted was submitted to Mitacs to fulfill the Mitacs-Accelerate Final Report at the end of the four month internship. The actual data analysis took place over the following six months, the majority of the writing of the document took an additional seven months after that, and the feedback and revisions required an additional four months.

2.2 Respondents

The participants of the study were experienced senior people in a range of positions and companies related to the Canadian mining industry. These 'industry experts' were selected based on their prominence in industry, their ability to provide a reasoned opinion on the topic,

their relative accessibility to the researchers, and their willingness to participate in this study.

The selection criteria were:

- a) Currently in a role relevant to the global extractive industries
- b) Aware of mining engineering education and requirements
- c) Knowledgeable of the recruitment and development of HQP in mining

Potential candidates were identified through discussions with UBC faculty and industry contacts

to cover the following groups:

- Executive
- VP
- Senior (non-engineering related company)
- Senior (engineering related company)
- Academia

These groups were further narrowed down to achieve variety in the following categories:

- a wide range of companies
- variation in roles
- variation in industries
- depth of knowledge of topic
- availability to be interviewed

Based on these criteria a participant list was deliberated with UBC mining engineering faculty and invitations were sent out to the shortlisted names. Approximately 60% of the invitations to participate received a positive response with approximately 75% of these resulting in a successful interview. The selection of participants evolved as the study was progressed to ensure that data was collected from a diverse group of people in a wide range of roles, different levels of seniority, and with a variety of organizations. The participants from organizations in industry include nine at an executive level and eight at a senior level; eight participants are from

academia, two participants are from government sponsored organizations involved in human resources in mining, and one individual is with a mining related non-governmental organization. The selection of six of the total 28 participants was a result of suggestion gathered from participants interviewed earlier in the study.

2.3 Methods of Data Gathering

The qualitative data collection technique in this study included structured interviews that were face-to-face or over the phone. Seven of the interviews were conducted via telephone, eleven at the participants' offices, five at a restaurant/coffee shop, three at a conference, and two at the researcher's office. Nine open-ended questions elicited opinions on university and industry partnership and these facilitated continued research on the topic.

2.4 Procedure

Potential candidates were contacted via email about participating in this study which included the purpose of the study, the opportunity to accept or reject with zero negative consequence, an opportunity to ask questions about the research, as well as the interview questions in advance of the interview (See Appendix A for the Interview Invitation and Questions). Interviews were then scheduled with the respondents who had accepted the invitation. After the interviews participants were provided with a written transcription of the interview correspondence for review and possible editing. Participants were provided the opportunity to withdraw from participating at any time during this process. The interview data is saved on an encrypted USB storage device and stored in a secure location under the care of the primary researcher in accordance with the UBC Behavioural Research Ethics Review.

2.5 Data Analysis

Data analysis is based on Grounded Theory methodology which is a research methodology that involves the construction of a theory through the analysis of data. Grounded Theory often begins with a question or with a collection of data. Researchers review the data to identify

concepts that are repeated, which are then tagged with codes. Codes are then grouped into categories or sub-themes through the constant comparative method (Corbin & Strauss, 2008).

2.6 Results

Through the initial coding twenty-one sub-themes were created which were categorized into six main themes. Analysis of the six main themes of this study lead to the development of four areas of 'Recommendations' as illustrated previously in Figure 2.

2.7 Limitations

Data was generated from a small sample group and cannot be generalized to a larger population. Interpretation of data and identification of themes is limited by the researcher's level of expertise in qualitative analysis and could be influenced by bias.

3 Cyclical Nature of the Industry

Mining is the only engineering discipline that is so inherently linked to the global economy. This is because a natural resource in the Earth's crust is not considered to be 'ore' unless it can be extracted from the ground and sold at a profit, which is dependent on two factors: the global market price of that commodity and the technology available to extract and process it. The decision of whether or not to go ahead and build a mine is made more challenging by the fact that it can take several years to both acquire the requisite permits and to construct a mine, at which point the commodity price will have undoubtedly increased or decreased depending on the economic climate at the time. Therefore the decision to extract a particular mineral or metal resource must be based on the projected market price of that commodity during the period that the mine will be operating as well as the latest technological advances available at that time. When a particular commodity price increases market conditions can suddenly become favourable for a natural resource to be mined. Conversely, when the price of a commodity drops, companies tend to respond by shelving projects, cutting production at operations, or shutting down mines altogether in extreme cases. The result of these economic fluctuations is the cycle of high demand for skilled labour followed by periods of high unemployment due to layoffs in response to poor market conditions. The instability caused by this cyclical phenomenon has a dramatically adverse effect on the attraction, development, and retention of people in the mining industry and mining education.

Developing solutions to resolving the cyclical nature of the industry is perhaps beyond the scope of a master's thesis. Instead this research considers avenues to mitigate the impact of future cycles on human resources in the mining industry based on the perspectives of industry experts. This section explores the importance of establishing structured partnerships with universities and companies to overcome turnover in the industry; making long-term decisions despite pressures to do otherwise; and prioritizing the attraction and retention of future HQP.

As previously discussed, the current demographic phenomenon in the mining industry is caused in large part by mining companies not attracting people to the industry, not retaining these people within the industry, and not supporting university mining programs for an extended period of time. By not mitigating the negative impact of the economic cycles then companies will again struggle to attract new people to mining, and the industry cannot afford to have history repeat itself. The general consensus from the interviews is a need for long-term strategic thinking when it comes to attraction, recruitment, retention, education, and research.

3.1 Fundamental Differences Between Industry and Academia

Collaboration between industry and academia is complicated by several factors. Some of the fundamental differences between the two are culture, priorities, organizational structure, and role in society. For academia, the goal is to promote learning, education, and research independent from external influences whereas corporations are generally profit driven. Corporations are under pressure to take action in response to the up- and downswings in the market which is influenced by their obligation to shareholders. Universities tend to be much more stable financially than their industry counterparts because they do not have to deal with the same quarter-by-quarter performance scrutiny faced by their counterparts in industry; however, this comes at the expense of flexibility and ability to respond and change to market conditions. Universities tend to be more bureaucratic in nature. When it comes to making changes then companies have a much greater ability to take action than universities, which can make it a challenge for universities and industry to collaborate over the long run. Universities ask for strategic long-term commitment on projects with industry whereas industry wants quick wins (Joseph, 2013).

3.2 Relationships and Structure

This research reveals that personal connections play an important role in establishing collaboration. According to UBC Career Services Manager, Jenny Au, compared with some of the other departments at the University of British Columbia the professors in the Norman B.

Keevil Institute of Mining Engineering are particularly well connected with industry (Au, 2013). And they have utilized their personal relationships with professionals in industry for the benefit of the department and students for research, education, student employment, and financial and in-kind support. For example, 4th year mining engineering student and President of the Mining Executive Council, Andrew Crook observes that “the professors rely on their friendships and their contacts to bring in guest lecturers” (Crook, 2013). However, change in personnel with either party can have a dramatic impact on the sustainability of relationships between universities and their industry partners. Turnover created by the economic cycles in mining is a particular challenge to maintaining collaboration between universities and companies. Malcolm Maclachlan, Program Manager at the Norman B. Keevil Institute of Mining Engineering, describes the impact of employee turnover at one of UBC’s industry partners:

“Some companies are much better at working with mining schools at developing relationships with the students and with the school. I think that’s something that’s really critically important. It’s often a company by company thing and it changes over time. Five years ago we had very close relationships with some companies that are not even on our radar anymore because they’ve changed. New people have come in. A good company that’s very close to us is *Company A*. We had a good relationship with *Company A*, a much better relationship with *Company A* at one stage. We almost don’t have a relationship with *Company A* anymore. If I was to be asked what would be the top companies that we now interact with on a regular basis, I would name *Company B*, *Company C*, and *Company D* immediately as companies we work with in various ways. *Company A* isn’t on that list, and that’s something that’s happened over the last 4 or 5 years where for whatever reasons, there’s just been a lapse in the relationship. Turnover at the industry level (is the cause of the change in this relationship) because nothing has substantially changed within the department”

(Maclachlan, 2013).

Employee turnover is a natural phenomenon within any organization and so companies and universities need to mitigate the impact of this eventuality by planning ahead and making strategic decisions. An organizational relationship can transcend the actual individuals involved if a sustainable process or structured relationship is first established. President of Cementation, Roy Slack, highlights the successful model established at the Canadian Mining Innovation Council (CMIC) with its industry partners:

“There needs to be some structure to a university and industry relationship. What I see (happening) is ‘old school’ networking. For example, if a professor went to school with someone who works at a company like Teck, or wherever, invites that person to join in on a lecture or those students go on a site visit. But it’s not formal. If I look at what we do with CMIC, there is a structured process where industry gives input into what areas they think are most important with regard to innovation. So where is the structure in our educational system?”

(Slack, 2013).

In response to projected demand for people in the mining industry the Canadian government tasked the Canadian Mining Innovation Council (CMIC) with the responsibility of developing a Pan-Canadian Mining Research and Innovation Strategy in 2008. One of the five action areas identified was Highly Qualified People. An HQP Taskforce was formed comprised of people from industry, universities, and associations. The four CMIC HQP strategic goals were:

- Attracting, developing and retaining a steady flow of HQP (students, faculty and practitioners) in mining research and innovation, and increasing student completion rates
- Strengthening the research capacity of Canadian mining schools and their linkages to industry and other mining innovation system stakeholders

- Increased industry involvement in HQP training and increased opportunities for students in co-operative educational settings
- Increasing the profile of mining research within educational institutions

(Canadian Mining Innovation Council, 2008).

Unfortunately, the proposed actions were not successfully completed and the CMIC HQP Taskforce was disbanded in 2014 due to a lack of leadership (Scoble, 2014). This research reveals that the best partnerships are led by people from industry. According to BC Human Resources Task Force chair, Dave Bazowski:

“The driver has to be industry... whether it is government, educators or other service organizations, they’re meant to literally serve and provide for the major client, which are the employers”

(Bazowski, 2013).

Not only does industry have to take on a leadership role but it needs to commit as well. Hawkins and Barclay suggest that a successful recruitment strategy begins with commitment at corporate level:

“Graduate recruitment and development must be considered as a strategic issue, to be addressed at corporate level. Companies must have a well-defined, structured approach to the whole process and be able to demonstrate this clearly to potential graduate recruits”

(Hawkins & Barclay, 1990a).

According to Marasco, the leaders at some companies recognize the importance of committing to a recruitment strategy:

“Dow's Sue Sun-LaSovage says. ‘Our leadership realized that if we have a strong pipeline, we can get the best talent who can fill more experienced-level jobs in the future. We've made a commitment to hire the best people from universities and to create an employer brand on campuses. We try to go not only when we need to hire.’

‘These are not just jobs we're filling,’ Shell's (Cary W.) Wilkins says. ‘These are employees who will develop and grow to fill our business needs beyond just their first few years, and, we hope, become leaders down the line’”

(Marasco, 2008).

What companies or universities appear to need to do is establish a liaison that is responsible for maintaining collaborative relationships. If this individual moves on to other career opportunities he/she is replaced with someone who carries on the role of maintaining the established partnerships. A liaison could be either an employee at a university or at a large company. A university liaison would not only maintain current relationships with companies but could also utilize alumni connections to seek out new research or educational collaboration opportunities with other companies. A liaison at a large company can focus on developing a comprehensive recruitment strategy at a number of universities that ties in outreach, sponsorship, scholarships, work terms, and new graduate recruitment to meet the organization's specific recruitment needs.

3.3 Investing Locally Versus Importing Talent

Developing HQP requires time and patience. Kirk McDaniel and Alan Moss state that what educational partnership cannot do is “provide instant results. Even starting a program today, it will take 3-5 years to produce the first crop of new graduates” (McDaniel & Moss, 2014).

Whether or not mining companies are aware of, or are concerned about, the significant amount of time investment involved in preparing new graduate mining engineers, they haven't acted in a manner that would suggest so. When faced with a shortage of HQP many companies have

simply turned to stop-gap solutions to address their human resources needs such as poaching from other mining companies and importing talent, and this fierce competition for experienced mining HQP has led to the escalation of some of the highest paying salaries of any industry (Deloitte, 2013). Brent Lyons, Partner at David Aplin Group, a Canadian recruitment firm, provides some insight into why some companies have decided to import skilled workers.

“Things are unfortunately moving so fast, they (companies) want talent now, rather than 5 years from now. Hats off to the companies that do still have those long-range plans there, but with volatile economies, they can get derailed... ‘Iron ore is now worth something again. We’re back on board, the investors want this to be up and running in 3 months.’ You can’t necessarily say, ‘don’t worry; the talent will be there in 5 years. So the whole idea of importing engineers is irresistible”

(Lyons, 2013).

There can be serious consequences to choosing to hire foreign talent over developing people locally. At the local level there may be disgruntled underemployed people in the community and in some rural areas in particular there potentially is a weak educational infrastructure that would greatly benefit from an injection of investment. In British Columbia many rural towns are the result of mining or forestry booms in the past and the people tend to be very much aware of the economic cycles. Meanwhile at the mine site one might find skyrocketing salaries and high attrition of the foreign workers who come into these situations with no plan to remain there long term (Lyons, 2013). At the national level there could be political issues raised about not investing in the education of citizens of that country. Hiring temporary foreign workers can be an extremely controversial and polarizing topic as discovered by HD Mining in 2013 when there was considerable public outcry over the company’s attempts to bring in over 200 workers from China based on changes to the province’s Temporary Foreign Worker legislation (Keller, 2013). This has been an ongoing controversy and a public relations nightmare that began in March

2012 and continues to this day. Conversely, there can be huge benefits to investing in local talent instead, such as developing world leading educational infrastructure which can produce top level graduates and cutting edge research and development, and lead to low regional unemployment, a high rate of retention, and strong support from the community where a mine operation is located. A number of mining companies with projects and mines in Central and Northern British Columbia have already successfully partnered with local colleges by providing equipment and working together to create programs to train local and aboriginal people to meet their operational recruitment needs. Imperial Metals has partnered with Northwest Community College (NWCC) School of Exploration and Mining to support an Environmental Monitoring Assistant Program. The company is collaborating on a mineral processing course curriculum as well as other programs with the Cariboo North Community Campus (CNC) Burns Lake, and supporting a Heavy Duty Mechanics Foundation Program at Thompson Rivers University through the Aboriginal Mine Training Association (“Imperial Metals Corporation: People,” 2013).

However, due to the challenge and length of time involved in developing HQP one form of recruiting international talent has seen success. At UBC growth in the Master of Engineering (MEng) in Mining Engineering Program over the past seven years has increased the mining department’s capacity to produce HQP as well as generate new revenue streams. The MEng program consists of three academic terms with a co-operative educational option. Through partnership with industry and faculty support nearly 100% of MEng mining students enrolled in the UBC Engineering Co-op Program have secured a 4, 8, 12, or 16 month work term. This has been an extremely attractive option for high achieving international students, many of whom graduated from top mining schools in other countries such as China, India, Chile, and Turkey and have chosen to further develop themselves in Canada. A large percentage of these students have seamlessly secured mining engineering careers in Canada upon graduation. The first co-op graduate of MEng-MINE program secured her first mineral processing co-op work term at a mine in central BC and began working there a mere nine months after initially arriving in Canada in 2007. Her work term success earned her an offer of a full-time position at the mine

upon her graduation in 2009. Today she is now the senior metallurgist in the mill after taking over the role earlier in the summer of 2014.

Countries such as China have invested in resource sector post-secondary education and consequently have developed large capacity to educate potential HQP. While some may not consider the quality of education to be at the same level as some of the top schools in the world one cannot deny that the population and educational capacity can have a significant impact on the pool of future mining engineering talent. University programs should be proactive in looking for ways to overcome the language and geographical barriers and bridge this gap through collaboration opportunities. Companies would be wise to support this concept and facilitate this collaboration as well. Industry leaders need to recognize the fact that there is no quick solution to the human resources challenges of the industry and they need to exhibit long term thinking by investing in education and training today to better position their organizations for tomorrow.

3.4 Impact of the 'Cycles' on Perceptions

Attracting people to the mining industry has a number of challenges such as the negative reputation of the industry, the impact operations have on the environment, the potential safety risks, the remote location of operations, and an overall lack of understanding about the industry by the general public. Conversely two of the attracting features of the industry are the high average salaries and opportunities to travel (Gallagher, 2013). The mining industry has made significant progress in attracting people over the past decade due in part to growth in the industry that has resulted in increased career opportunities. However, when faced with an economic downturn mining companies have traditionally responded with mass layoffs simply to provide confidence to shareholders that costs are being contained. Typically there has been no ethics when it comes to this type of knee jerk reaction and no guilt or remorse afterwards. Any gains in public perception of the mining industry and increase in the number of people entering the industry are all for naught when jobs are suddenly cut. According to Ryan Montpellier, Executive Director at Mining Industry Human Resources Council (MiHR), when some university

students witness the effects of economic downturns on the mining industry many reconsider their career goals and seek a more stable and secure industry.

“I think the biggest challenge facing HQPs is the volatility that the industry is facing. It's the cyclical nature of the industry that is one of the biggest barriers in attracting, recruiting and retaining HQPs in our sector. What we see is when times are good, everybody's looking for HQPs, and when times are bad, nobody's hiring them and then we, we essentially lose a cohort of graduates or we push these people away inadvertently and then we have trouble finding them in the future and we're crying labour shortages in one breath and then in the next breath we're laying off people because commodity prices have fallen”

(Montpellier, 2013).

Whether in times of prosperity or in times of financial struggle both the extreme high and low ends of these 'cycles' put pressure on engineering programs which in turn can have an adverse effect on student perceptions. When commodity prices are low and the industry is struggling financially most mining companies tend to shelve their support of university recruitment and student development which affects the future supply of engineers. However, not only can canceling all recruitment during tough economic times increase attrition from mining schools, but binge recruitment of a large number of students during periods of high commodity prices can create its own issues. Many students who were enrolled in school during good economic times were wooed by multiple companies that competed for an insufficient number of potential candidates by making various promises in order to attract them (Dehaas, 2012). According to some of the interviewees this led to many students developing a sense of entitlement and unrealistic expectations of the immediate value that they bring to an organization, their desired compensation, and rate of career progression. Consequently, recruitment of university graduates potentially becomes more challenging when the reality of what companies can offer

doesn't meet the expectations of the available candidates. Furthermore, this also increases the likelihood of some of the new hires becoming disappointed within the first few years of employment when their expectations are not met. This situation is described by Ross Pritchard, director of Mining and Mineral Processing at Teck Resources:

“In the last couple of years, we've seen undergraduates come in and what would typically be expected to be 3 or 4 years in a particular role, thinking it is good experience, students are now expecting that after 6 months. They've been there, done that, and can move on. There's been the usual 'grass is greener on the other side', particularly if they went through a couple years when there were multiple (job) offers to students, and the stories they heard of the offers, which many of them probably were never really privy to the real details of what the offer was”

(Pritchard, 2013).

Students who graduated during a difficult financial year for mining companies, such as 2009, after experiencing years of prosperity while they were in school have struggled to adapt to the realities of not being able to find employment due to companies attempting to reel in costs by cutting spending. Pritchard suggested that it is actually a good experience for them to experience a downturn as a student since it is a reality of the industry and it can temper expectations. What the recent economic cycles in the mining industry have led to are two main types of graduates: new graduates who have gained valuable work experience during undergraduate years of prosperity in mining but because of the desperation of companies resulting in multiple offers they have also developed unrealistic expectations for what they can expect after graduation; and graduates who have lower expectations about their job prospects immediately after graduation due to experiencing the down cycle of mining as a university student but as a result they have gained little or no work experience prior to graduation because

companies were not looking to hire students during this period. Neither situation is ideal and should be mitigated by industry prioritizing the development students into HQP.

3.5 Long-Term Planning

It may be inevitable that commodity prices will continue the cycle of rising and falling into the future and that each time there is a downturn mining companies will face considerable pressures by analysts to make short-term decisions that will have long-term ramifications; however, companies can choose how they respond to these pressures and prioritize certain commitments by recognizing the long-term ramifications of not doing so. According to Bob Gallagher, CEO of New Gold Inc., it was the short-term decisions like not supporting university mining engineering programs by continuing to attract students to the industry and hiring them after graduation that occurred ten to twenty years ago that has led to the industry struggling to find mid-career mining engineers today.

“(W)hen there’s a downturn and mining companies start to cut back it’s the worst thing they can do. It’s the most short-sighted thing. There are so many other ways you can save student jobs. I don’t know whether you’ve got to sit down with industry and just talk about it and say ‘you know, you guys, if you haven’t realized it, one of the reasons you’re so short on people now, especially people with 10 years of experience, is because you stopped hiring in the last downturn”

(Gallagher, 2013).

Larger organizations, and to some extent private companies, have a better ability to withstand economic pressures and make longer term decisions than do smaller companies. However, along with this ability comes the responsibility to do so for the benefit of the industry.

Unfortunately, according to Slack even the largest organizations have seen a drop in student hiring over the years (Slack, 2013). With mining schools around the globe having increased

intake of undergraduate students over the past several years at the request of industry, post-secondary institutions will need to see renewed commitment by industry to provide the summer and co-op work experiences to match this growth (Maclachlan, 2013). Therefore it is essential that the large companies in particular lead the way in providing consistency in terms of student employment opportunities that the smaller companies may not have the flexibility for. In recent years industry hasn't shown the level of commitment and support of student development, such as an ability to absorb the increase in student employment demand, to match academia's commitment to increasing student numbers at industry's request. This is reflected in the UBC Engineering Co-op Program summer 2014 numbers as the Program experienced the lowest number of work terms secured by mining engineering undergraduate students since 2004, a drop of nearly 20% compared to the average of the previous three years (Miyoshi, 2014).

A lack of long-term strategic planning when it comes to collaboration with universities has not been restricted to recruitment, but is also evident in other areas such as research, as stated by Bruce Hebblewhite, Professor of Mining Engineering and Head of the School of Mining at the University of New South Wales:

“Trying to get industry commitment for longer term strategic education and research needs is not always there. Industry wants solutions to problems today. You say, ‘we’ll support this three or four year research project that we can get a PhD student on to’ but they say, ‘no, no, no, we want an answer in six to twelve months’”

(Hebblewhite, 2013).

Research collaboration between universities and industry not only has the potential to increase a company's competitiveness as well as a university's prestige, but it has a long history of contributing to the education and development of students at both the undergraduate and graduate level. Various forms of research collaboration have produced many HQP in the mining industry over the years (Thompson, 2013).

A general theme that emerged from the research data, regardless of whether it is from the perspective of academia or industry, is a need for industry to better commit to partnering with universities. One of the main challenges of this is the fundamental differences between the two in terms of how decisions are made and the impact this has on many things such as the ability to make changes. According to McDaniels and Moss universities are “like a large ocean going vessel. They are well suited to long journeys, but not necessarily well suited to making sharp turns” (McDaniel & Moss, 2014). Education is a long-term commitment for universities. Once a partnership with industry is established it is easier for the university to remain committed to this partnership than industry because they do not face this quarter-by-quarter economic pressures that affects decision making. Despite this Hebblewhite suggests that industry needs to prioritize university partnership over economic decisions because of the important role university plays in the sustainability of the industry.

“You need to see education as a long term strategic commitment and not something that can rise and fall on the daily commodity price variations... The fact is if you don’t support it you might come looking in a few years’ time and there’s nothing there. That’s an ongoing challenge. Two, three, and four years ago companies said to us, ‘yes, education is a top priority for and it’s a long term commitment’ but all of a sudden as soon as the economy has gone bad they’ve forgotten those conversations and we are back to short term or reactive responses. There are exceptions so I’m not casting everybody into that net”

(Hebblewhite, 2013).

The recession in 2008 and 2009 was a global phenomenon that has affected mining students at schools around the world. Not only have universities made financial decisions that affect students such as increasing tuition, but industry has had to make changes as well. A professor

at a European university describes the profound change in attitude of companies towards investment in the development of young engineers ever since the recession in 2008.

“The recession has distorted the company training development programs. They are taking much more short-term decisions. They are not looking at a person and seeing a development, I don’t think. They are looking at a person they can employ and use now”

(Anonymous, 2013).

Much like new graduate hiring, co-op student hiring is also directly affected by the economic cycles. The impact of the recession on mining students was felt dramatically during the summer of 2009 when the percentage of students who successfully secured work dropped by 13% compared to the average of the previous two summers (Miyoshi, 2014).

Co-op hiring at many mining operations disappeared completely due to the economic downturn. One of the UBC Engineering Co-op Program’s top employers, and one of the top ten mining companies in the world, saw co-op hiring drop by over 90% between the 2008 and 2010 due to a company-wide hiring freeze (See Table 1) (UBC Engineering Co-op Program).

Table 1: Annual UBC Engineering Co-op Hiring by *Company A*

Year	Hiring
2007	23
2008	24
2009	13
2010	2

However, despite the financial pressures created by the economic downturn some operations and companies have found a way to maintain a consistent rate of student or new graduate hiring and not react by cutting hiring during challenging years. Prior to their 2014 tailings impoundment disaster Imperial Metals’ Mount Polley Mine was an example of one such operation that had maintained a relatively consistent record of hiring both co-op students and

new graduates. Mount Polley Senior Metallurgist, Graeme Lamson, explains the company's strategy:

“(A)t Mount Polley we try to keep everything stable. We’ve pretty well always hired students, or at least students into mineral processing anyway, and I think the mining is fairly similar. So I think we’ve tried to do our part in not all of a sudden wanting lots of students and then few. I think some other operations are different where they take a lot of students one year and then almost none when times are lean”

(Lamson, 2013).

There is nothing necessarily unique about the Mount Polley Mine that provides it the flexibility to hire new graduates and students more consistently than other operations. Rather leadership at the mine has simply made a commitment to student development and established Co-op as part of its recruitment strategy. Each year there is money allocated to hiring Co-op students in the annual budget and they hire students regardless of the current or projected commodity price (Lamson, 2013). This kind of commitment to development of future HQP by the decision makers at one mining operation has a significant, direct impact on the attraction, development, and retention of people in mining. Up until the temporary shutdown of the mine there were at least four UBC Engineering Co-op alumni working full-time in the metallurgy department, two of whom had previously worked there as co-op students with similar, if not higher, numbers on the mining side as well, which is a testament to the success of their recruitment strategy (Miyoshi, 2014).

3.6 Impact of Cycles on Future HQP

Because of the history of layoffs in mining in response to the economic cycles, veterans of the industry have developed expectations that this is simply just part of the mining industry.

However, the people most vulnerable to the economic downturns, and most likely to leave the

industry after being laid off, are the younger workers who are just establishing their careers. However, strategically this isn't the best course of action to take as these individuals technically are your least expensive and have the greatest upside potential to contribute to the organization in the long term. Lyon attributes this simply to economic pressures:

“Company A knew they had a limited runway in terms of the aging engineering talent out there, and they needed to develop some young engineers. But then when everything went sideways (due to the economic downturn in 2008/2009) and they had to let some people go, forcing them to ‘eat their young’, as they described it. I think that’s just due to the quarter-to-quarter nature of financial reporting; it’s sometimes hard to take the long view necessary for hiring a student”

(Lyon, 2013).

However, there are also encouraging signs that leaders in the mining industry are aware of the need to do what it takes to keep HQP in the mining industry such as Gallagher. He argues that industry needs to prioritize the hiring and development of young people in the industry and that it is possible to ensure that these people make it through the downturns and continue to develop a career in mining:

“operations not hiring new engineers isn’t going to make the difference between survival and not. It just isn’t. It’s just someone from the head office saying, ‘okay, I want to see a 10% decrease in manpower or payroll,’ and so you start picking off the so-called low hanging fruit, which are the students and new graduates”

(Gallagher, 2013).

This sentiment is shared by the CEO of the third largest diversified mining company in the world, as Maclachlan describes:

“one of the things I had heard that the new CEO of Rio Tinto said was, ‘the line in the sand is new hires’. He does not want new hires to be touched. That’s the one area that there will be no layoffs and no dropping in numbers on”

(Maclachlan, 2013).

These are two positive examples of mining industry leadership recognizing the importance of developing and retaining HQP in the mining industry. However, addressing the impact of the cycles on the development of young people is easier said than done. One of the greatest challenges is that not one individual or company has to take ownership of the problem but that it is a shared challenge amongst competing companies. Without a real sense of responsibility and financial pressure to be held accountable for there is less incentive to make the tough decisions required to create positive change. Lyon suggests that the HR challenge of the industry will be treated and supported financially like a charity unless it has “some real economic pain associated with it” (Lyon, 2013). The issue today was recognized over a decade ago and many senior people in the mining industry expressed concern about this challenge; however, very little action has taken place since the beginning. According to Imperial Metals VP of Exploration, Patrick McAndless:

“everybody pays lip service to it, but they’re not doing anything about it... we need to get off the selfish horse and get on with trying to help others make this work”

(McAndless, 2013).

Mining companies have not been consistent in their hiring of students and new graduates over the years which has led to some students and new graduates choosing alternate career paths than mining. However, some mining companies have proven that recruitment can remain consistent despite the economic cycles. Without mitigating the impact of the economic cycles the mining industry will struggle to meet the projected human resources demand for HQP.

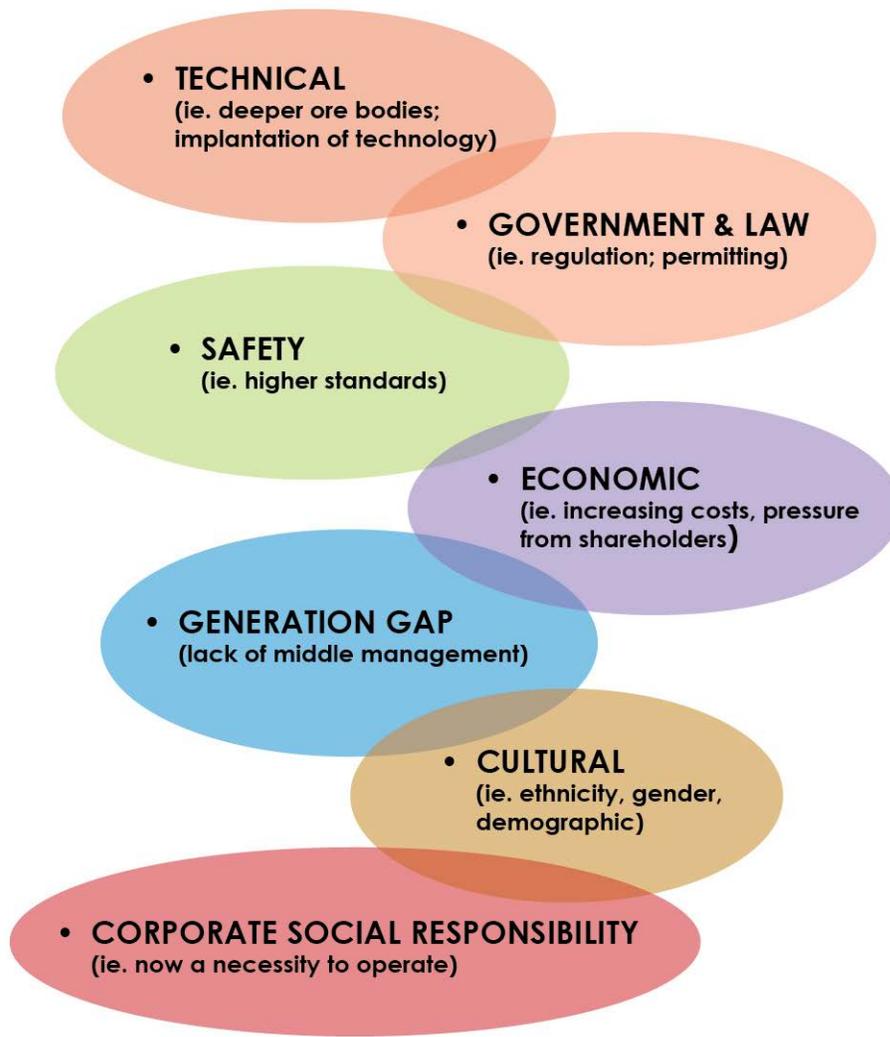
Short-term reactionary decisions have led the global mining industry into the human resources challenge that it faces today and so only long-term strategic decisions will lead it out. What it will take is commitment from leaders to make attraction, development, and retention of HQP a strategic priority.

4 Role of Mining Engineer has Evolved

The practice of mining natural resources can be traced back to the beginning of human civilization, and it has evolved over time through advances in methodology to meet demand by an ever expanding human population. Technological advances have introduced new methods of extraction and processing, such as the utilization of massive equipment in the shift to large scale operations to reap the benefits of economies of scale in both extraction and processing. Topics such as the environment, law, and safety were unheard of in mining engineering fifty years ago. A course on mining and the environment was first introduced at a McGill University in the 1970's (Scoble, 2014). The Westray Mine disaster of 1992 in Nova Scotia led to the creation of the 'Westray Bill' and subsequently to today's strict adherence to effective safety practices at mines in Canada and other parts of the world. More recently the federal government's rejection of Taseko's New Prosperity Mine in British Columbia is an example of a company not obtaining the required support of the local communities. Corporate social responsibility and the importance of earning a social licence to operate have become critical to mining companies.

Success or failure of a mining company has become increasingly dependent on the decisions made by Highly Qualified People and their ability to adapt and perform under these new realities. Clearly the role of the mining engineer has evolved. This section identifies the various pressures that the mining engineer of today faces and explores whether or not the current education system has evolved along with it. Some of the pressures facing today's mining engineer are technical, economic, legal, managerial, cultural, demographic, and institutional.

Figure 3: Evolution of the Mining Engineer



4.1 Technical

The planet is running out of many finite natural resources while demand for these has only increased. As high grade deposits become depleted more remote mines with lower grades become economically viable, shallow deposits are replaced by deeper deposits, and deposits with simple mineralogy are replaced by more complex ores that are increasingly more challenging to process (International Council on Mining & Metals, 2012). All of this puts pressure

on engineers to decide whether or not the extraction of a resource is actually feasible and to determine the optimum strategy to extract and process it. For many decades now the strategy has been to continue to utilize economies of scale while implementing new technology, such as large open pit mines like the Kennecott Mine just outside of Salt Lake City, or the Kalgoorlie Superpit in Western Australia. However, with dramatically escalating development costs in recent years there has been a focus on optimization and reduction of operating costs. The new CEO of BHP Billiton, Andrew MacKenzie described this shift as being similar to “Formula One’s search for constant improvement” (Ferreira-Marques, 2013). In terms of adoption of new technology such as automation, Australia leads the way with mines in the Pilbara Region of the country featuring entire fleets of driverless trucks. According to Schneider Electric’s solutions vice president for mining, minerals and metals (MMM) Diego Areces, “the next great leap will be less on the capital equipment itself and more on the technology progression side, seeing the full integration of Informational Technology and Operational Technology, more simple plug and play process, and most remarkably, augmented reality” (Latimer, 2013). Lastly, according to professor Erik Brynjolfsson, at MIT Sloan School of Management, data will drive operations going forward with a focus on predictive analysis and the entire chain of production (Latimer, 2014). These radical changes will require HQP to not only have a thorough foundation and understanding of traditional mining methods much like their predecessors but who will have the additional burden of developing and maintaining a comprehensive understanding of new technologies in order to best determine when and how to implement such options.

4.2 Government and Law

Governments around the world have responded to public demand to better protect the natural environment from the impacts of mining more than ever before; consequently, mining companies are facing tighter permitting and licensing procedures, increased environmental controls and expectations, and growing lists of regulations (Grant Thornton, 2013). According to an international mining survey conducted by Grant Thornton, 42 percent of executives rated that

government involvement and/or regulation was a constraint on growth and another 36% indicated that permitting and licensing procedures were a constraint (Grant Thornton, 2013). Furthermore, according to the BDO 2013 International Natural Resources Study “Environmental restrictions and regulations” was the second biggest risk facing the mining industry. However, executives specifically in the US cited that this was in fact their top concern (Dewhurst, 2013). According to Areces both the government and the community need be part of the governance of the mining company of the future:

“If you take a look at some of the countries in the world, the most important investor in some of the major companies in the world is the government... and it’s important that the government sits at the board of a mining company, for instance. I have the feeling that mining companies will have to (increasingly) involve the community and governments into the governance of the company, and I have the feeling that mining companies will have to be more adaptive to the evolution of the market”

(Latimer, 2014).

The responsibility of addressing the increasing challenge of government regulation and working with government falls on HQP. Today’s HQP need to develop a comprehensive understanding of the permitting and licensing requirements and process as well as develop the experience and ability to work with government officials at all levels in order to ensure that a project or operation has the best chance to proceed. Furthermore, many of the companies involved in the extractive industries are some of the largest and most diversified corporations in the world. Within these organizations there is demand for HQP to have a technical understanding of engineering as well as many other areas of law such as securities, tax, labour, and employment to name a few (Abraham, 2013).

4.3 Economic

Quarter-by-quarter economic pressure is an additional challenge for Highly Qualified People which can become exacerbated during challenging economic times. The response of mining executives to a drop in commodity price has typically been to implement cost reduction measures such as layoffs, hiring freezes, capital spending cuts, and the cancellation of projects. According to a Reuters report, in order to attract investors again, in August 2013, “BHP, Rio Tinto and others big and small promised shareholders they will slash billions of dollars of spending, shedding jobs, reining in wages and cutting back on fringe costs, such as staff travel” (Ferreira-Marques, 2013). The consequence of such changes at an operational level is additional pressure on senior engineers and managers to not just maintain production with fewer human and capital resources available, but to actually find ways to increase production with a smaller workforce that is potentially disgruntled by the sudden austerity measures. Layoffs and subsequent turnover can put stress on employees with people taking on additional responsibilities as well as having to spend time to train new people (Schultz & Grimm, 2014). Furthermore a high rate of employee turnover in mining due in part to the economic cycles and high employee mobility can also have a negative effect on performance (Mining Industry Human Resources Council, 2010). HQP are required to not only possess the technical knowledge and experience to run an efficient operation but also have the communication and interpersonal skills to motivate employees and deal with the human side of the equation for which there is limited training at most engineering schools (Montpellier, 2013).

4.4 Safety

Today mining operations are under pressure to maintain a strong track record of safety for which the impact of the economic cycles can present a number of challenges. Cost cutting measures in response to economic downturns such as layoffs and budget cutting force mine managers to do more with less. Having fewer experienced employees and putting unqualified or inadequately trained people into roles they are not yet prepared for can potentially lead to

mistakes being made due to the absence of knowledge, experience, mentoring and guidance (Abraham, 2013). Similarly, the inexperience or lack of familiarity of new employees as a result of the sudden onboarding of new hires in response to an economic upswing or the implementation of new technology can also impact safety. Furthermore, maintaining safety in mining is becoming increasingly more challenging as ore bodies are being found deeper underground and in more remote or politically unstable regions, presenting challenges such as ground control, ventilation, as well as social and geopolitical challenges (Ernst & Young, 2013). Due in large part to the generation gap in mining HQP today have to have the technical foundation, field experience, confidence in themselves, and common sense and wisdom to make the best decisions, without the luxury of the guidance enjoyed by their HQP predecessors in the past.

4.5 Cultural

The workforce in mining today is potentially more challenging to manage than ever before. Due to the development of a skilled labour shortage in heavy industries, mining companies have been forced to reach around the globe for talent and labour and so it is not uncommon to see mines with employees with many different ethnic origins and a wide age demographic. In Canada women and new immigrants are under-represented in the mining industry, whereas the industry is the single largest employer of aboriginal people, which is only projected to increase due to the large population of young aboriginal peoples in the hinterland and the close proximity of many of their communities to the mines in the country (Marshall, 2013). According to a MIHR report on the human resources outlook for the mining industry in Canada, “(t)he future strength of Canada’s mining labour force will depend greatly on the participation of diverse groups, such as Aboriginal peoples, women and immigrants” (Mining Industry Human Resources Council, 2013). Because of the increasing diversity of employees in the workplace, managing workforce dynamics in mining requires skills in the areas of communication, leadership, and management.

Managers have to find ways to better communicate with their workers in order to motivate them to get the work done.

Much like the impact of cultural differences, the unique characteristics of the three main age demographic groups has an impact in the workplace. The ‘Millennial Generation’ or ‘Generation Y’ that is projected to make up the majority of workers in all industries over the next few decades bring with them characteristics that are unlike their predecessor ‘Baby Boomers’ and ‘Generation X’. This can be both positive and negative when it comes to careers in mining. According to Jennifer Engels, author of *The Millennial Generation and the Workplace*, Millennials “have high expectations for compensation, rapid advancement, job flexibility or work/life balance, and meaningful and challenging work and they are less agreeable to menial work or long term commitments to a company” (Engels, 2011). Table 2 identifies the gap between some of the expectations of Millennials and the realities specific to mining.

Table 2: Expectations of Millennials and Realities of the Mining Industry

Millennials	Mining Industry
<ul style="list-style-type: none"> • Indifference towards long-term commitment to a company 	<ul style="list-style-type: none"> • HQP skillset makes them particularly mobile • Competition for limited pool of HQP • Economic cycles increase turnover
<ul style="list-style-type: none"> • Prioritization of work-life balance 	<ul style="list-style-type: none"> • Restrictive options due to remoteness of sites
<ul style="list-style-type: none"> • Expectation of rapid advancement 	<ul style="list-style-type: none"> • Necessity of experience
<ul style="list-style-type: none"> • Desire for coaching and mentoring 	<ul style="list-style-type: none"> • Limited mentoring capacity

The expectation for high compensation and rapid advancement can potentially be an invaluable tool to attract talent in an industry that features some of the highest salary averages and vast potential for career advancement. However this can also be a risk to mining engineering depending on the approach. Due to the generation gap in mining and a dearth of mid-career HQP, over the next few decades young engineers will be repeatedly tempted by the various employment opportunities for senior level roles and the generous compensation that will

naturally arise from the supply and demand disparity. The industry needs individuals who have the confidence in their abilities and have the eagerness and drive to take on the challenge and responsibility of these vital vacant positions. However, a theme identified from the data is a tendency for this generation to have unrealistic expectations as described by Guy Elliott, Corporate Risk Manager at KGHM International:

“I think there is a bit of a disconnect between the expectations of what the jobs are like, and more importantly the roles, and the rewards. Especially the demographic issue with ‘Generation Y,’ they have an expectation that they are going to get everything right away and the reality is that typically they are going to have to work ten years before they are going to be there... Getting that into students’ heads so that they are going into the job market with the right expectations is important”

(Elliott, 2013).

In an industry that features billion dollar operations involving massive pieces of machinery operating in tandem with large workforces, utilizing sophisticated technology, and faced with many potential dangers, knowledge and experience are invaluable to both production and safety. Traditionally young engineers have had to gain a satisfactory amount of experience in the field supported by the guidance of an experienced engineer before earning more responsibility within the company and receiving compensation accordingly. However, according to Pritchard, the economic boom periods can create unrealistic expectations:

“In the last couple of years we’ve seen undergraduates come in and what would typically be expected to be 3 or 4 years in a particular role, thinking its good experience, students are now expecting that after 6 months. They’ve been there, done that, ‘I can move on’. There’s been the usual ‘grass is greener on the other side’, particularly if they went through a couple years when there were multiple offers to students... Some of it is because we’ve created unrealistic expectations for people that were largely immature on

the world stage, and we had to let that play out... There are many people in industry that are saying, it wouldn't hurt for us to have a decently long downturn because the one in '09 barely hit the mining industry, so that many of the younger people in the workforce have their expectations adjusted"

(Pritchard, 2013).

The realities of career progression in the industry combined with unrealistic expectations for career progression of Generation Y increases the risk of low job satisfaction with new hires; which for a group with a skillset that makes them highly mobile, who are already low in long-term commitment to companies, and working in an industry with a glut of lucrative opportunities will lead to turnover issues (Pritchard, 2013).

Lastly, Generation Y prioritizes work-life balance more so than previous generations which may be less conducive to a career in mining given the remote location of many of the opportunities and the potential limited facilities that come with living in small towns (Elliott, 2013).

The HQP of today need to possess the cultural sensitivity and interpersonal skills to effectively work with a diverse group of people and best utilize their unique attributes as well as manage group dynamics, manage expectations and minimize attrition.

4.6 Corporate Social Responsibility

Maintaining a 'social licence to operate' has evolved from being a compliance exercise to becoming a vital competitive advantage for many companies. A good reputation can help a company to access capital or establish trust when dealing with communities (Ernst & Young, 2013).

Up until 2012 Imperial Metals had experienced challenges in establishing a social licence to develop its flagship mining project, Red Chris Mine, due to opposition from the local Tahltan First Nations (Pollon, 2012). However, establishing an Impacts Benefits Agreement and mining

tax revenue sharing agreement in 2013 with the Tahltan leaders and commitments to the local communities such as investments into educational infrastructure led to a dramatic turnaround in public support from the First Nations group by the summer of 2014 (Peebles, 2014). However, on August 4th the tailings dam at Imperial Metals' Mount Polley Mine failed spilling tens of millions of cubic metres of contaminated tailings slurry which instantly destroyed both the environment below the dam and the fragile social licence earned just earlier for Red Chris Mine (Hunter, 2014).

The support of local communities and aboriginal groups has become increasingly more critical in getting public and government approval to conduct mining related activity and a few interviewees identified the concepts of Corporate Social Responsibility and a Social Licence to Operate as important topics to teach in the classroom (Jenkins & Yakovleva, 2006). According to Gallagher, working with Aboriginal groups and local communities has become increasingly critical to his business.

“It used to be that you really have to be good with Aboriginal issues or social issues if you go to developing countries. However, it's extremely challenging to build a mine in this country. Right now, I spend 30% of my time working on First Nations challenges. I think you've got to at least introduce the concept in school. You've got to tell the students that if they want to run mines then they are going to have to work with communities, may it be our First Nations aboriginals here or may it be the people living in the countryside in Indonesia, Chile, and other places. Addressing environmental challenges is pretty straightforward now. The industry is used to meeting environmental and safety regulations. The real challenges are in dealing with the social issues and these have to be addressed early in the process too”

(Gallagher, 2013).

Many universities have begun to teach this in the classroom. At the University of British Columbia students are being taught the significance of CSR at the undergraduate and graduate level in a few courses such as *Mine Management*, *Mineral Resource Development and Canadian Aboriginal People*, *Mining and the Environment*, and *Mining and Society*. According to Gallagher, the most successful HQP will need to possess the ability to see things from the perspectives of others and have the skills to effectively communicate their own perspective as well as negotiate to reach a common goal, for which engineers may not be the best suited for (Gallagher, 2013).

“Around 15 years ago I came to the conclusion that mining managers in remote locations shouldn’t be mining engineers or geologists, they should be social scientists. When you’re trying to keep people happy, within remote locations too, you’re dealing with the communities around you.

In order to be successful in dealing with local communities and First Nations peoples you’ve got to have personal characteristics that are suited for that. You’ve got to have patience and be able to look at situations from the other person’s perspective. With some people it doesn’t matter how many courses or skills they pick up, their attitude about these situations will prevent them from being successful”

(Gallagher, 2013).

Engineer and journalist Michael Ross suggests that schools need to expose engineering students to more humanities courses to remove the structure of engineering courses and facilitate engineering students to become well-rounded human beings (Ross, 2013). HQP need to be front and centre when it comes to engaging local communities and earning a social licence. Currently the university curriculum introduces the topic, which is a start, but further development of knowledge and communication skills needs to be developed at some point in time in order for HQP to be best prepared to deal with future CSR responsibilities.

4.7 Generation Gap

The generation gap mentioned earlier is having, and for the foreseeable future will continue to have, a huge impact on the development of young engineers in mining. First, there is a dramatically reduced ability to provide mentoring and guidance to young engineers especially when compared with engineers of the past when there was a more equally balanced workforce of younger, mid-career, and older generations of engineers working together. Brian Abraham, Partner at multinational law firm Dentons, describes the current demographic phenomenon and the consequence of it on the development of HQP.

“There are the old people like myself and then you have to go right down to people with 4 or 5 years of experience. We’ve got a monstrous gap in there, and that’s hurt the industry... I think the biggest impact is that you have a lack of mentoring that’s taking place, unofficial mentoring. Like when I graduated, I had the opportunity to work with geoscience people and students; you know the whole range, from first year and second year students to people with 40 years of experience after their PhDs. But because of that gap we don’t have that whole stage mentoring system”

(Abraham, 2013).

Abraham argues that it is industry’s responsibility to provide mentoring and knowledge transfer to the next generation of engineers. His conclusion is that there will be very serious consequences of not addressing the generation gap and its impact on mentoring options.

“If we don’t (provide young engineers and geoscientists with mentoring) I think what we are going to see is people making decisions without the necessary knowledge, skill and experience, and we are going to see mistakes. We already see mistakes in our industry because people are doing things that you wouldn’t have in the past. It’s not that people are deliberately taking risks, but they are taking risks unknowingly”

The second significant impact of the generation gap on the development of inexperienced engineers are the large number of opportunities for career advancement that are projected to become available early on in the careers of young engineers in mining. Due to the large number of engineers projected to retire over the next few decades compounded by projected growth in the industry, the supply of highly qualified people will not meet demand. According to a 2013 report conducted by the Mining Recruitment Group (MRG) 39% of mining executives were planning for retirement over the next five years and that only 22% of them had any sort of succession plan in place (Jamasmie, 2013). Competition for HQP has increased over the past several years as companies around the globe compete to fill positions for engineers with the desired five to ten years of experience. Many inexperienced engineers will be tempted by the lure of higher salaries, greater challenge, and the prestige of roles that they may not be quite ready for, both technically as well as non-technically. Moreover, companies may be forced to hire someone who is not experienced enough for one of these roles simply due to a lack of alternative options. Associate Dean, Faculty of Engineering and Program Director for School of Mining Engineering at the University of Alberta, Tim Joseph, warns about the dangers of this trend:

“This generation that is graduating now, ten or fifteen years ago they would expect to move into a middle management type of position or a leadership position in ten or fifteen years. Now we are seeing people into those positions in three to five years and that scares the hell out of me. They don’t have enough experience but they think they do. The worst enemy to a young engineer is himself. They will go out into the world and they will think they know it all because they got a degree and try to tell the workforce they know it all, and the workforce will turn around and say, ‘I’m going to smack the edges off this guy and cut him down to size’ and that’s exactly what happens. There is something valuable about that learning process. Nowadays that’s been softened. Suddenly the

young engineer comes out and in a couple of years he's in a supervisory position. It's endorsing their assumption that they do know everything, but they don't... The consequence of this is that we are going to see our safety statistics fall through the floor to start with”

(Joseph, 2013).

Perhaps the best solution is to focus efforts on the education and development of young engineers and future graduating students because one day they will become the leaders of the mining industry. If we do not we will only be preparing this generation to struggle and to fail to live up to the unrealistic expectations put on them by themselves and by society. However, if we take this opportunity to nurture them and develop both their technical and non-technical skills we provide them with the tools to best be able to address the challenges they will undoubtedly face.

4.8 The Career Path to Management

While university curricula tend to focus on preparing graduates for careers of a technical nature what is identified in the data is that there is, in fact, a 'dual ladder' to career progression for engineers. The first ladder is based on gaining a wealth of technical expertise in a particular field while the second ladder is based on managing an increasingly larger number of people. “The dual ladder concept exists, but only one of the ladders has rungs” was found to be a typical comment from a study on engineering and management (Hawkins & Barclay, 1990b). Hawkins & Barclay came to the conclusion that, “like it or not, the management function is one of the main, and in some cases the only, route for an engineer to progress in terms of status and the more tangible reward of money... Almost all engineering graduates will, therefore, move into a management position at some time in their career” (Hawkins & Barclay, 1990b). This sentiment is echoed by Gallagher:

“The way I see it, basically there are three routes that students who go through mining engineering take. They leave the industry, and most do; they stay technical and be an engineer the whole time; or they go into management. If they are thinking they want to make serious money, it’s either get out of mining (which doesn’t mean don’t be an engineer) or don’t be technical, because those guys don’t make as much money. They tend to work by the hour. But if you’re not doing the technical route, then you’re going to be dealing a lot with social issues both internally and ever more externally. I don’t know if students understand that, and I think they should know that when they’re going to school and they’re thinking about what they want to do”

(Gallagher, 2013).

Executive Works President, Rosie Steeves, believes that not everyone has the personality traits to become an effective leader and that those who wish to pursue the technical route should be encouraged to do so. Steeves suggests that, “we need to make that okay for them and have a career path that goes down (the technical) road and give it as much credence and prominence as we do (management)” (Steeves, 2013). The mining industry needs technical people and supporting technical professional development is vital in encouraging people to pursue a technical career. However if, as Gallagher suggests, industry in Canada doesn’t give as much credence to a technical career as it does to management and consequently doesn’t equally reward those who choose this path, this can have serious long-term consequences for the industry as a whole (Steeves, 2013).

Many companies offer professional development in the areas of business and leadership. The largest mining companies in Canada such as Teck and Goldcorp have partnered with universities to provide MBA and EMBA programs to their key employees. However, Steeves claims that “(s)o many people end up in leadership because they think it’s the only place to go, and they should not be leaders” (Steeves, 2013). Teck Resources has a successful fifteen year

history of providing professional development in business and leadership for its technical people in partnership with the Beedie School of Business at Simon Fraser University; however, according to Prichard this might also be inadvertently discouraging people from pursuing a technical career.

“What isn’t working is a coordinated approach to encouraging advancement of technical skills... Consequently, we see a lot of our technical people developing other skills and then leaving the technical field. And that becomes a bit of a drain because you no longer have these sharp people applying themselves in the technical role and they’ve moved to more of a business role... We’re much more focused on getting that business education and advancing the non-technical skills, which makes them highly qualified, but we don’t have complementary programs to increase their technical skills... we don’t have any coordinated approach on that. It’s very ad hoc”

(Pritchard, 2013).

Pritchard suggest that there may be room to expand professional development on relevant technical topics but they would have to be fairly universal in order to have enough people interested in taking the program to justify the investment, such as project management, sustainability, water, or mineral processing (Pritchard, 2013). This presents a challenge for industry as most companies do not have the critical mass to warrant a particular course for its technical staff; however, this could be seen as an opportunity for universities. Post-secondary institutions could provide technical courses for an audience comprised of technical people from a number of different organizations. Whether in collaboration with universities or not, the mining industry needs to recognize and reward those individuals who pursue a technical career in order to encourage enough people to choose this route and meet the future needs of the industry.

The role of the mining engineer has evolved, and so not only are these individuals required to have a technical engineering foundation like their predecessors but they must develop the tools

and knowledge to address other aspects of the role such as implementing new technology to improve production; navigating environmental regulations and permitting; responding to economic and business decisions; adhering to higher safety standards; managing a much more diverse workforce both culturally and demographically; and most recently, earning and maintaining a social licence to operate.

This current generation of young people view the world differently than their predecessors. They have not only grown up in the 'Information Age' surrounded by rapidly advancing technology but also with a sense of environmental stewardship spurred by concerns over global warming throughout their childhood. Because of these factors perhaps they have the potential to revolutionize this industry with their core values, disposition, and ability to utilize the advanced tools available to them. Perhaps the next generation of leaders can learn from the mistakes of the past and steer mining companies to choose a different path, one that is more sustainable and more globally accepted and supported by both the local communities and by the general public. The challenges that the next generation of mining leaders faces are great. It is industry's duty to ensure that today's young engineers are best prepared to meet these challenges and that they are encouraged and facilitated to progress into roles, either technical or management, that best suit their disposition in order to best utilize their potential.

5 University & Industry Collaboration

This research produced a wide variety of suggestions for collaboration between universities and industry. Different forms of collaboration have had varying degrees of success. Some have been adopted by many companies and universities while many others are unique to a particular company and university. The various forms of collaboration will be discussed in the following ten topic areas: Attracting people to the industry; Different Perceptions; Introduction to Mining; Scholarships; Education; Training; Research; University Industry Advisory Committees; Recruitment Strategy; and Retention.

5.1 Attracting People to the Industry

The mining industry can be an extremely polarizing topic of discussion. There are those who understand how the industry provides most of the materials used to produce the essentials of life, the global economic significance of the industry, and the positive shift towards sustainable mining practices that the industry has undergone, and then there are those who oppose the sheer scale of mining, the environmental impact of its operations, the negative social and health impacts that the industry has had on communities in the past, and the corruption and scandals that have taken place. Perhaps mining columnist Stan Sudol sums it up best in his 2011 article, *The Horrible Reputation of Canada's Mining Sector*, "The future of mining has never been brighter, yet its image among the general population seems to have plunged lower than the famous Kidd Creek mine in Timmins, Ontario – the world's deepest base metal operation" (Sudol, 2011). The mid- to long-term career projections indicate incredible career opportunities for young people; however, "the sector is currently viewed as an unattractive career option to young graduates and professionals as it is in cyclical decline" (Ernst & Young, 2014).

Disasters such as the Mount Polley Mine tailings dam breach is a stark reminder of why it is important to ensure the safety of workers and the protection of the surrounding natural environment (Hunter, 2014). Today simply being associated with a natural disaster such as this

dam failure carries a stigma with it, and can have a devastating impact on the number of people who decide to pursue a career in the industry.

The ability of universities to attract students into mineral extraction related programs is tied to their preconceived views of the extractive industries at the time. This viewpoint evolves over time through various influences such as general media, and so it is essential for industry to develop and maintain a positive image if companies want to ensure the availability of a pipeline of talent.

“The reputation of a company is impacted not only by its most recent performances but also by the sector as a whole. In addition, community expectations on what constitutes acceptable risk are rapidly changing and the biggest challenge mining and metal companies now face is how quickly they can respond to changing community attitudes”

(Ernst & Young, 2012).

Although, in the end it is a university’s job to attract the best and brightest high school graduates to enrol in their schools, it is industry’s responsibility to create awareness of the extractive industries and, where possible, develop positive public perception. The industry has made some significant progress since the turn of the century as a consistent increase in student enrolment in mining engineering programs in North America and around the world over the past decade would suggest. However, the data suggests that there is room for improving public awareness of the sector such as at the high school level. Goldcorp Director of Human Resources, Jenine Ellefson, suggests that there is opportunity to educate the educators:

“Often the career centres that are helping people decide career paths even they are not aware of what opportunities there are... I’m not sure if everyone is quite up to speed as they should be.

Definitely at the high school level there is real lack of knowledge there. Probably better

knowledge at the university level but I still don't think there is much appreciation of how much mining business goes on in a place like Vancouver, or in Canada in general and how important the industry is in Canada"

(Ellefson, 2013).

This general lack of awareness of mining is not a specific issue at high schools in Canada or North America, but rather it is a global phenomenon. One university professor echoes the sentiment that there could be significant improvement in the education of high school teachers and guidance counsellors in the UK as well.

"High schools are dreadful at telling (students about careers in mining). They can tell a student to go to university and study maths or physics. They don't know about telling a student to study mining engineering, they don't know anything about it"

(Anonymous, 2013).

To address the challenges with recruiting high school graduates into mining engineering the Mining Department at the University of New South Wales has partnered with industry to provide a number of initiatives to attract high school students from all over Australia as Hebblewhite explains:

"Once a year the university has an open day and so students from high schools all over, not just Sydney, but from further afield come along to that. The rest of the university is just all about the academic program and what the university degree is about but we actually invite industry people to come along to that to start filling in the gaps a bit more about what a mining engineering career means as well as just starting to talk to them about their companies... We run a high school summer school each January for a week where we call for applications from kids in year 10 and 11 at school going into grades 11

and 12, the last two years of school. We got about 100 applications last year and we took 35 students. We have a day at the university and then we go around mine visits. The mining companies actually support us there and we get some sponsorship from mining companies to expose them to what mining is all about. That's been a real positive initiative in opening kids' eyes to opportunities... We run a series of regional dinners around different parts of the state where we will put on a dinner and send out invitations to all of the local high schools for anyone interested in the mining industry. It's mostly for students but sometimes so teachers and parents come along”

(Hebblewhite, 2013).

Some companies in Canada have also recognized the need to educate the general population in order to attract people to the mining industry. Management at Cementation Canada have taken it upon themselves to educate the educators about the mining industry by annually inviting Ontario teachers to learn about the mining process first-hand from geology and exploration to production, mineral processing and mine site reclamation (Ontario Mining Association, 2014).

Slack explains:

“Each year we get a group of 40 to 50 teachers and we introduce them to mining. Over a four day period we take them underground and introduce them to mining. Most of these teachers are not involved in mining at all. They could be geography, science or any area. The whole purpose is that these teachers can go back to their students with a better understanding of the mining industry, possibly include it in their curriculum, and most importantly they hopefully come away with a positive image of the industry. We are trying to make sure that students at a high school level recognize the opportunities in our industry and hopefully we have more people interested”

(Slack, 2013).

Industry associations are also developing public awareness of the industry to encourage more people to consider a career in the sector. By providing labour market research and future hiring forecasts specific to the mining industry the Mining Industry Human Resources Council provides tools for industry to reach out to the general public and educate them on the vast career opportunities in the industry. More locally government and industry groups such as the BC HR Task Force provide career information specific to the mining industry in British Columbia and organizes events to engage and attract people to mining. Ellefson suggests that outreach can be more successful through industry collaboration with universities.

“I don’t think the mining industry necessarily does a great job always of promoting itself. Especially outside of the typical mining specific disciplines I think that’s an opportunity for the mining industry to do a better job of partnering with universities, and with schools in general, to let people know what it is like to work in the mining industry and what kind of opportunities are available because I don’t think that people even know that it is a career choice... I think the responsibility does lie with the mining industry itself but it is helpful to have that partnership with universities”

(Ellefson, 2013).

There are many ways in which industry and universities are reaching out to the general public to create awareness and attract people to the mining industry. Companies must continue to work with universities to attract people to the industry during good times, but more importantly through bad times, as that is when there is the highest risk of losing people who may never come back to the industry.

5.2 Different Perceptions

A 2012 McKinsey Report on education and employment in general, not specific to mining education, identified a number of areas where there was a clear discrepancy between the

perceptions of the education providers, the actual student experiences, and the perspectives of industry. Professors at universities were out of touch with the concerns of prospective students and the needs of industry. This is could be a significant opportunity for the extractive industry to capitalize on to attract people to the industry. The study revealed that student survey respondents felt that they were not well informed about the availability of jobs or the level of wages in their chosen industry and it discovered that less than half of them would study the same subject again if they had to do it again. Furthermore, almost half of respondents were not familiar with market conditions in their chosen field and had chosen courses “half-blindly” and without considering where demand will be (Mourshed, Farrell, & Barton, 2012).

The study also discovered that educators were also clearly out-of-touch with the realities of the job prospects of their students believing that nearly three quarters of the students were successful in securing work within three months of graduation when in reality the number was closer to half (Mourshed et al., 2012). The study suggested universities should prioritize the successful employment outcomes of students more.

“educators could pay more attention to what is for many students a key priority of pursuing education—getting a good job. Far too many of the providers we spoke with did not understand how they could contribute to improving the current education-to-employment system, or even see it as part of their role. They need to begin to figure this out, or they will lose their most important constituency—the young.

Too many of the young people we spoke to doubted the value of their education. In the short term, that can translate into discouragement and disengagement. In the long term, if young people do not believe that education will deliver returns, economic as well as intellectual, they are not going to pay for it. It is in the interest of providers themselves, then, to do more to help. For example, only half of the youth surveyed believe that their postsecondary education had improved their chances of securing employment”

(Mourshed et al., 2012).

By providing this information and better facilitating employment success upon graduation, mining departments and industry could capitalize on student uncertainty to attract more people to the mining industry because of the projected future demand for skilled people, the higher than average salaries, and the relatively high rate of new graduate employment. What companies and universities would need to do is track statistics on alumni from various institutions, compile a report on the career successes, and disseminate this information as Mourshed et. all suggest:

“Imagine what would happen if all educational institutions were as motivated to systematically gather and disseminate data regarding students after they graduated—job-placement rates and career trajectory five years out—as they are regarding students’ records before admissions. Young people would have a clear sense of what they could plausibly expect upon leaving a school or taking up a course of study, while education institutions would think more carefully about what they teach and how they connect their students to the job market”

(Mourshed et al., 2012).

A compensation survey conducted by PayScale Inc. in 2012 brought a lot of positive attention to careers in the mining industry when it revealed that “Harvard University’s graduates are earning less than those from the South Dakota School of Mines & Technology” (Richter, 2012). Despite Harvard student tuition fees being almost four times higher than their South Dakota counterparts, their graduate starting salary average was \$54,100, whereas the average salary of the 2,300 graduates from South Dakota was \$56,700. Besides the high salaries, universities in collaboration with industry should collect data on employment rates, career opportunities, and career progression as well as describe lifestyle choices and travel opportunities afforded to people who have had success by pursuing careers in the extractive industries in order to be as competitive as possible.

This suggestion is supported by the recommendations of a 2013 US study on Emerging Workforce Trends in the U.S. Energy and Mining Industries that found that public negative perception of the extractive industries in the US dissuades some people from pursuing a career in the industry.

“National industry organizations, in partnership with educational institutions, should embark on a national campaign to create and provide accurate and timely information on the industries and their careers, educational and career navigation resources, and experiential learning opportunities to explore jobs and career paths in energy and mining... national industry organizations and educational institutions should also embark on an informational campaign to educate students, parents, educators, and public policy makers about the importance of the energy and mining industries to our economic and national security, the relevance of STEM education to jobs and careers in these industries, and the opportunities available in these industries”

(The National Academy of Science, 2013).

What universities and industry are lacking is a collaborative marketing strategy. It may be simply a matter of organizing, collecting data, and putting together a marketing tool that can be used to attract the best and the brightest students to the industry.

5.3 Introduction to Mining

When it comes to knowledge of the mining industry in most cases high school graduates are a veritable ‘tabula rasa’ (a blank slate). New students tend to have developed a few limited perceptions of the sector through media such as Hollywood’s interpretation of mining in movies like the 2008 blockbuster *Avatar*. According to Hebblewhite, “(m)ost high school kids don’t even know that there is such a thing as a mining engineering discipline. Sure they hear about the mining industry in the media but they have no idea that there is such a thing as a mining

engineer” (Hebblewhite, 2013). This can be viewed as a great challenge to attract people to the industry or a great opportunity to educate people on the rewarding career opportunities available.

For the majority of young engineering students at university who are still learning about the various opportunities available to engineers, their first experiences being introduced to what modern mining is all about will go a long way in helping them determine their eventual career path. Traditionally, at university the companies that come to campus and engage students early on end up receiving the most interest in their operations when it comes to group projects topics and co-op applications (Maclachlan, 2013).

What management at companies need to remember is that every year a new cohort of students enters university and this process of introducing ‘green’ students to mining begins again.

Therefore, companies that have a strategic recruitment plan in place and commit to maintaining a presence at particular campuses every year, especially during tough economic times, will develop a competitive advantage when it comes to being top of mind to students when recruitment needs arise. According to Maclachlan, “companies need to recognize that students are very aware of who supports them and who doesn’t... Continuous engagement is what keeps a company on the student radar” (Maclachlan, 2013).

Attracting people to the mining industry can take on various forms each requiring differing levels of commitment and amounts of resources. The bottom line for the mining industry is that with the forecast for large scale demand for workers combined with a dramatic retirement projections, an injection of new workers is vital to the sustainability of the industry and requires the efforts of both the people working in the industry and at educational institutions.

5.4 Scholarships

University scholarships come in many shapes and forms but the goal is usually the same: to attract, support, and/or retain students. Designed and executed well, a scholarship can lead to

the attraction and retention of amazing talent that might have otherwise ended up studying something different. However, designed and executed poorly a scholarship can potentially do irreparable damage to a company's reputation despite the best of intentions.

In collaboration with the University of British Columbia, Rio Tinto put together a set of annual scholarships to attract and engage students in mining engineering and geological engineering ("Rio Tinto Scholarship," 2006). This scholarship was unique in that it was only open to students enrolled in the Engineering Co-op Program and included a potential four or eight month work term along with a monetary award. The scholarship was offered each year to two students in mining engineering and one student in geological engineering in second- or third-year of their studies. The monetary award was a sum of \$6,000 per year for the remainder of their undergraduate degree, which typically meant there were three payments totalling \$18,000 by the time the students graduated ("Rio Tinto Scholarship," 2006). From a student perspective the prospect of such a large sum of money combined with work term opportunities with one of the world's largest diversified mining companies was extremely attractive; consequently the company managed to attract some of the top students in these disciplines to apply to the scholarship each year. The first few years saw great success as high achieving students were selected for the scholarship and subsequently ended up working at various Rio Tinto operations in Canada and other countries. During economic boom periods Rio Tinto was successful in filling many full-time and student roles with high achieving new graduates and students whereas some other companies struggled (Hendricks, 2014).

However, the economic downturn in 2008 dramatically affected Rio Tinto overall. In an effort to reduce costs the company ended up disbanding the Copper Division based in Vancouver, instituting a company-wide hiring freeze, and laying off thousands of employees worldwide. The impact of the hiring freeze and the loss of the Vancouver office on the scholarship program were profound. The scholarship eventually was passed on to people unfamiliar with the history and impact of the scholarship and it lost its momentum and continuity. The scholarship continued to

be offered to students each year for the next few years; however, during this period none of the scholarship recipients ended up being hired on with the company despite applying to the occasional job posting appearing on the company website or on the co-op job board. Three years later two co-op students were hired by Rio Tinto to work for the company; however, they ended up being non-scholarship recipients despite the fact that scholarship recipients had applied for the positions earlier. This oversight was due to a lack of communication from head office to the people at the operation regarding the existence of the scholarship program.

Rio Tinto had fulfilled all of its monetary commitments to the scholarship winners and scholarship recipients were never guaranteed work terms with the company; however, having heard the success stories of the previous scholarship winners the latter group eventually began to harbour resentment towards the company due to the lack of work opportunities, a perceived lack of communication, and some disorganization during the handover process of the scholarship. Unfortunately, there are two cohorts of scholarship winners that never had a chance to work for the company during the remaining three years of their undergraduate degree one of whom admitted he/she will never work for the company despite having benefited financially by receiving \$18,000 in awards from the company over three years.

However, this same scholarship has also led to numerous success stories such as two class of 2009 UBC mining engineering alumni who still work for Rio Tinto today. They both completed multiple work terms with Rio Tinto both at site as well as in the Vancouver office, have remained with Rio Tinto since graduation and have progressed into roles of increasing responsibility and seniority. Five years after graduation the scholarship investment of \$18,000 each looks like money well spent by Rio Tinto considering the successful employment of these two HQP.

Class of 2010 UBC Mining Engineering alumnus Jeffrey Duck completed all five of his Co-op work terms at various operations and offices within Rio Tinto and eventually was hired on after graduation despite graduating in the midst of the recession of 2008/2009. It was his co-op supervisor who recognized the potential of this student and who fought to ensure that the

company did hire him after graduation despite a company-wide hiring freeze at the time. Jeff Duck repaid his supervisors efforts a few years later with his contribution while working at the Bingham Canyon Mine in Utah.

The Rio Tinto scholarship was cancelled at the end of 2011. Upon hearing the news of the cancelled scholarship Jeff wrote an impassioned letter to the company as both a current employee and a former co-op student to persuade management to reconsider their decision and reinstitute the scholarship. Below is the email sent by Duck that describes the impact that the scholarship had on his career and enabled him to contribute to the company:

Excerpt of an email from Jeff Duck to Rio Tinto HR regarding the cancellation of the Rio Tinto Scholarship at UBC:

... I apologize that this email doesn't come in a better tone, but I have received some rather disturbing news regarding Rio Tinto and I'd like to reach out to you about. I apologize for the length of this email but I'm passionate about this subject.

Recently, I attended a networking event at UBC in Vancouver and represented Rio Tinto. I was approached by UBC and informed that a decision was made to no longer offer a scholarship to UBC mining engineering students. It's no secret that this news upset me greatly.

As you are aware, in 2007 you interviewed me at UBC for this scholarship and chose me over some pretty stellar competition. Since then I have had the privilege to work at Diavik and IOC in Canada, the latter giving me the chance to be a short range planner for 5 open pits while still being a student. Since then I transitioned to Copper Projects (once headquartered in Vancouver) and worked under Allan Moss for 2 years. Under Allan I received amazing opportunities to grow as a professional while seeing the world. I contributed to the Oyu Tolgoi Pre-feasibility study (as we know, this is Rio's flagship construction project) and re-designed and implemented a geotechnical monitoring system at Northparkes. More recently, I managed the Order of Magnitude study to finally take Bingham Canyon underground. Many times (for almost 20 years!) this was attempted with no success - there was quite a resistance to transition to underground here at

KUC. Needless to say. I completed this report (with help from some amazing people) and obtained funding from the IC in London even though senior Rio Tinto people (names withdrawn) told me I would fail. Now we have nearly 1000 feet of underground development, a team of 40 very talented individuals, and best-in-class technology and equipment. Of this current project, none of it would of been possible without me. As humbling as that statement sounds, it is true. Only 2 of us worked on this project and we were both crucial in its success. What I never tell people about my journey at Rio Tinto is that in 2007 I almost dropped out of university due to financial troubles and it was the scholarship that kept me in and introduced me to great people who have helped me achieve things far beyond my experience.

I do not know if you're the right person to contact but a decision in Montreal was made to cancel this scholarship. I am reaching out to you because I see this as a mistake and investment in building better mines tomorrow starts with finding the best young engineers today. Hopefully this email gets the ball rolling on overturning this decision. I'll be the first to admit that the scholarship program was broken and I can see the reasoning for its cancellation, but with a bit of work it can be fixed and it can bring amazing future leaders to this company. Thanks for your time in this email. I look forward to finding a resolution to this matter.

Regards,
Jeffrey Duck

This scholarship has helped nurture rising star mining engineers to reach their potential and enable the company to retain such talent for long tenures. However, it has also unknowingly led to negative impressions as well simply due to miscommunication within the organization. These two extreme opposite results support the argument that developing a strategy for scholarship design and implementation and securing long term commitment to ensure the effectiveness and sustainability of it are essential for its success. When it comes to scholarship programs good intentions are not enough.

Scholarships have also been utilized to educate local people in developing countries for future HQP roles in their home country. New Gold VP of Operations and former CEO of Inmet Mining,

Ernie Mast, describes the solution to address the shortage of mining workers for their project in Panama during his time with Inmet.

“We decided to send 4 - 5 students a year for any engineering in North America, but hopefully mining, metallurgy, or geology... every year there's been a group of 3 or 4 that are going to (the University of) Reno... (F)or the Master's students, what we did is we found all the Panamanians who finished an engineering degree in the United States and said, 'would you like to do a Master's?'... (W)hen the mine starts up in 2016 we're going to have at least 8, 12, or 16 young Panamanians that are going to be HQP's. We had no other way of getting that because the quality of the local universities was inconsistent... We did that for a few reasons. One is, we were really developing the future managers of the site. At first, nearly everyone would be an ex-pat but one of these kids we are hoping one day would have had my job. And the other reason was, at the end we realized it was cost effective. It cost a lot to take each student and send them to the US or Canada. But we saw down the road with each of those replacing an ex-pat, it sort of paid itself off in 2, 3 years...”

(Mast, 2013).

In many cases the rewards of a successful scholarship can far exceed the financial costs. The benefits of well executed scholarship program will not only benefit a company but can have a positive impact on the mining sector as well. According to Gallagher, “I think we've got to work harder to attract people to the industry, and I think scholarships are going to be one way to get people” (Gallagher, 2013). The success of a scholarship lays not necessarily in the monetary amount but rather in the strategy behind it and the investment of resources into the process. Planned and executed well the potential returns are unlimited.

5.5 Education

Perhaps one of the most consistent themes that emerges from the data is a desire to increase industry involvement in curriculum content and delivery. Faculty and staff at post-secondary institutions recognize the importance of not just providing students with the requisite fundamental theory but also to include relevant case studies, and the latest modern techniques and technologies, which only professionals currently working in industry can provide. Students mirror this in their responses including more industry participation in the classroom and laboratories, having industry experts share their experiences, and provide real world situations and the resources that come with it. Lastly, it is also clear that companies desired more input into the curriculum and are willing to provide resources and expertise to support classroom lectures.

One of the challenges brought up by a few interviewees is the heavy course load that came with studying engineering at university. Because engineering students' schedules are filled with lectures and laboratories there seems to be limited room to add any other courses; however, others question the relevance of some of the current core courses. Bruce Butcher, VP Technical Services with Aura Minerals questions the amount of mathematics currently required.

“Do students really need that much applied maths? Particularly in mining? I can only remember one instance in my entire career where I actually used calculus to solve a problem. You spend hours and hours and work hard in calculus in school. I know it's kind of about training the mind or training the engineer how to think and how to solve problems with all of the available tools, but if it's just a training technique why not alter it into something more practical?”

(Butcher, 2013)

Lyons suggests providing students with more freedom to choose courses relevant to their chosen career path.

“...did this person have to take three electrical engineering courses given with the path they were going? Perhaps they could have taken two electrical engineering courses and there would instead be a business development entrepreneurship 101 course that’s necessary for engineers as well too... I get that there’ll be some differences between various countries, where we want to make sure engineers are good enough to be employed in England, Australia, US, what have you. But surely there’s got to be some ability, some nuance there where we can say, well honestly, what would Teck want?”

(Lyon, 2013)

Not surprisingly interviewees from industry expressed interest in having more input in engineering curriculum to cater the education of students to better meet the needs of companies. However, students are also supportive of the industry presence in the classroom as Crook describes:

“At UBC, the professors rely on their friendships and their contacts to bring in guest lecturers. And I’ve noticed that that is a very important part of learning. Some of the things that I enjoyed the most and I learned from the most were actually those guest lectures, whether it’s just having a different voice, or maybe it’s the weight or authority that someone from industry carries. Even just having a different person, so you’re not listening to the same person all the time. You get interested when someone comes in, and that’s some of the stuff I remember the most from any of the classes and they do a pretty good job of that. I would like to see more of that”

(Crook, 2013).

Ramsay Hart, Program Coordinator with MiningWatch Canada suggests that exposing students to a wider variety of perspectives on particular mining issues would help students to become

more sensitive to the nature of different types of conflicts and possibly better prepare them to work with communities if and when they become HQP in the future.

“we would certainly like to see more variety of perspectives brought to bear in the training of highly qualified people. Diverse perspectives from the social sciences and things like that... I think the sooner people get exposed to the range of perspectives and views on the sector, the better. So I think certainly within academic institutions, it’s quite appropriate. I think diversifying the perspective that people are exposed to and really trying to understand why you might have community opposition from two mines, and that it’s not just based on ignorance and knee-jerk reaction. Any kind of presentations or first-hand experiences or exchanges that could be done that would give people a greater sensitivity and greater awareness of community level concerns about mining I think would be beneficial”

(Hart, 2013).

It is academia’s role to educate the undergraduate and graduate students; however, industry plays a significant role in ensuring that the curriculum prepares the students for the challenges that they will face and so it is essential for universities to continually seek input from industry to some degree when it comes to the education of engineers and for industry to participate and support the programs.

5.6 Training

Industry seeks engineering graduates who have work experience; however, they are also the gatekeepers to the work experience students hope to gain prior to graduation. If industry were able to create capacity to hire every last university student considering a career in the mining industry then companies would have the luxury of hiring their next employee from an entire graduating class with relevant work experience and who are better able to transition to the

workplace because of it. The interviewees all agree that companies benefit from co-op because new graduates are better prepared for the workplace, as Ellefson describes: “When I went to school ten years ago there wasn’t co-op in my area of study. This has been a really important shift that really assists new graduates to be job ready” (Ellefson, 2013).

In the end it is up to industry to determine their level of commitment and how much capacity they have to hire co-op and non-co-op students each summer as well as throughout the year, which will then determine the amount of work experience students have when they graduate. During economic downturns many students are unsuccessful in securing work in industry consequently they eventually graduate with little or no work experience and possibly develop a negative perception of job prospects in the industry and decide to leave the industry altogether. Conversely, if companies find a way to increase capacity to hire all students and provide positive work experiences this will lead to all graduates having work experience and positive perceptions of the industry, which should potentially lead to greater retention of HQP.

Companies that provide young engineering students with experienced supervisors who either have had training or inherently have the skills to facilitate a quality work experience have an advantage when it comes to hiring the top students after graduation. Not only have these companies had the opportunity to judge the student worker over a four or eight month period but they also are in an advantageous position to encourage a student, who happens to be a particularly good fit, to sign on with the company after graduation. This is perhaps the greatest advantage a company can have when it comes to the retention of new hires. Theoretically, familiarity between the employer and new graduate should dramatically reduce attrition. Compared with working for an unfamiliar company after graduation, a student working for a company he/she completed a four or eight month work term at should have well developed expectations of the position, work environment, coworkers, and culture meaning to greatly reduced risk of unpleasant surprises.

Perhaps industry can leverage its influence with government to increase capacity for training. In Saskatchewan, the International Minerals Innovation Institute (IMII) is looking to fund programs at colleges and universities designed to train students for the mining industry. IMII is a collaboration of six mining companies and the provincial government with the goal to encourage people in the province to start a career there (Crane, 2014). According to Marshall Hamilton, vice-president of human resources at Mosaic Company, “(b)y offering these programs in Saskatchewan, people are staying in the province to get their education and it encourage them to work and live in the province; there are great opportunities for people to put their training to work” (Crane, 2014).

Whether independently or supported through collaboration with government the payoff of investing in the training and development of students and new graduates can be significant if done well.

5.7 Research

When it comes to research universities and industry have an extensive history of collaboration. For the purposes of this study this section will focus on the impact of research collaboration on the development of HQP.

At the undergraduate level, many students have gained technical work experience working on a research project directly through their department, industry, or a collaboration of both. Students increase their technical knowledge and skills, develop their portfolio, and expand their professional network; consequently, they increase their ability to secure work in the future. Meanwhile companies are able to identify priority recruitment candidates and professors can identify potentially strong candidates for graduate studies.

At the graduate student level research collaboration is even more common as research is a requirement of many degrees. In many cases students research a particular area under the guidance of a professor, sometimes in collaboration with industry. However, in other cases there

is a more formalized research partnership program established. One example of a successful research partnership program between a university and industry is the Mineral Deposit Research Unit (MDRU) at UBC, which facilitates collaborative research with one company or with multiple companies on a shared research interest. According to John Thompson, Director of Geoscience BC (former director of MDRU and VP Technology with Teck Resources):

“(MDRU) is a phenomenal example of a program. It started with a bit of seed money from NSERC and some industry money and has been a standalone fully-funded research organization for 20 plus years. That’s a phenomenal track record. It has run programs of several million dollars every year throughout that period with multiple 10s of students, post docs, and research associates. It’s a standout case of what can be done in a collaborative environment...

As they become more successful it has become easier as more and more good students want to come there because of the access to industry. Success breeds more success... There are people at the VP level, senior technical people, CEO’s of smaller companies, consultants, and researchers who came through these programs. So I think there is pretty strong evidence that these really do produce very capable people and more typically on the applied end. It would be nice to document that better... Anecdotally, I think the evidence is pretty clear that it’s been a great success.

From the student’s perspective the advantages are obvious because they get exposure, in the collaborative sense, to sometimes ten or 20 companies but often at the very least five companies, and if they are good they stand a chance of one of them picking them up even if times are tough, and if times are really good they could have five competing companies. It’s a great environment for the student”

(Thompson, 2013).

In Canada, organizations such as the Canadian Mining Innovation Council (CMIC) facilitate problem solving of bigger resource industry challenges through broad-based collaborative projects that involve multiple companies and students. This reduces the risk to the individual company and students potentially get access to a wider network of companies, peers, and faculty (Thompson, 2013). More generally, organizations such as Natural Sciences and Engineering Research Council of Canada (NSERC) provide funding for research in the sciences and engineering while Mitacs provides funding for internships and fellowships. So there is support for research, however this has not necessarily translated into a lot of mining research conducted in Canada. Lamson senses that the level of research in Canada has decreased over the past two decades:

“The (Australian and South African) companies pour a lot of money into (R&D). And you know, it’d be nice if the Canadian mining industries did a little bit more of that. A lot of our research is gone... the mining industry (in Canada) had really strong research programs up until I think about the ‘90s. Companies like Cominco, Inco, Placer all had research centres. And then they all started getting rid of them in I think it was the early ‘90s... it’s kind of a shame because from what I can see, there really hasn’t been as much development as there could be... It’s due to money because after exploration it’ll probably be one of the first things which is cut”

(Lamson, 2013).

Research and development in Canada is lagging behind other developed countries according to ATB Financial Chief Economist Todd Hirsch. In a 2014 Globe and Mail article he describes a disturbing trend in research and development funding in Canada. Not only is the total amount spent on R&D in Canada quite low it is mostly funded by government: According to Hirsch, “(a)t 1.74 per cent of GDP, we lag behind countries including the U.S. (2.77 per cent), Sweden (3.37 per cent) and Finland (3.78 per cent). Israel, a powerhouse in innovation and creative design,

tops the list at 4.38 per cent” (Hirsch, 2014). World Economic Forum chief economist Jennifer Blanke reveals that “Canada's private-sector spending on research and development ranks just 27th in the world, while university/industry collaboration on R&D ranks 19th” (Parkinson, 2014). Hirsch points out that the source of research funding and how it has changed over time is particularly interesting:

“The source of funding for scientific research is dominated by government... the overall tax dollar-funded contribution for scientific research is about 81.4 per cent. Canadian business enterprises make up a relatively small source of funds for research, accounting for only 8.1 per cent of funding.

Even more troubling than the low level of business contributions is that it's been falling over time. As a percentage of total R &D funding in the higher learning sector, it has slipped from 9.6 per cent in 2000-01 to 8.1 per cent in 2012-13... This drop in business funding has been particularly acute in British Columbia. Business contributions in that province have collapsed from 10.4 per cent at the start of the millennium to a mere 4.8 per cent last year”

(Hirsch, 2014).

According to Harvey Weingarten, President and CEO of the Higher Education Quality Council of Ontario, who was a member of the Council of Canadian Academies panel on The State of Industrial R&D in Canada, too many Canadian executives do not understand the value of research and development because in this country they tend to have business rather than technical backgrounds (Hemmadi, 2014):

“If you look at who the CEOs of companies are, in the United States they tend to be engineers, and in Canada they tend to be MBAs and businesspeople. If you look at the total number of researchers and scientists in Canadian companies versus other

countries, we have a lower percentage of scientifically-trained and research-trained employees in Canada relative to other countries”

(Hemmadi, 2014).

Moreover, according to a 2014 report by PricewaterhouseCoopers on the state of the mining industry reveals that investment in R&D in mining is particularly low and is a global phenomenon. Compared to other industries, mining is a very conservative industry in terms of R&D investment. Only nine mining companies are included in a recent survey of the world's top 2,000 companies by R&D investment (PwC, 2014). This low level of investment in research by industry means that there should be great potential for companies to increase research collaboration with universities in all industries. Research collaboration can reap benefits for students, academia, and industry alike. Initiatives such as MDRU provide some significant examples of research collaboration developing HQP in the mining industry. Universities need to seek out opportunities to collaborate with industry just as much as industry needs to seek help from universities, and it appears that there is plenty of room for industry in Canada to increase their contribution.

5.8 University Industry Advisory Committees (IAC)

A message that is clear from the data is the importance of having the interest and commitment of top decision makers of organizations to provide consistent support to help university programs weather the economic cycles. It is not always possible to have the top decision maker represent a company but rather he/she can designate someone to represent the organization. One vehicle where these representatives can have a significant impact is involvement in an Industry Advisory Committee (IAC) for a particular department at a university. Some university departments have set up an IAC to assist in responding and adapting to the changes in the industry and provide an industry perspective and in-market expertise on key department initiatives. One of the challenges of developing an IAC is identifying potentially interested executives or senior industry people to represent an organization, managing to catch their

interest and having them see the value in participating, and then developing and maintaining a relationship that is mutually beneficial. Ellefson discusses participation in an IAC and one of the challenges with this for mining.

“Involvement in an IAC is from a connection. We have involvement in a number of universities worldwide where people’s alma mater is. I don’t think it is a good idea to pressure it unless someone has an interest in it. One thing that makes things difficult is the fact that our locations aren’t where people went to university. That’s a bit of a challenge because the mining industry is so global”

(Ellefson, 2013)

Not surprisingly many of the members of IACs at universities in Canada are alumni of those respective schools. One route to identifying potential candidates is to search through a department’s records for particularly influential alumnus from a variety of organizations. The experience that a student has during his/her formative years at university can be vitally important factors in making career decisions and can have a huge impact on their future engagement with their alma mater. One can postulate that someone is more likely to contribute and participate if they feel that they received value in their time at university and so it is in the best interest of schools to ensure that graduates leave with a real sense of value and connection with their alma mater.

“When I came out of UBC and was hanging around this part of the world I met engineers from other schools in Canada... When I’d listen to what these guys studied, even then as a young kid, I felt the curriculum that UBC had was so much superior... I was pretty impressed with the curriculum. I didn’t know any better when I was taking it and only realized this was once I got working”

(Gallagher, 2013).

And it is these motivated alumni, who due in part to their post-secondary education have achieved career success, that can bring back to the university both clout and leadership through involvement in an Industry Advisory Committee. For example, according to UBC Mining Engineering alumnus, Gallagher, “it is fundamental to have an industry advisory committee and I would fully support that and be prepared to serve on that if invited” (Gallagher, 2013).

The make-up of an Industry Advisory Committee can have some profound effects on the university, departments, faculty, and students. The University of Alberta has a successful IAC made up entirely of senior executives and has managed to maintain this through strong leadership as Joseph describes:

“One of the big successes for us at the University of Alberta is our Board of Directors. We have an Industry Advisory Committee which is essentially a board of directors led by a very senior industry person who has now retired, a former Mining Association of Canada President, a former president of a major corporation in Canada, and he has led us for over 20 years. He is still our board of directors chair. If he says we are going to do this, everyone sitting around that table, and we have 17 industry representatives who are all VP or higher, are going to say ‘of course we are going to do this’. And the jobs are there, the support is there. But it’s establishing that... it takes one very strong industry person to take the lead and be the chair. They will bring together everyone else”

(Joseph, 2013).

The impact of having senior people and decision makers on a university’s IAC can have a significant impact on the experience of a student. The University of Alberta has such a strong commitment from its industry advisory committee for mining that virtually all of their co-op students and new graduates secure work by graduation regardless of the economic cycles.

“Our success rate for placing summer and co-op students is still in excess of 95% placement for all students. It’s 100% placement for Co-op for the last 20 years”

(Joseph, 2013).

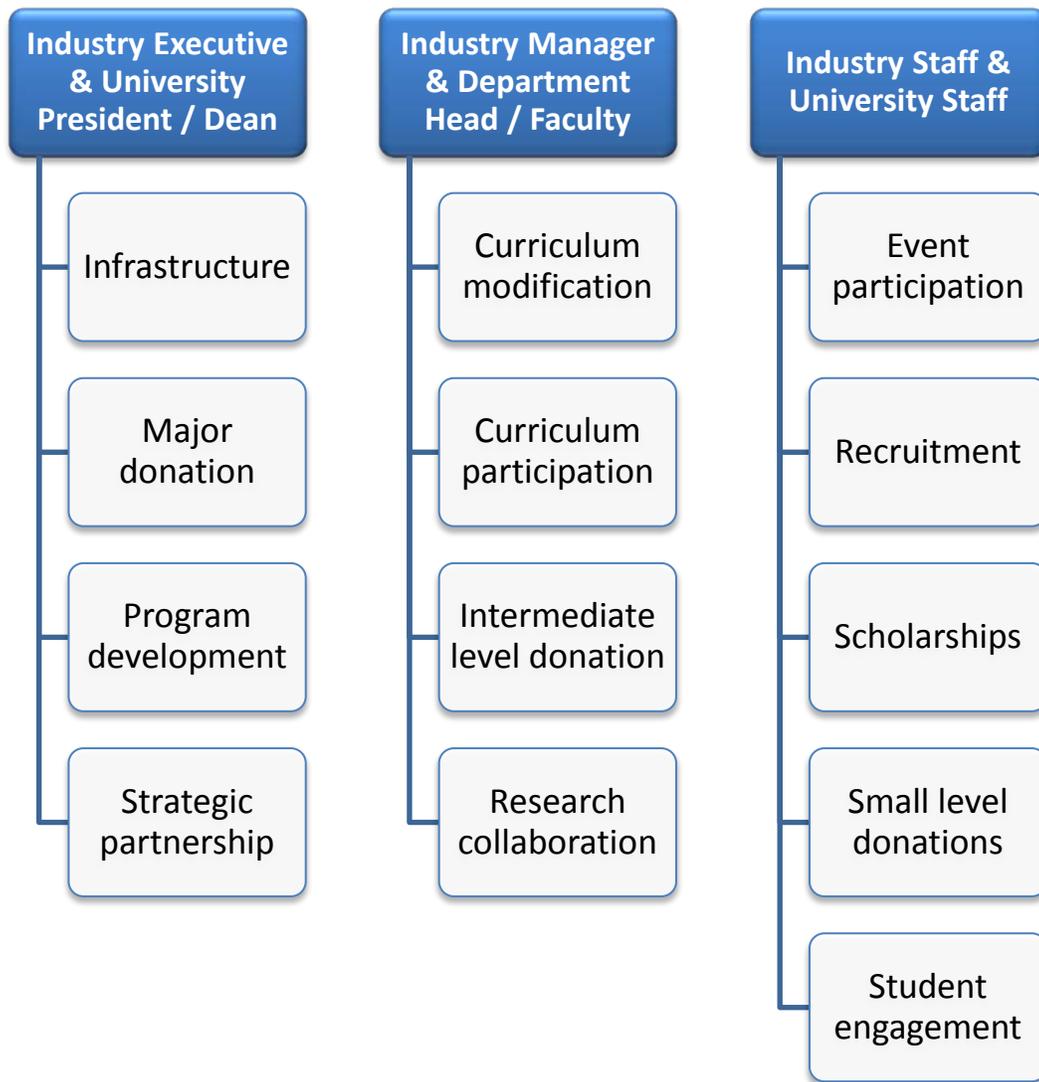
This incredible track record of both co-op or non-co-op mining students at the University of Alberta securing work in industry is not seen at any of the other mining programs in Canada. Undoubtedly, this phenomenal track record goes a long way in terms of attracting high school graduates to choose to go to university in Edmonton. However, some suggest that having too strong an IAC can affect the integrity of a department and call into question the level of independence of the department or even the university as a whole.

5.9 Recruitment Strategy

Universities have the ability to provide many different opportunities for industry to engage students on or off campus as part of a recruitment strategy. However, what many Canadian universities haven’t been providing companies with is a comprehensive list of the various options available or an easy way to access them. Many schools provide information on a group of services such as attending career fairs, hosting information sessions, posting job descriptions, and booking interview rooms. Others will have a page on structured scholarships and bursaries. However, what is lacking is a service enabling a company to develop a comprehensive customized recruitment strategy. For example, as discussed in the previous section, scholarships that include an internship can serve as a foundation of a powerful recruitment strategy. This can be even more effective when it is supported by information sessions, field trip competitions, and campus ambassadors for a tailored strategy to meet the particular needs of an organization. Implementing this kind of service may require universities to invest more resources in industry engagement; however, not only can this be an additional source of revenue for a university but it will also enhance the experience of industry when it comes to working with the university and will attract students to the school.

Different forms of collaboration between universities and industry require the cooperation of different levels of management at companies and at university. Below is a list of options available for collaboration in three hierarchical levels:

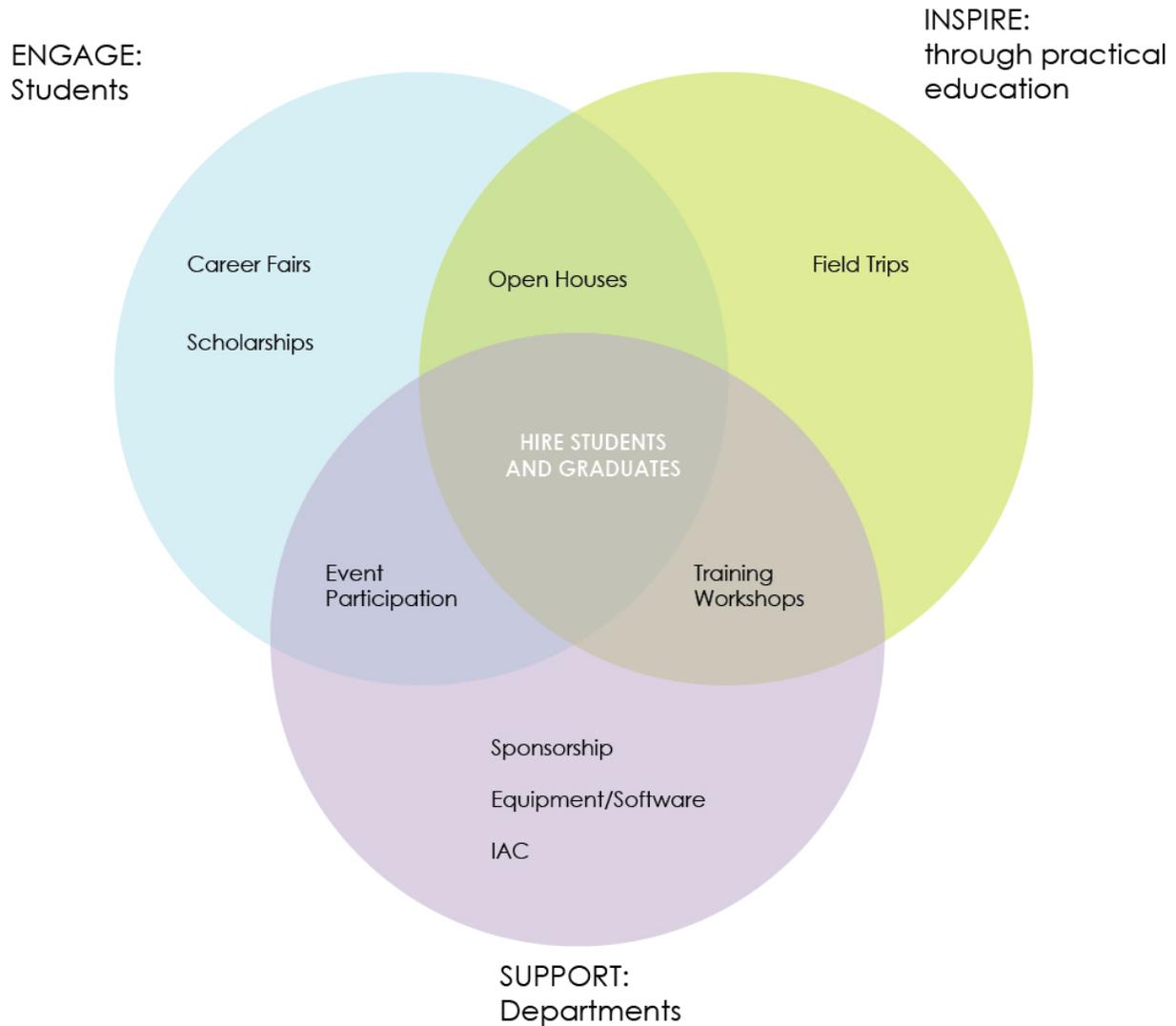
Figure 4: Collaboration by Level of Organization



Major donations, the construction of new buildings on campus, development of new programs, and strategic partnerships are the domain of the leaders of companies and universities. Senior level managers can collaborate with department heads and faculty on curriculum, research, and medium size donations. However, the vast majority of collaboration takes place between staff in industry and universities such as on campus or industry events, recruitment of high school

students for universities or recruitment of university graduates for industry, scholarships, small donations, and general student engagement. It's these interactions that take place several times throughout the school year that have the greatest impact on the perceptions of students and yet require the least financial investment. Each form of collaboration can be categorized based on the direct impact it has on the students and the department: Engage, Inspire, and Support. Some forms of collaboration fall under the Engage category because these efforts contribute directly to recruitment by attracting students to consider a career at that particular organization whether it is through activities such as participating at career fairs or offering scholarships to individual students. Students become motivated to pursue a career in mining in general from first-hand experiences such as field trips to an operating mine or mineral processing laboratory, which fall under the 'Inspire' category. Whereas departments benefit directly from sponsorship, receiving equipment/software, or the participation of company representatives on an IAC, which falls under 'Support'. And there is crossover between categories as well as illustrated in Figure 5.

Figure 5: University and Industry Collaboration: Engage, Inspire, and Support



Together these three areas combine to create a powerful recruitment strategy for a company that benefits the students as well as the university.

There are a multitude of opportunities for industry to interact with universities to support their programs, develop students, and recruit new graduates. Figure 6 is a list of some specific options available at UBC that are not necessarily well advertised.

Figure 6: Opportunities for Industry to Support and Collaborate with Universities



Some companies have taken advantage of a few of these options but none have utilized more than a handful. Perhaps if Canadian universities had a system in place to promote and facilitate these opportunities more companies would try more options and invest more in their campus recruitment.

In the USA, Dominion Exploration & Production is a company that has embraced collaboration with educational institutions beyond just the post-secondary level as part of their competitive advantage to recruitment. The company has developed an internship program working with fourteen colleges and universities in the US, similar to companies in Canada that are involved with the co-operative education programs offered by most universities. Dominion recognizes the intrinsic value of these undergraduate students as potential full-time employees and has historically extended offers to 80% of their interns according to their President and CEO Daune Radtke.

“Eighty percent is a remarkable figure, but we try to have a culture here that they are part of building something and not just generating numbers in an office. And that is the approach we take with our interns as well as our young engineers and geologists”

(Anonymous, 2006).

Many companies in Canada and the US attract undergraduate co-op students and eventually offer some full-time positions. However, understanding the importance of attracting people to the sector and seeing this as part of their responsibility Dominion has taken their student recruitment a step further by engaging with high schools and their career advisors. Dominion was alerted by high schools about three potential candidates that were interested in the industry. These students had no prior exposure to the business, and Dominion worked with the students and as of the time of the article all three had enrolled in Petroleum engineering degrees. "We went to their schools, worked with them, and now we have some outstanding young people interested in the industry," Radtke says (Anonymous, 2006).

Recognizing the importance of encouraging young people to pursue a career in applied sciences, the Dominion Foundation also sponsors a grant program to strengthen math and science education in grades K – 12 in public schools in six US states where they have operations (Anonymous, 2006).

There are a number of companies doing their part in attracting people to not only their companies but to the industry as a whole. However, these are more the exception rather than the norm. It is important for these companies to share the stories of their efforts in attracting people to the industry so that other companies become aware of what others are doing and a culture shift takes place where it becomes the norm rather than the exception.

5.10 Retention

When a talented individual leaves an organization not only does the company lose that person's skills and career potential, but knowledge and intellectual property are lost. For some organizations talent retention starts during the onboarding of new hires. According to Training Industry Inc. CEO, Doug Harward:

“we must impress designated talent early; if we wait to bring them into a special fast-track program, it will be too late. After all, top talent quickly perceives the difference between good and bad”

(Harward, 2012).

This can be extended to the onboarding experience of co-op students and summer hires considering many companies use them to assess talent and for future recruitment. By providing students not only with challenging and rewarding work term experiences but with experienced and capable mentors companies can assess the competence and potential of these students, as well as plant the seeds for a full-time career after with the company upon graduation. Mentors help new hires fit in more easily, pass on best practices, and generally reinforce a development culture (Gilmore, Coetzee, & Schreuder, 2005). However, a reduction in mentoring programs over the years has had a negative consequence on retention and succession planning according to Simmons:

“Mentoring is one of the only mechanisms that senior management can identify junior engineers as being management material. Unfortunately, organizational downsizing has diminished mentoring programs, which were also vital in teaching junior engineers effective interpersonal skills”

(Simmons, 1999).

One area of potential further study is the retention rate difference of new graduate hires who have worked at a company previously compared with those who have not. Theoretically those individuals who have worked at a particular organization as a student should have more realistic expectations going into their first career job with that same company compared to those who had not. A previous summer or co-op student would enter this job familiar with the position, many of the tasks, the location, the hours, the work environment, his/her coworkers, the corporate culture, as well as many other details, whereas someone who has never experienced any of this will have expectations created mostly by the messaging of the interviewers.

According to Carla Radloff:

“it is critical that employers give an accurate picture of the organisation and the jobs, even if it means losing stars who are looking for a different work environment than that what the company can offer. If employers 'dress it up', they raise expectations that can not be met once the employees are in their service”

(Radloff, 2005).

The importance that expectations play in retention is also supported by to Harry Chambers. “Negative employment surprises of any kind usually result in frustration and anger along with depleted performance, a decrease in commitment, and an increase in the likelihood of their spreading rumour, gossip, and critical comments; a quick departure usually follows” (Chambers, 2001). Based on the successful hiring and retention of former co-op students in mining companies in Canada, anecdotal evidence would suggest that this theory holds true.

After Resource Nationalism the second biggest risk facing the mining industry was Skills Shortage according to the 2012 Ernst & Young Report *Business risks facing mining and metals 2012–2013*. The human resources challenge involved both the attraction of people to the industry and the retention of employees. The results of a Deloitte employment survey suggest that leadership plays a large role in retention, and when employees trust their leaders, have a

clear understanding of the corporate strategy, and believe that the leaders are capable of delivering, the employees are more committed to the organization and their position. The Deloitte report recommends that, “(e)mployee retention should be driven by business leaders, not simply left to Human Resources. In fact, business leaders should consider developing the next generation of workers as a core component of their day-to-day jobs and be held accountable for regrettable attrition” (Deloitte, 2012a).

If better utilizing university partnership can potentially increase retention of employees, HQP in particular, it is in the best interest of industry leaders to explore this further and invest resources into supporting collaboration initiatives in order to stay competitive in an increasingly challenging human resources environment.

For academia, the benefits of partnering with industry range from attracting top students to developing sponsored research activity. For industry, the benefits of partnering with academia range from hiring the best quality graduates with the proven aptitude and motivation to succeed towards future industry leadership.

6 Changes at the University

A large number of minerals programs around the world disappeared prior to the turn of the century due to a combination of factors such as a lack of demand for people by the mining industry, a shift in public support away from mining in general, and neglect from industry, government, and academia. Resurgence in global appetite for natural resources over the past decade and the resulting demand for HQP to facilitate an increase in production of minerals has put pressure on the few remaining universities with mining programs around the world to educate and prepare a higher number of new graduates than most have capacity for. Moreover, since the economic downturn in 2008 most universities around the world have implemented cost reduction measures that exacerbate the situation.

This section identifies the areas of challenge facing universities specific to the mining industry such as a financial pressures and the global shortage in faculty and explores suggestions for changes that arose from the research.

6.1 Financial Pressures

The economic downturn in 2008 not only had a devastating impact on corporations but it had a profound impact on higher education as well. A 2013 article in the *New York Times* describes how widespread and serious this issue is in the USA.

“While few financial experts foresee mass closings in the years ahead, only 500 or so of the 4,000-plus colleges and universities in the United States seem to have stable enough finances to be truly safe. The remaining colleges, where a vast majority of Americans attend, can no longer hold off the technological, demographic and economic forces quickly bearing down on them.

One-third of all colleges and universities in the United States face financial statements significantly weaker than before the recession and, according to an analysis released

last July, are on an unsustainable fiscal path. Another quarter find themselves at serious risk of joining them”

(Selingo, 2013).

Understandably universities have responded to these new economic realities much the same as industry has: by seeking ways to cut costs. Minerals specific courses in particular are more vulnerable to closures due to a tendency to have smaller student populations and higher costs per student relative to other programs, especially during periods of low enrolment caused in part to the economic cycles (Minerals Council of Australia, 1998). However, this comes at a time when mining departments are under pressure to expand due to growth projections in industry. Joseph argues that universities need to stay the course in expanding engineering programs because of the fundamentals of the long term projections of demand for engineering graduates by industry; however, not everyone at their university agrees.

“Most universities are looking to expand in engineering. However, all of us are into budget cuts right now across the country. We are having a hard time. Fiscal management is more and more important. I think in most universities engineering has taken the stance that we are not going to cut at all. We are either going to try and keep the status quo or we are going to expand. At the U of A we are expanding much against the board of governors’ decisions and against the wishes of the president and everyone else”

(Joseph, 2013).

Universities are large organizations with multiple stakeholders and many different interests. The priorities of smaller programs like mining oriented ones can sometimes get overshadowed by those of larger programs or those currently highlighted in popular media. Sometimes it takes

industry partners to leverage their influence on the university decision makers or to support programs directly as Maclachlan describes:

“One of the problems that every university is now dealing with is budget shortfalls. How do you support programs when you don’t have the money to support those programs? Universities are looking at partnerships elsewhere or different ways of doing things that will allow them to deal with shortages of staff and faculty, and that’s where, if industry is committed to maintaining their numbers and having the HR shortfalls addressed, they need to step up to the plate and support to a certain degree”

(Maclachlan, 2013).

If universities continue to fail to adequately support extractive industry related programs the quality of education, and consequently the quality of future HQP, may suffer. In the end with the direction that things are heading it may end up that direct support of mining engineering programs by industry will become the norm. There are numerous ways in which industry can support universities in providing the education for HQP which is discussed in the previous section on *University & Industry Collaboration*.

6.2 Faculty Shortage

The loss of mining departments around the world over the past few decades has had a dramatic impact on the number of new graduates each year entering the mining industry today. For instance in the USA the number of mining engineering graduates dropped to an all-time low of 54 graduates in 2004 down from a peak of 700 graduates across the country in 1981. Today there are only 14 accredited mining engineering programs in the US down from a high of 25 in 1982. Correspondingly there has been a drop in the number of faculty teaching at these school from 120 in 1984 down to 70 today, and there continues to be a serious global shortage in qualified candidates to fill these vacancies (Society for Mining Metallurgy & Exploration, 2014).

In 2005 nearly one third of mining engineering faculty in Canada were 55 years of age or older; however, the situation is even more critical in the US with all senior mining faculty projected to need to be replaced by 2020 (Poulton, 2012). Despite this challenge mining departments in Canada and the USA have responded to industry's increasing demand for new graduates by steadily increasing student enrolment since the turn of the century. The reality of this situation is a reduced capacity to conduct research and develop their programs to address the changes in the industry that these graduates will face. Top schools have been forced to depend on sessional lecturers to teach core courses because they have been unable to attract and hire qualified candidates to fill vacant faculty roles and they don't have the resources or no longer have the expertise within their department.

Today, it is estimated that more than half of all undergraduate students at Canadian universities are being taught by contract academic staff (Basen, 2014). At McGill University according to Teresa Barrett, "(w)hile we are filling holes with course lecturers the goal is to have more full-time faculty because we have more students, we want more students, and we want more opportunities for research" (Barrett, 2013).

Contract instructors lack the job security, benefits, and pay enjoyed by full-time faculty. On average contract academic staff receive 19% – 35% of the salary of their full-time counterparts despite providing a large proportion of a university's education (Basen, 2014). In 2012, 52% of students at Wilfred Laurier University were taught by contract instructors; however, less than four percent of the university spending goes towards their salaries. In other words, only four percent of the university budget goes towards teaching over 50% of its students (Basen, 2014).

"Our universities are rightly celebrated for their great achievements in research. That's what attracts the money, the prestige and the distinguished scholars. But the core of the teaching is being done by the most precarious of academic labourers... I think it's regrettable, and I think there are legitimate concerns about having such a large part-time

workforce, but it's an unfortunate consequence of underfunding of the university. And without them, the business model of the university would collapse”

(Basen, 2014).

Industry can better ensure the quality of education provided at universities in the form of endowed professorships or research chairs. Without university and/or industry commitment to investing in increasing teaching capacity, it will remain an immense challenge to hire qualified candidates to become faculty. Joseph explains the situation quite simply:

“Nobody wants to teach in education. There's no money in it. Industry pays far better. We cannot attract the people we want to attract into education”

(Joseph, 2013).

For the mining industry, this inability to bring on new faculty not only presents a challenge for a department to expand its resources, but it also makes it almost impossible for other universities to start or restart a mining program as well. Hebblewhite questions the wisdom of Monash University deciding to offer a mining engineering degree in response to pressure from industry in Australia given the chronic shortage of faculty.

“The issue is, is it really needed given that the biggest limitation is the number of academic staff available? They've appointed a couple of people but across the world there is a chronic shortage of appropriately skilled (ie. with Ph.D.'s and preferably experienced) academics that the last thing you want is another school or department setting up that's going to be out there on the lookout for staff when we are all struggling to get enough”

(Hebblewhite, 2013).

Whether it is more strategic to develop the quality and capacity of current mining programs or to expand the number of mining programs, especially into areas with potentially high demand for mining education, is a potential area for further study. However, what remains clear is the need for universities and industry to commit financially in order to attract the highest level of mining educators to better prepare future HQP.

6.3 The Educator

The data provided various suggestions to change the education of mining engineering students in university. Interviewees from academia all affirmed Joseph's statement that "(t)he union ticket to teach is the Ph.D" (Joseph, 2013). Many of these individuals questioned the merit of the Ph.D. when it came to teaching. Hebblewhite describes how a professor's research credentials has traditionally always taken precedence over his/her teaching credentials when it comes to hiring decisions.

"(O)ur university requires Ph.D.'s because it sees itself as a research university. So if we wanted to go and grab someone with a huge amount of industry experience and will be great for our teaching but really not equipped in that research area, we can't. Our hands are tied. That's a real restriction"

(Hebblewhite, 2013).

The importance of educators possessing previous practical experience in industry is a consistent theme. However, due to the faculty shortage not every school has been able to hire qualified candidates with satisfactory levels of experience. This has been the case at the University of Alberta according to Joseph:

"We've gone through a glut in the last decade of hiring people who have minimal industry experience purely because we couldn't get people to come and teach at the university. So we have taken people who went straight through from a bachelor's to a

master's and to a Ph.D. straight to teaching; but they have never been out there. Someone who teaches blasting who is like that really worries me. Someone who teaches blasting should really have a blasting ticket”

(Joseph, 2013).

Industry can contribute to the education of students by collaborating with universities and providing expertise and resources. One example of successful collaboration in the classroom is when two guest lecturers from Orica provided their expertise and equipment in a surface and underground blasting course at UBC as described by Crook:

“...they were able to do everything from the actual technical teaching, but also case studies and stories and photos, it was incredibly interesting. And these guys were very passionate about their jobs, so they had the humour, they had the pictures, they had the technical experience and the knowledge. And amazingly, they were happy to give us all these resources as well... another thing that Orica did which was really cool was... he brought in dummy equipment and for maybe 6 or 8 of the people on (the mining games) team, gave us a hands-on workshop as well. So he had all the same stuff he'd used in industry, so when I went into my work term this summer, I had already seen those tie-ins. I knew how to do it, and I was thinking back to that workshop we did at UBC with (Orica), okay, it's the exact same thing that time, but it's for real this time, so that was amazing. You couldn't even put a value on it if you wanted to hire someone to do that... It's more important and more memorable... he benefited the class, the whole class was probably 50 people in that class. Some mining engineers, also some (geological engineers) as well that were taking that as an elective... once we're in industry, and we're thinking about explosives, we're going to be thinking about Orica. And we're going to be going back to those resources and we have those contacts”

(Crook, 2013).

Mining programs must offer a wide variety of mining courses; however, the number of faculty available in each department to teach them is limited. Therefore most schools are unlikely to have individuals who are experts in every subject offered which may hurt quality of education provided and the credibility of those schools overall. However, by utilizing the expertise of industry partners departments may no longer need to have experts in every field. For particular courses perhaps faculty can serve as the facilitator of a course while an individual or a series of individuals from industry provides the expertise. Implemented well this may ultimately provide a richer experience for students.

6.4 Teaching Method

Universities are exploring different methods of delivering course content to students whether to be more competitive in an increasingly more competitive industry, to be innovative as an institution of higher education, reduce costs and/or resources, or other situation specific reasons.

UBC is in the process of modifying the delivery of the entire mining engineering curriculum based on Flexible Learning methodologies (Maclachlan, 2013). These online, flipped, or blended learning environments “provide students with rich learner centred experiences by rethinking and redesigning the teaching and learning relationship” (UBC Centre for Teaching and Learning, 2014).

The University of Alberta has implemented Scenario-Based learning into its curriculum which involves students in teams of four gaining the experience of going through feasibility, planning, environmental impact assessment and dealing with government, communities, and with business. Students are provided with a database of volunteer contacts from industry to draw expertise from and in the end have to answer to a board of directors for a pseudo-mining company and sell them on their business project. Joseph describes how education needs to change:

“We should not be teaching through lectures and assignments anymore. We should be teaching through scenario-based learning. We should be bringing in more industry people into the classroom. We should be encouraging a larger volume of adjunct professors from the retiring industry who are the expertise and they now are training those students who are just about to exit, maybe in their final year or year and a half”

(Joseph, 2013).

Abraham supports the idea of involving people from industry in the curriculum. Not surprisingly given his background in both engineering and law, he suggests that universities should set up a course that introduces students to people from “downtown” to talk about how the business world operates from the perspectives of accounting, business, consulting, government, and legal. Ideally this would incorporate people from large corporations to small, from consulting to operations, and from the private sector to the public sector (Abraham, 2013). Overall there is general consensus from all stakeholders for more industry involvement in the education of students.

6.5 Inter-University Collaboration

The Society of Mining Professors (SOMP) is a body of academics who meet every year to facilitate “information exchange, research and teaching partnerships and other collaborative activities among its members” (Society of Mining Professors, 2014). With respect to the global faculty shortage it is also a good means to identify the emergence and availability of new faculty members. According to Hebblewhite, the current Secretary General of SOMP:

“It’s a tremendous network to get to know academics from around the world. A number of my younger staff have really started building relationships through being part of that group. Whether its staff exchanges, arranging collaborative student project work, or ideally collaborative research. We had one small research project that came directly out

of a society connection last year which had one of our people working on a project in West Virginia. So I think all of those things are important because mining engineering academics are an endangered species worldwide so the more they can work together the better"

(Hebblewhite, 2013).

It is a global collaboration mechanism; however, to date there has been little industry involvement despite being the obvious body to approach large mining companies to improve university and industry collaboration.

Since university mining departments are struggling to meet industry demand for new graduates due in part to their limited resources and in many cases a lack of financial support perhaps sharing resources across the different schools is an attractive solution.

Academia has a long tradition of competition between schools in many different facets such as in athletics, academics, research, and prestige. In many ways departments between universities have little or no communication at all. "There might be individual linkages between professors, but there is no real communication between mining schools within Canada, at least between ourselves and any of the other mining schools" says Maclachlan (Maclachlan, 2013). This may require a complete change in mindset. However, internationally there are countless cases of successful inter-university collaboration in a wide variety of areas from research and equipment to classroom teaching and exchanges to base a model on. Some extractive industries programs around the world have taken significant steps in inter-university collaboration. In Europe five of the top schools have created the European Mining, Minerals and Environmental Program which is a two-year joint master's program (European Mining, 2014). In North America the University of British Columbia, the University of Arizona, and the Colorado School of Mines, have been working on a proposal to collaborate with Rio Tinto to address some of the faculty shortage issues when it comes to teaching resources. However, this cannot be accomplished by

universities alone. Maclachlan explains that one of the reasons why this collaboration between the three universities and Rio Tinto has been possible is because “it’s being driven more by industry” (Maclachlan, 2013). Rio Tinto recognized the importance of supporting university mining education for the future of the industry but also the value for the company that comes with this type of collaboration such as competitive advantage in recruitment. Second year students would be “using Rio Tinto data sets... that they will continue to use for various projects right through their entire academic career to the final capstone design project.” (Maclachlan, 2013) The company would also potentially provide technical expertise in the classroom as well as support field trips to one of their mines in Nevada. Unfortunately, since the time of the data collection this collaborative initiative has been cancelled by the company.

According to Houlding, some companies have created their own schools in partnership with various universities to meet their particular training needs:

”The new Sandvik International Mining School is an example of industry sponsored development of courses tailored to company requirements. It is the result of a partnership between the company and six mining schools around the world”

(Simon Houlding, 2008).

Perhaps Australia has taken inter-university collaboration to an even higher level than schools on other continents with an initiative called Mining Education Australia (MEA). MEA is a national joint venture between four university mining schools supported by the Minerals Council of Australia. It provides a common curriculum to 3rd and 4th year students across each of the schools, which is a world first in undergraduate mining education. The basic goal of MEA was to establish a sustainable national mining education program that would attract people to the industry and improve the quality of teaching to ultimately increase the number and quality of mining engineering graduates (Lind & Andrews, 1999).

One of the drivers behind the creation of MEA was a 1998 paper entitled *Back from the Brink: Reshaping Minerals Tertiary Education* created by the Minerals Council of Australia. The interviewees of this study brought up many of the same challenges that were identified by the Australian taskforce in the 1990's such as a faculty shortage, under-resourcing of minerals departments, poor industry support in terms of new graduate hiring, cyclical nature of the mining industry has negative consequences on the education system and the subsequent graduates produced, and companies are inconsistent with their student hiring (Minerals Council of Australia, 1998). Through collaboration with industry and with the support of government these four Australian universities have managed to address these core issues affecting the sustainability of their minerals programs. According to Hebblewhite, former Executive Director of MEA, not only is MEA meeting its objectives but it has opened up the possibility of further collaboration between the schools.

“(MEA) set out to achieve a program that increased both the quality and quantity of mining engineering graduates across the country and it’s well and truly done that... What it has achieved is a very close degree of collaboration between the four universities that are members of MEA, which we would never have thought possible if we looked beforehand. We didn’t even know each other, let alone work with each other. There is recognition that in most things we aren’t competing with each other anyway and so there is actually a lot of mutual benefit in working together”

(Hebblewhite, 2013).

Because the mining industry is so global it makes strategic sense to see international university collaboration as Hebblewhite describes:

“The mining industry is an international industry. Most big companies operate on multiple continents. The education sector ought to be doing more of that. We are doing a little bit

in that regard but always keen to do more... In terms of strategic initiatives into the future international university collaboration is a huge thing to be pursuing”

(Hebblewhite, 2013).

As the initiative for partnership between the University of British Columbia, University of Arizona, and Colorado Schools of mines clearly shows, inter-university collaboration is not limited by international borders but rather the motivation and of all parties to come together to make it happen and the commitment and support of industry to see it through to fruition.

6.6 Open for Business

It is not just industry that needs to increase its level of commitment towards working with universities; universities need to focus more energy on industry engagement as well.

Considering the potential revenue to be generated by conducting more business with companies, failing to reach out to industry is a huge missed opportunity for universities argues Mark Selman, Director of the Executive MBA in Aboriginal Business and Leadership at Simon Fraser University:

“I think there are lots of companies that never even think about going to a university, and the university does little to encourage them. (Universities) send out people for fundraising, for alumni support, and for recruiting but we don't send out people to develop relationships that could lead to (business) partnerships”

(Selman, 2013).

With over 58,000 students and 15,000 faculty and staff the total population of the University of British Columbia is slightly lower than that of the province's capital city, Victoria and slightly higher than that of Prince George. Consequently, the sheer scale and structure of a university the size of UBC can be a challenge for people in industry to seek out the information they need

or contact the right person to discuss a business opportunity. Moreover, this is challenging even for people within the university. According to Au, “some of the faculties don’t even know who we are (as a Centre for Student Involvement) or that there is such a person as a community liaison within the faculty a lot of times” (Au, 2013). Selman suggests that “when industry wants something, they don’t know how to navigate the university, they don’t know how to find the particular resources within the university, and the universities do little to make it easy for them” (Selman, 2013).

Au echoes this sentiment and suggests that the university could also be more coordinated in its correspondences with industry partners so that interaction from an industry perspective becomes less complicated.

“There are a lot of internal changes that need to be made so that our front that industry sees is much more united than it is right now. If you pick any of the mining organizations, I bet you, 10 different people from UBC would have called them unaware of the other contacts made and they don’t understand that they’re all from different places within the university. All they recognize is UBC”

(Au, 2013).

One example of a successful mining related university and industry partnership is the Executive MBA program at Simon Fraser University that has been tailored to meet the specific needs of Teck Resources. Selman explains why it has been successfully running for fifteen years:

“(Engineers at Teck) are absolutely perfect for what we do... as they progress through their careers, they end up being responsible for managing people and so, the more advanced positions have very little to do with blasting patterns or analysis of ore samples or anything like that. They’re primarily to do with how to get people coordinated and working together to be more effective, and that, we know how to do. So we get

these students who are great academically, they have all the quantitative skills in the world, but they've had no formal training and some experience, varied experience, in terms of actual leadership and management. So, it's a dream for a business school like us that has long experience doing executive education at that MBA level. We've got the oldest executive MBA in Canada, and so what they need and what we have to offer are a perfect fit"

(Selman, 2013).

However, because there wasn't a protocol within the department at the university to set up a tailored program for a company, the Teck EMBA almost didn't come to fruition as Selman recalls:

"when (Teck) approached Simon Fraser University, they approached the faculty of business, and it got bounced down to the academic director of the executive MBA program because they wanted to have a course, a graduate level course, offered. And, they wanted their managers to register as graduate students in the university, but nobody in the faculty of business knew how to register, how to set up a course like that, that wasn't part of a program, and was going to register students who weren't otherwise enrolled in a graduate program and so on. Or how to design a course that would respond to what the folks from Teck were wanting. So, that kind of shows you, they ended up coming to me, because I had developed programs like this, but it just happened that we worked in the same building. I had to negotiate with the faculty of business to be able to offer some of the courses and programs that I did. So they knew about me and my work. So, it was a fluke that we were able to put the right people together to form a project that started out very small, but ended up developing into this very large, ongoing program. And universities shouldn't really depend on that to respond to these opportunities"

(Selman, 2013).

According to the research data it's not in the nature of academic institutions to be proactive in seeking business with industry. In fact, Selman argues that academia looks down upon such activities, which is part of the problem.

“You don't develop a partnership of this nature (a tailored EMBA program for Teck Resources) without selling something... Once in a while, you get someone who knows what they want, they come to you, and they say, 'this is what I want'. But for the most part, you have to reach out to people and say, 'this is what we can do for you', and universities, of course, don't value that. They think it's unseemly to be out there selling things, but it is okay to produce a catalogue or website to view and sign up on, and it's okay to go out and solicit funds. They don't get it that they're missing out by not going out and making deals”

(Selman, 2013).

The universities that proactively pursue opportunities for collaboration with industry are the ones most likely to end up developing the most partnerships with industry and potentially ensure the sustainability of their program at their university in this increasingly financially challenging era of post-secondary education.

6.7 Knowledge Transfer

One major concern of the mining industry is the impending loss of expertise at all levels of an organization due to the retirement of “Baby Boomers” and the lack of options to effectively transfer this knowledge to the younger generations. The loss of this invaluable knowledge will affect all areas of the industry from exploration, design, construction, and operations, to health and safety. According to Lutchman, one route to mitigating the negative impact of this phenomenon is to retain workers.

“Success in knowledge transfer can only be improved if workers remain employed long enough to learn processes and new technologies and are able to transfer acquired knowledge to less experienced and less knowledgeable followers within the organization”

(Lutchman, 2008).

Another route is to encourage the older generation to postpone full retirement and to mentor and educate co-op students, EIT's and their younger colleagues (Ernst & Young, 2014).

Bazowski suggests:

“I think what we have to really do is try as much as possible to either retain the expertise that currently exists in the industry as much as possible or find creative ways to have some of those individuals that are perhaps leaving the industry on a full-time basis to somehow give back, whether it's in terms of mentorship programs or part-time work”

(Bazowski, 2013).

This issue is not new and many companies have taken steps to address this concern; however, with a challenge of this scale it will require a more concerted effort, possibly involving collaboration between companies, industry associations, universities, and government to ensure the successful transfer of knowledge.

There are many avenues for knowledge transfer such as publishing written works, providing education in a classroom environment, providing hands-on supervision in the field, and succession planning, to one-to-one coaching whether in-person or using communication technology. Each has its unique merits and limitations, and consequently should be utilized in different situations and in strategic ways.

The vast majority of retiring knowledge workers are in industry whereas the majority of the target audience of the knowledge transfer are young engineering students still in school and the

engineers-in-training working in industry. One thing the people in these three can have in common is their alma mater. The research data revealed that universities could do more to engage their alumni and that people in industry are not attracted by what academia currently offers to alumni (Kwong, 2013). This is a potential opportunity to engage experienced alumni and have them contribute technical knowledge to the younger generation as well as attract recent graduates to come back and learn from them as well. Universities already have the resources required in place and would simply need to facilitate this.

Among the many ways that industry supports mining programs and students, the mining department at UBC offers various scholarships with some that not only involve a monetary award but also assign the award recipient with an experienced engineer from industry to provide advice and help. Some of these mentors are retired individuals who remain strongly committed to the sustainability of the industry. These individuals have a wealth of knowledge and expertise that they share with these young engineering students which has great benefit to the individuals involved as well as the industry overall. Industry and academia should look at ways to expand this form of mentoring to be offered to more students.

There are other forms of mentoring happening in industry as well. Mining Industry Human Resources Council launched its Virtual MineMentor Program in 2009 which is a structured program that involves experienced industry personnel volunteering a few hours each month to provide guidance to a student in a mining related field. Currently there are 47 mentors and 122 mentees registered in the program (Sturk, 2014).

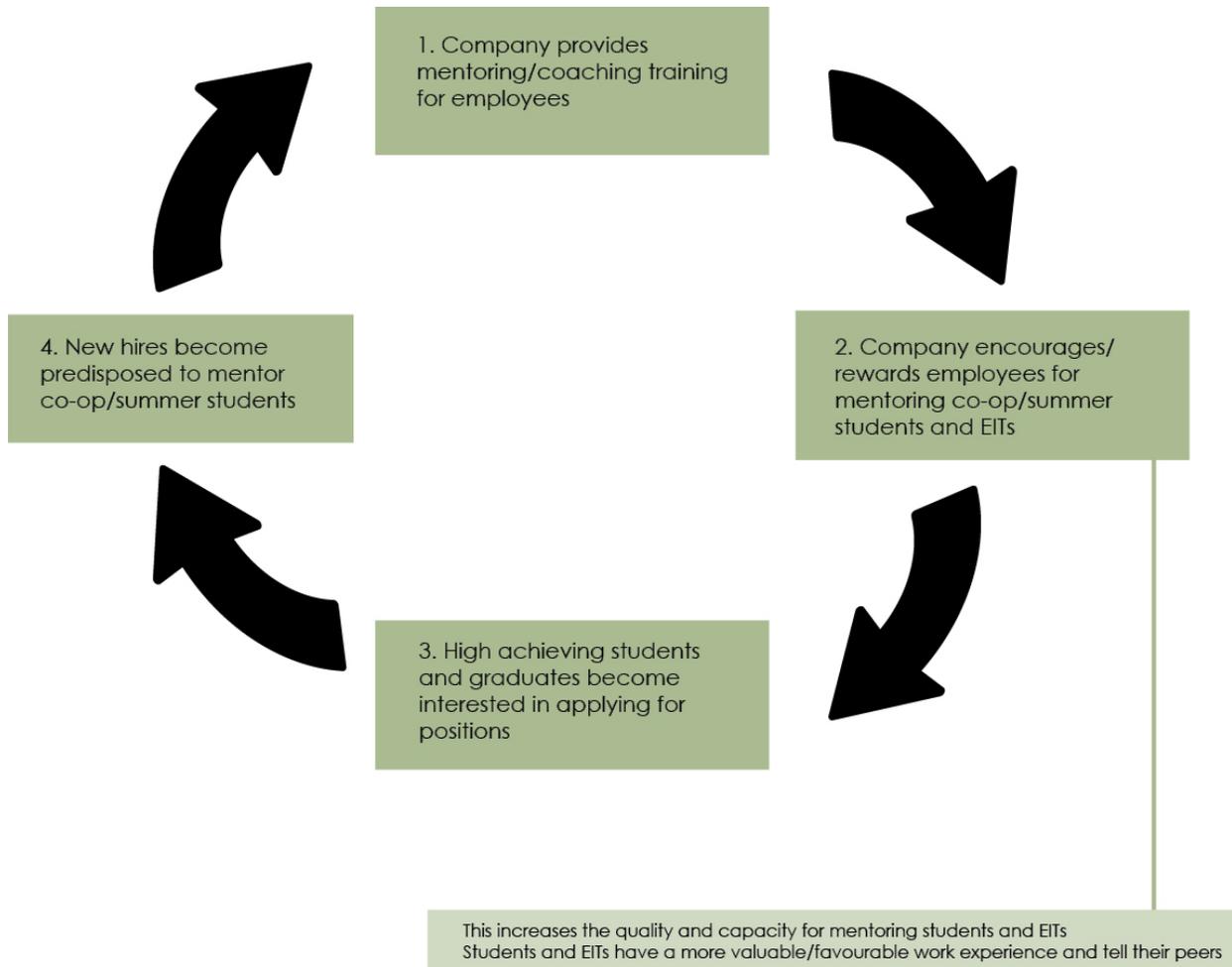
Some forward-thinking companies have also set up mentoring programs in-house. For example, co-op students at a consulting company are assigned a 'buddy' who provides guidance outside of the immediate work tasks. At another company, co-op students are offered one opportunity to spend an hour with any one person within the entire organization. In many cases the mentor ends up being the student's supervisor by default. With any mentoring relationship success is dependent on the individuals involved and the relationship that develops.

Some people are naturally inclined to provide coaching to less experienced co-workers and are well-suited to a mentoring role whereas others may not be. A lot of what happens in the workplace is “unofficial mentoring” where a young engineer gravitates towards the person(s) who is the most helpful and with whom they develop a bond. In some cases these more approachable co-workers end up taking on the mentoring role for a number of students. Companies should look to identify these individuals, recognize their important contribution, and reward them for their impact on the development of new staff. By doing so it may encourage others to see the value in investing one’s time and energy in developing others leading to a ‘Culture of Mentoring’ within the organization which is attractive to future graduates. The impact of a quality mentor can be vast and can lead to a self-sustaining cycle as described in Figure 7. Universities can play a large part in the development of future mentors by enhancing the quality of advising offered to undergraduate students and graduate students early on. Vesilind recommends that:

“Universities should establish policies that would allow students to have the option of selecting advisors... must be the organizers for improving advising... should provide rewards and appropriately recognize faculty participation in an advisor training program... develop regular feedback sessions with students... and create awards for exemplary mentoring”

(Vesilind, 2001).

Figure 7: Developing a Sustainable Culture of Mentoring



By providing quality mentoring at the university level new graduates will benefit from having a solid foundation of what a quality mentoring relationship is like and in many cases they can continue the mentoring relationship beyond their time in school.

According to a multigenerational workforce study conducted by MIHR, 'Professional Development' was ranked as the second highest priority for workplace satisfaction of the Millennial Generation (Mining Industry Human Resources Council, 2012). Therefore its plausible that companies that embrace the development of young engineering students and EIT's may not only end up with the most educated and skilled workforce, which can be a competitive

advantage in terms of production and innovation, but they may also gain a competitive advantage when it comes to recruitment and retention of HQP.

Financial pressures at universities and a global shortage in mining related faculty are forcing mining oriented departments to relook at how they operate. Increasing industry participation and support in the delivery of course content as well as adopting modern teaching methods are desirable options. Examples in different parts of the world provided evidence to support the benefits of working collaboratively and sharing resources and expertise amongst universities, both domestically and internationally.. Schools that proactively seek business with industry have a greater potential to develop revenue streams through business collaboration. Lastly companies and universities need to facilitate knowledge transfer through various means such as via mentoring young engineers.

7 Co-operative Education is Invaluable

Employers want to hire new graduates who have work experience and are ready to hit the ground running while students want to have work experience on their resumes so that they can land their dream job after graduation. Universities are in a position to facilitate this in partnership with industry. Each summer many students independently secure work in industry while formal co-op programs at universities across Canada provide a service to facilitate educational work experiences to a large number of students year round as part of their curriculum. This section explores the benefits of students securing work in industry, as well as the challenges in succeeding at this on a consistent basis, from the perspective of students, companies, and universities.

The type of work experience that students gain on a work term varies from country to country. Furthermore, terms 'co-operative education' and 'internship' are often used interchangeably; however, there are many interpretations of what each one exactly entails. Compared with other countries Co-operative education is most developed in Canada and so students working in Canada tend to receive more challenging work and responsibility than those working in other countries. Many co-op programs at universities across the country have undergone a rigorous accreditation process through CAFCE and are nationally accredited. According to the Canadian Association for Co-operative Education (CAFCE):

“Co-operative education is the bridge between the employer, the student and the academic institution and benefits everyone involved. The employer benefits from the latest theories and fresh ideas from the academic world, the institution gets practical input from the professional community, and the students receive hands-on experience in their chosen field of study”

(Canadian Association for Co-operative Education, 2014).

Co-operative education was founded by an engineering professor at the University of Cincinnati in 1905 (Cooperative Education & Internship Association, 2014). Since then it has expanded to encompass many other disciplines of study in many countries around the world. There are 56 post-secondary institutions with nationally accredited co-op programs including the University of Waterloo, which has the world's largest co-op program with over 14,000 students enrolled in the program (University of Waterloo, 2014a).

7.1 Students

The opportunity for students to gain hands-on experience prior to graduating university is invaluable. Students can implement the theory learned from the classroom in an applied setting in the workplace and test the skills that they have learned. Students get to explore their career options in different industries and expand their professional network to gain a competitive edge when it comes time to graduate (Canadian Association for Co-operative Education, 2014).

The process of becoming a professional engineer is an indicator of the importance of work experience and mentoring to the mining industry. A professional engineer designation (P.Eng) is earned after spending approximately four years as an Engineer-in-Training (EIT) gaining skills and experience in a number of core areas under the supervision of a professional engineer, and then passing a test provided by a regional engineering association. Co-op programs mirror these requirements. Supervision provided to the student on a work term is one of the requirements of co-op programs; consequently, students can use up to 12 months of their co-op work experience towards their professional engineering designation.

Not only do Co-op students apply the theoretical knowledge gained in the classroom to real world situations on a work term but students returning from school also bring their practical experience back to the classroom. UBC mining engineering and co-op alumnus, Graeme Hendricks, describes the impact that his co-op work experience had on his academic performance.

“Naturally, a great majority of the experience that I received during my work terms was directly applicable to the theoretical knowledge that I was receiving in the classroom. I was able to draw on my own experiences to supplement my understanding of the lessons being received, and as the years progressed within the Mining Engineering program I found that the mining-related studies became easy and second-nature due to the familiarization that I had with most of the subjects covered”

(Hendricks, 2014).

Typically co-op students have the opportunity to complete four or five work terms at more than one company which provides them with a glimpse of the various career paths available and enables them to try out different roles and situations to discover the best fit.

“Exposure to different types of mining, as well as the specific roles that are available to Mining Engineers, provided me with a good idea of which direction I would like to focus my career upon graduation. I think that this is a unique benefit of the co-op program, as the work experience that I received within my field of studies not only had academic benefits, but confirmed that I was embarking upon a career that I was passionate about and was attuned to my interests. Based on the types of mining that I had been exposed to, I knew that I wanted to work at an underground mine immediately post-graduation”

(Hendricks, 2014).

Having this sort of insight prior to graduation enables students to both choose courses in their final years of study more strategically and potentially accelerate their career progression by choosing the best company or position for them at this early stage in their career.

Studies on Co-operative Education, such as the one conducted by the Higher Education Quality Council of Ontario (HEQCO) in 2013, provide evidence of other benefits to students from

enrolling in Co-op. For example, according to the study co-op graduates on average receive a higher starting salary for their first full-time job after graduation than non-Co-op students. Furthermore, nearly half of the respondents in the study who didn't participate in co-op said they would pursue this option if they could start their post-secondary education again (Sattler & Peters, 2013).

University tuition fees in many parts of the world have increased dramatically over the past two decades and Canada is no exception. The increases in tuition and other university fees in Canada are a direct result of federal government cuts to post-secondary education funding. Comparing inflation adjusted tuition fees the projected tuition for 2016/2017 will be triple what it was in 1990/1991 (Habib, 2013). Aware of this phenomenon parents of university students have been extremely supportive of co-op. They tend to have a better understanding than their children of the importance of gaining real world experience and they appreciate the fact that their child will have the potential opportunity to earn a significant income during their time in university to help pay the high cost of university tuition.

Having work experience and a network of contacts prior to graduation undoubtedly increases a graduating student's chances of securing work upon graduation. In some cases co-op students secure work well in advance of graduation because of their co-op work terms. Hendricks describes his experience with graduation having completed 20 months of experience through co-op.

“Although I was fortunate to graduate at a time when there were still numerous jobs posted for junior engineers, it was at the start of a downturn so the available positions were becoming competitive. My co-op background provided an edge over the graduating engineers that did not have prior work experience, and the contacts and friends that I had made throughout my co-op rotations provided an excellent network of contacts and references to aid in the job search. The mining industry is a relatively small one, and the ability to network prior to graduation was very advantageous when it came time to

search for a job. In a sense, the co-op work terms are extended job interviews and many of the students who participate secure an offer of employment by the end of their final work term”

(Hendricks, 2014).

Because co-op students have the opportunity to complete five four-month work terms they have the ability to try working at different companies, different types of operations, different types of organizations, and different work schedules. There is great value in finding out prior to graduation whether one is better suited to consulting or working at an operation; underground or open pit; or a Monday to Friday schedule or a two weeks on and two weeks off fly-in-fly-out (FIFO) schedule. Having this knowledge may not only help young engineers secure a full-time job after graduation but it will also help to ensure that they make an informed decision on their career path upon graduation.

7.2 Industry

Employee retention in mining is a challenge that many operations face. The remoteness of many locations alone can dissuade potential candidates from even considering employment at some mines (Mining Industry Human Resources Council, 2013). Many companies recognize the various benefits to hiring students in the summer or on co-op work terms and have incorporated Co-op hiring into their workforce planning to address these kinds of challenges. And it is this kind of consistent hiring and collaborative approach of industry that is most beneficial for universities when it comes to providing a quality service to students, and particularly in the case of mining engineering, increasing the rate that students decide to complete their degree and to pursue a career in this industry (Lamson, 2013). This in turn ensures a supply of talent is available to meet industry’s projected demand.

Through Co-op Programs companies have the opportunity to meet short-term recruitment needs as well as assess student performance for longer term recruitment needs (Canadian Association for Co-operative Education, 2014). For Ellefson, participating in co-op is almost a requirement to stay competitive as a company.

“The whole notion of co-op is excellent... This is a really important part of any company’s long term strategy to be connecting with universities to hire for their businesses. We are very supportive of this kind of partnership. You’d be crazy not to be. I don’t know how you would be competitive otherwise. At the end of the day we are competing against everyone in the industry for the top students so it is everyone’s best interest to have a good partnership. Industry really relies on universities to prepare people for the workforce and I think industry has high demands, absolutely. I have to be honest, we have hired a good number of co-op students this summer and they are great quality and I think that university has come a long way since I was in university”

(Ellefson, 2013).

Some companies rely on co-op programs to address their short-term recruitment needs during peak periods. An example of this is during the summer when there is a surge of construction projects which leads to demand for people to fill roles to assist engineers, cover vacation leave, quality assurance and quality control, testing, inspections, reporting and documentation, as well as many other entry level roles that an engineering student is capable of doing. Depending on the amount of training and resources required to ensure a successful work experience and the nature of the work a student would do, hiring co-op students can be a cost-effective, low risk, and low commitment staffing strategy with incredible upside potential. Neil Singh, Partner at Klohn Crippen Berger, describes how they use co-op as a strategic recruitment tool:

“It’s been a focus of ours to recruit through the Co-op Program and use it as a screening tool to identify the cream of the crop. We look for like-minded individuals who share our

goals, objectives, ideals, and values and then to try them out. It's one thing to see a resume on paper or to sit in a room and interview someone but then you have to have the rubber meet the road somewhere. You have to see how they actually perform. The Co-op Program has given us a real opportunity to do that with a lot of young engineers and it has been really successful”

(Singh, 2013).

However, co-op is not just for assessing talent. The majority of students provide real value as productive employees during their work terms. In fact, there are countless success stories of the impact a student has had on a company that can be drawn from the various co-op programs in Canada. Co-op students are armed with the latest technology and bring to a job with them fresh eyes and innovative thinking that when utilized can have a significant impact within an organization (Canadian Association for Co-operative Education, 2014). One recent example that stands out is student Dominic Toselli at the University of Waterloo as described by Dehaas.

“On a work placement at Apple in California, he pitched the design team a mechanism that will allow a camera component to detach from a product like an iPhone if it hits the ground, reducing the likelihood of anything breaking. Steve Zadesky, vice-president of iPod/iPhone design, was so impressed, the company took out a patent that had tech blogs buzzing in March. ‘It wasn’t easy,’ says Toselli. ‘It definitely made the work term.’ On a co-op term at Shell, Toselli had another idea that so impressed engineers near Fort McMurray, Alta., that he was flown on a private jet to present it to researchers in Calgary. His boss told him that his analysis, showing that human factors were behind a particular heat exchanger problem, will save the company \$1 million per year. One idea that stuck from his co-op terms at Shell and Cenovus (another oil sands firm) was how frustrated engineers were that oil and gas leaks could go unnoticed for years, potentially contaminating water and cutting into profits. The result is PetroPredict, a six-

month-old company Toselli and a partner started that will use data analytics to find leaks. Their pitch has garnered awards, including \$25,000 from Waterloo business incubator VeloCity. Toselli lined up a few pilot projects in Calgary over his Christmas and reading breaks, and says investors are lining up, too”

(Dehaas, 2014).

Much the same as hiring for a full-time position companies sometimes hire someone who isn't a good fit. With Co-op the risk is low as the work term length is predetermined typically for four or eight months. Many UBC Engineering Co-op employers have had tremendous success utilizing the Program to screen candidates as part of their recruitment strategy. One such individual is Graeme Lamson, Senior Metallurgist at Mount Polley Mine. “Before we started hiring UBC students this way, it was really kind of hit-and-miss,” claims Lamson (Lamson, 2013).

For any company with growth projections there is no better way to ensure a pipeline of talent than to utilize co-op as a testing ground. Not only will this provide the company an opportunity to view the performance of candidates for four or eight months on the job, but it is also a powerful marketing tool to attract future students. Upon returning from a work term it is common for students to discuss their work term experiences amongst their peers which leads to the formation of opinions of companies in industry well before they graduate. Consequently, it is in the best interest of an organization to ensure that they provide students with a high quality co-op work experience.

7.3 Universities

Co-operative Education programs attract high achieving, well-motivated students to departments and/or universities and can have a positive influence on student enrolment (Canadian Association for Co-operative Education, 2014). Universities boast the co-op successes in their recruitment campaigns and the co-op booth at open houses receive many

questions about co-op from both future students and their parents. Headlines such as, “Waterloo co-op students earned \$190 million + last year” suggest that Co-op can be used as a powerful marketing tool when it comes to recruiting top high school students to their programs (University of Waterloo, 2014b).

There are a variety of ways co-op can benefit a department. Co-op students can act as a bridge to connect industry to their academic institution as well and facilitate the opportunity for employers to provide feedback regarding curriculum content (Canadian Association for Co-operative Education, 2014).

At UBC the personal connections of the professors in the mining department has enabled the department to facilitate co-op and summer work opportunities for its undergraduate and graduate students over the years. Joseph argues that it is important that faculty are involved in co-op and maintain contacts in industry which is not the case in some other countries:

“One of the things that the Australian and European universities have fallen down on is that although some of them do run very successful cooperative education programs they have not given it a high focus. It is an extra thing that happens within the curriculum. It’s not seen as being part of the curriculum process. So the academic staffs restrict their roles to teaching environment and research environment. They aren’t involved in the cooperative process, and it is administrators and people who have HR backgrounds who are interfacing with other HR people in industry, and that’s wrong. We need to do both. We need to have academics who have colleagues that have contacts within industry, and they are talking to engineering professionals and to technologist professionals. They are addressing, ‘what are your needs? Where are things going?’ and building those relationships”

(Joseph, 2013).

At UBC the Faculty of Applied Science has set lofty new goals for future graduating students. The aim is to provide all engineering students with professional development experience during their undergraduate years and to facilitate an international experience for 40% of them within the next few years. Co-op will play a huge role in reaching these targets through work experience opportunities both domestically and abroad.

Many students are attracted to the idea of having the opportunity to travel and work in a different part of the country or around the world which many co-operative education programs offer. At the UBC Engineering Co-op Program approximately 5% – 15% of students each year work outside of Canada in developed countries such as the Australia, Germany, Japan, and the USA and developing countries such as Ecuador, Mongolia, and Tanzania.

By focussing not just on the student experience but also the successful career outcomes of their graduating students, universities can develop better ties with their alumni. Those who had a positive experience should be more inclined to collaborate with their alma mater or other university. Conversely, those who had a negative experience with their university may be less inclined to participate in any university activity.

As discussed previously, the cyclical nature of the industry is challenging for the development of engineering students. This is particularly the case for engineering co-op programs as Slack describes:

“The cyclical nature of mining is difficult for (co-op). When mining is booming the enrolment rates go up, which means you have more students to place; and when mining goes into a downturn there are very few student jobs available. So you end up with the worst of both worlds – high enrolment and low number of summer jobs available. Of course, when it goes the other way – enrolment drops and an upturn happens you’ve got summer jobs and no students. That’s been our cycle. It’s difficult for the students”

(Slack, 2013).

Mining related work term opportunities dropped dramatically in 2009 and 2010 in response to the economic downturn. The result was that students at schools across the country struggled to secure co-op and summer work as well as work after graduation until 2011. "If we lose these individuals mid program, so if they start mining engineering or geo science and half way through they leave because they can't find a summer job, well, we'll never get that person back," according to Montpellier (Montpellier, 2013).

Co-operative education is perhaps the epitome of collaboration as it benefits industry, students and universities alike. However, with collaboration is the need for consistency and long term commitment. When industry stops hiring students in response to a dip in the economy the impact is felt at universities. The cyclical nature of the mining industry is the single greatest challenge to co-operative education programs.

8 Professional Development

One theme that emerged from the data is a lack of communication, project management, and leadership skills. This is consistent with industry survey results as well. According to a report by learning and textbook rental company Chegg, only half of college graduates felt 'Very/Completely prepared for a job in (their) field of study when (they) graduate' and less than 40% of employers surveyed felt the same way (Chegg, 2013). This section discusses the benefits to industry of strategically investing in the professional development of key employees.

8.1 Communication, Leadership, & Management Skills

The research data revealed that weak communication skills is not limited to international new graduates with a weak handle of the English language, but rather encompasses all individuals with an inability to effectively get a point across either verbally and/or written. McAndless describes one example:

"If a student or graduate is involved with me on the mentoring side, what we start to work on almost right away are communication skills... and it is surprising and almost shocking the lack of communication. I'm dealing with a (native English speaking) Master's student right now who is really challenged with communication, and an incredibly bad speller... and it is shocking"

(McAndless, 2013).

Much like at other schools in Canada the engineering curriculum at UBC requires students to take an English elective in first year as well as a technical writing course in second year to provide a basic foundation. Nick Kwong, Corporate Mining Engineer with New Gold, argues the importance of developing verbal communication skills: "A first year engineering course at university emphasizes written communication (APSC 201). So why isn't there verbal communications?" (Kwong, 2013). Learning concepts such as organizational behaviour have

developed his communication and interpersonal skills which has enabled him to better manage people:

“The most valuable thing I learned in my MBA was organizational behaviour. That’s helped me the most in my job. The technical stuff is pretty straightforward but getting people to do stuff is the challenging part. Organizational behaviour is not even touched in undergrad and there’s no continuous learning on that topic...

I think it is more and more important to teach this at a university level because the management style in mining is totally different today from 20 or 30 years ago. For me, I can’t just go up to an engineer and say, ‘hey, get this done’. A long time ago you probably could and it would have gotten done. Now you have to talk to the person a bit, see what they’re up to, see if they have time, see how their family is doing, and then you can say, ‘hey, if you have time can you get this done?’ and then it gets done. So, learning different styles of communication and understanding how groups work, how people tick and things like that is important”

(Kwong, 2013).

A common stereotype about university students is that those who are strong at maths but weak in English go into Science while those who are not good at maths but have strong reading and writing skills go into Arts. The common misconception is that there is not much writing involved in the Sciences and so many students choose this path to avoid having to write. This has its consequences when it comes to some companies seeking employable, well-rounded individuals. Singh describes the trend that he sees with new graduates:

“it’s a key skill and so many young engineers come out without that ability and without understanding how to effectively and logically tell the story. They may be able to solve the problem but if they can’t tell me how they solved the problem and why that solution solves the problem then I can’t deliver that to the client”

(Singh, 2013).

Another significant area of weakness identified is a lack of time management and project management skills. From the consultant perspective there is high importance given to the ability to prioritize tasks and deliver on time. As a manager of a diverse team of employees, including a number of co-op students every term, Singh describes a tendency for young people to struggle to meet deadlines which can be compounded by a lack of communication.

“You want things on schedule as much as on budget and have that quality of work, but so often schedule is the thing that slips. You tell someone to do something, you check in with them three times in the week and they say that they are on track, but at the end of the week they don’t have it done. When you ask why it’s not done they say that they had this problem and that problem and so they ran out of time. Why didn’t they know about this on Tuesday? Why didn’t they say something when I checked in on Wednesday? Those sorts of things. That lack of understanding of when to finish and deliver is something that I’m always having to deal with”

(Singh, 2013).

As for project management its noted that there may be more opportunities to get project management experience for some students in disciplines such as civil engineering; however, according to Mast, engineers of any background can end up tasked with managing projects as they progress in their careers:

“...once you leave school, you’re either doing research, you’re doing operations, or you’re doing projects. Eventually, everything is related to those three... The school prepares us well for research and for operations, but I don’t think the schools do as good a job preparing people for projects.

That may be something that the curriculum could focus on a little more: basic project

management. You do have mine design as a course and the (metallurgists) have a project as well, but those are studies and not about executing a project. It's about doing a study so that someone else can do the project... Projects affect us incredibly, and we kind of learn it on the fly”

(Mast, 2013).

Project management skills are perhaps even more critical for engineering / consulting companies as their business is dependent on delivering projects to completion for clients. Most students graduating university are familiar with group projects; however, perhaps not all of the students in each group reach the desired skills development outcomes without additional guidance and facilitation from the professor. According to Slack students graduating university just do not possess the project management skills required by industry and instead they tend to pick up these skills on the job:

“Students get experience in that through projects they work on, but actual training and learning of project management is something that doesn't seem to be in core curriculums. I may be wrong there and that some schools may have picked that up. But that has traditionally been a shortcoming of new grads. People who come out of school invariably get involved in projects usually early in their career”

(Slack, 2013).

The university system at the undergraduate level has its limitations when it comes to educating students to meet all of the demands from industry. One argument from academia is that perhaps it is not the job of university but rather it is industry's responsibility to provide employees with the professional development and coaching to become HQP. “I think we've just got to go on and do what we do well, which is produce the rough uncut diamond and let the companies do the finishing and polishing” (Anonymous, 2013). This is supported by the

argument that universities are overwhelmed and do not have the capacity to teach the professional skills. The engineering curriculum is heavy and there may not be any room to add additional courses to address the lack of these skills and so it is up to industry to find a way.

According to Slack:

“The solution at present, which I don’t think is the best solution, is that industry just does what we need to do. So people come out with gaps in certain areas and we address those gaps. That’s the status quo. It would be great if people had a foundation in (safety, project management, and communication skills). As an employer we have to address that”

(Slack, 2013).

Others suggest that perhaps it is not the university that is unable to provide the education but that it is the undergraduate student who simply is not ready.

“...the young man of eighteen when he becomes twenty-two when he’s leaving us is a different person. They go through a maturity step. It’s not like puberty but it’s almost like moving from wild kid to young adult. Once the young adult gets there and they understand the importance of hard work and self-promotion you get a different animal then and they are receptive to a company telling them to do things and molding them. Whereas I don’t think they would have been receptive at a university”

(Anonymous, 2013).

In some cases it is maturity while in others it may be a lack of life experience that makes it difficult to put theoretical concepts into context. However, much like with technical skills, after gaining some real world experience a young person may be in a better position to develop the

professional skills more easily. Kwong suggests that this might be the case with organizational behaviour:

“...after you’ve worked for a year or two and you find out that you can’t communicate with all of the guys, that they don’t want to do what you want them to do, and go through that learning experience in real life, then you can understand the actual mechanics of that”

(Kwong, 2013).

Perhaps more challenging to develop than communication and project management is leadership skills. According to Steeves, leadership is not necessarily something that can be simply taught in a lecture but rather is developed over time through a combination of theory and experience:

“...I think it should be integrated throughout the whole (curriculum). And the moment you treat it as something separate you have got a problem. If someone is on a 4-year engineering program, whatever (discipline) they are, every semester there should be something going on around leadership. Every semester. And so it becomes part of how they show up, and they become learners about themselves. So when they do some assignment there’s a reflective piece in there. When they do things in groups they should look back and ask, ‘who led this group? How come? How did you show up as a follower? How was that? Who don’t you want to work with?... But before you do that you need to provide the skills they need to have a tough conversation, to give some real feedback. You give them those skills, and then it’s integrated with what they do on a day-to-day basis. So it’s not a course, but it’s a part of how they show up, so that then out of it, they develop confidence and the self-awareness that they can deal with the tough people stuff, and it’s not just theory. They don’t need theory. They need confidence and skills to be able to do it”

(Steeves, 2013).

Universities are acutely aware of the need for undergraduate students to develop these core skills and many universities around the world have already taken steps to adapt their curriculums over the years to provide opportunities for students to develop these soft skills.

“We try to include presentation skills not as a taught course but we try to embed it into the program. Whatever program you are doing there will come a time when you are doing a project and you will be expected to present to your faculty and to your peers on how you are doing. It’s a particular thing that I’m concerned about. I’ve seen some awful presentations,...

We do try to embed into our course group work because that is the other key thing. If you are an engineer and you get a job in a company you will be working in a group. They are not going to let you work on your own and do your own thing. You are going to be in a multidisciplinary group or a group of your peers and you are going to be learning to work with them and being a member of the team. We try to make that happen at university as part of the program. It’s not up front, it’s not a specific program, it’s just embedded into the program, in the same way we embed sustainability, we embed environmental issues, or how to design. These are issues that we try to build in”

(Anonymous, 2013).

These are excellent ideas in theory and perhaps some schools are having greater success than others. However, the data indicates that there is much room for development. One of the challenges in expecting students to gain particular skills through group projects is a professor’s limited ability to influence group dynamics and the soft skills developed by each member of a group. Not only is it difficult to ensure that students distribute the workload evenly and that all members participate, but it is even more challenging to facilitate each student developing new skills or being pushed outside their comfort zone. There is a natural divide between students

with leadership experience and skills and those without. The tendency is for the students more comfortable in leading to take on a leadership role while the others tend to support this. These stronger students continue to develop their communication and leadership skills more so than their group mates further increasing this divide. “It seems almost like the people that have an innate ability develop it further and the people that struggle with it don’t get any help and struggle with it for a good part of their lives, according to Slack (Slack, 2013). Those with the stronger communication and interpersonal skills tend to also have an easier time securing work according to Lyon:

“When you see the students that actually get the jobs though, they were marked for it from the beginning. They were these vibrant, exuberant, gregarious, social individuals that went out there and were able to attend all the job fairs. They go up and shake your hand. They would network at the student industry mixers”

(Lyon, 2013).

Recognizing the importance of communication skills, Science faculty at Dalhousie University have recently created a program to develop leadership and communication skills and added a Certificate in Science Leadership and Communication to their options. This is the first program of its kind in Canada. This innovative initiative evolved from collaboration between professors in both the Arts and Sciences (Jang, 2014).

By the time they graduate many undergraduate students are aware of their shortcomings and the fact that university courses do not provide all of the non-technical skills required for success in industry. According to Hawkins and Barclay this can be incorporated into a company’s recruitment strategy:

“the selection qualities that organisations use are not, in general, being developed by undergraduate courses, and this should be taken into account when assessing

individuals. This apparent problem can be turned into an opportunity. The graduates themselves are aware of this lack of skills based development, so the offer of such training as part of the development package is very attractive to them.

The concept of career management is one which must be developed within the undergraduate educational system and maintained by the employing organisations. The individual should be encouraged to take responsibility for this process as early as possible, with academics and employers playing a supporting role”

(Hawkins & Barclay, 1990a).

Regardless of whether its universities or industry that takes on a larger role, it is imperative that young engineers receive professional development in order to meet the demand for HQP.

8.2 Investment in Professional Development

One example of investment in the development of young engineers is the Graduate Development Program at Goldcorp Inc., which involves newly hired engineers, metallurgists, and geologists placed in a three-year program designed to put them on the fast-track to their chosen career (Brown, 2014). Many mining companies attract new graduates by offering similar programs such called rotational training programs or EIT programs. However, because of Goldcorp’s commitment to developing future leaders to meet its considerable growth projections it accepted 19 new hires in the program’s first year and added an additional 40 who were chosen amongst existing employees (Brown, 2014).

Each individual completes two 18-month rotations at different operations in North America with as many as three job rotations at each mine, all designed to provide them with the broadest experience in a short period of time. Each member of the program is also assigned a personal mentor from outside their area who guides them through the entire three years. The program supplements the hands-on technical work experiences with leadership training sessions and

developmental projects. All of this training, education, experience, and mentoring is designed to accelerate their careers and to facilitate the acquisition of a professional designation in their field, such as a Professional Engineer (P.Eng) designation for engineers (Brown, 2014).

Provinces in Canada have a licensing and regulatory body for engineers that requires lifelong learning and the continuation of professional development for licensed engineers. The Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) requires engineers to complete 80 hours per year and offers various forms of education to help fulfill these requirements and to maintain a P.Eng designation. According to tenet six of the APEGBC Code of Ethics:

“Members and licensees shall keep themselves informed in order to maintain their competence, strive to advance the body of knowledge within which they practice and provide opportunities for the professional development of their associates”

(Association of Professional Engineers and Geoscientists of British Columbia, 2014).

However, according to Mast for many university graduates the learning and development opportunities can stop when they enter the workforce or the learning can get very narrow or focused whereas the need for many HQP is to gain a wider level of knowledge.

“We are pretty well-prepared coming out of school but not that well-prepared, and then you start in industry and a lot of the learning stops. You only start learning what you’re doing and you get a very, very narrow focus, and it would be good to continue that learning... People get out of school and they forget a lot of what they learned... You have some blind spots as well... for instance, someone like me, I knew nothing about geological modeling because someone else always did it, and it’s just like those people who did the geological modeling knew nothing about processing. You have to learn it as you go. But you only learn it as you go if you have to, if you get to a certain level in the

company where you have a good overview. But when you're still developing as an engineer, it's a blind spot"

(Mast, 2013).

According to Gallagher, times have changed and much of the technical engineering work that used to be done by engineers at operations is now outsourced to engineering companies to the detriment of young engineers at the mines.

"I really believe that mining companies owe it to their young engineers to give them a chance to do stuff. Maybe they are a bit slower and maybe they might get it wrong, but in the long run it will probably cost a lot less than getting a consultant to do it for you, plus you will enrich the guys' experience and they will probably stick around longer"

(Gallagher, 2013).

According to Kaliprasad, research numbers reveal that there is financial benefit to a company investing in the development of staff:

"Investing in employee education and training and subsequent development does have a financial payback aspect for the company. For example, Motorola believes that it receives \$33 for every \$1 invested in its employee's education and training. Also, Standards & Poors list 124 companies with revenues per employee in excess of \$300,000"

(Kaliprasad, 2006).

However, a study conducted by the Conference Board of Canada reveals that companies in this country do not invest as much in the professional development of employees compared with countries in other parts of the world.

“The evidence for Canada's weak track record on employer-sponsored training is clear. In 2009, only 31% of Canadians aged 25 - 64 participated in some form of non-formal job-related education. This is slightly higher than the OECD average of 28%, but well behind leading European countries such as Sweden (61%), Norway (47%), Finland (44%), as well as the United States (33%). Moreover, Canadians received just 49 hours of instruction - lower than the OECD average of 59 hours and less than half the hours (105) received by adults in Denmark, the leading performer”

(Munro, 2014).

The survey revealed that company spending on training and development of employees in Canada has declined 40% over the past two decades. The main reasons for this phenomenon are an increasing reliance on post-secondary institutions to provide the training and development, a concern about the cost of training and education, and the risk of losing an employee to a competitor after making such an investment. The study also shows that although 67% of companies train employees, 47% also lure talent away from competitors. It remains to be seen whether or not initiatives such as the Canada Job Grant provide enough incentive to encourage companies to invest more in training their people (Munro, 2014).

In contrast, a National Centre for Vocational Education Research (NCVER) study commissioned by the Minerals Council of Australia reveals that the mining industry spent \$1.1 billion (Australian) on training during the financial year ending 30 June 2012. Only 2% of this was government funded with almost 98% funded directly by industry (National Centre for Vocational Education Research, 2013).

Many interviewees based in Canada indicate that their current employer does, in fact, support both technical and non-technical professional development of its employees. Furthermore, there is clear demand for both technical and non-technical professional development options from engineers such as Kwong:

“Course work for industry would interest me. Ongoing courses are part of our development plans every year. There is a portion of learning you have to do, whether it is conferences or coursework. But it is often really hard to find courses to go to. You first need to find a title you like and then you call around to see if it’s worth your time or not. What would be attractive is to see courses offered that were the ones that I didn’t take when I was in university...

There are a lot of courses that you don’t take in 3rd and 4th year and it could be like one of those courses but compressed and completed over a weekend. It’s important to learn the fundamentals of a particular topic and then apply it in real life. The short course workshops at CIM are not comprehensive enough. For me, one of the big gaps is mineral processing and I don’t have time to attend a class every week on campus. However, if they offered something at Robson Square that you can complete in a few days I could take it”

(Kwong, 2013).

According to Executive Consultant, David Cawood, there is great value in a company providing in-house training to its employees.

“...most of the successful companies over the long term that were identified in the book “Good to Great” developed people from inside. The most classic example of this was General Electric when Jack Welch was there. They had a GE college at Crotonville in the United States and I attended a few of these. Jack Welch used to go every second Friday and give a presentation at the college for their executives. And they put in a huge amount of energy and they had top level academic guys and Jack Welsh himself and odd visitors like myself. They really put in major resources into in-house training and as a result of it many of the American organizations today are being led by ex-GE people...”

(Cawood, 2013).

Cawood is also involved in professional development at the University of British Columbia delivering lectures to students on communication and leadership.

“My reason for donating my time and resources to UBC is because I think that some aspects of the university and industry partnerships are not working. One aspect that I’m trying to change by demonstration with (the Electrical Engineering Department) is to say the universities need to play a greater role at that development aspect as Stanford does. Stanford runs a course on management and strategy for engineers”

(Cawood, 2013).

With the remote nature of many mining operations, online education becomes attractive. In collaboration with the University of British Columbia, and the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) EduMine, the professional development division of InfoMine Inc., has developed a Certificate of Mining Studies (CMS) program. The program provides online courses, short courses and live webcasts in support of professional development and training for the mining industry. In order for Rio Tinto to meet its eventual workforce target of 90% Mongolian citizens at its flagship Oyu Tolgoi mine in Mongolia it arranged a partnership with UBC and EduMine to set up virtual campuses at the Mongolian University of Science and Technology (MUST) and at the mine site. Canadian developed mining short courses are delivered in-person supplemented by online courses as part of the certificate program (SW Houlding, 2011). This is one example of successful collaboration in education; however, according to Simon Houlding, VP Education with EduMine, the industry has been slow to embrace online education:

“The biggest negative we have experienced is the conservatism of the industry itself to accept new ways of doing things. This has been an experience along the way. I wouldn’t

say it's like that now. We've obviously overcome a lot of that. Getting people to agree that this was a good way to do things was probably the biggest negative we experienced"

(Houlding, 2013).

Currently the number of professional development options for engineers is limited. Figure 8 provides a list of some of these options provided to employees at companies in Canada.

Mining companies are looking for well-rounded individuals to come out of university with all of the necessary skills to become future leaders in industry, whereas universities are more focused on producing graduates with a solid technical foundation enabling them to successfully become professional engineers. When and where these individuals develop the non-technical skills required to become successful leaders and managers remains unclear. However, given that universities have the resources, infrastructure, and expertise, they are in a strong position to capitalize on this demand.

Figure 8: Professional Development Options



9 Conclusions

The three main objectives of this research were to identify successes and failures in collaboration between universities and industry; explore possible solutions to address these failures; and discover what specific actions have been taken by stakeholders or what actions they are willing to take to contribute to leadership development in mining. The following conclusions and recommendations mainly discuss the first two objectives. The third objective has been discussed very little up to this point mainly due to a lack of data, which leads to the conclusion that it is not a lack of awareness of the challenges facing the industry that is the problem but rather a lack of ownership or a sense of responsibility of the challenges. There is much room for individuals and organizations overall to become more involved in the development of mining leadership in Canada and there is a necessity to convince and motivate them to take action.

Based on the recent history of the industry, the economic cycles that plague mining seem to be unavoidable. The resulting short term decisions made by companies damage the industry. During the low cycles the reaction of companies by laying off workers and freezing hiring deters new recruits and the attrition of people is high. During the high cycles human resources pressures inflate salaries, as well as the expectations of new graduates, which leads to unsustainable practices and challenges with respect to retention.

Industry and academia differ in their mode of management and development due to their fundamentally differing philosophy and priorities. This makes it challenging to develop relationships and establish collaboration with each other. On the one hand, companies generally place low priority on partnership with universities and place little priority on recruitment, development, and research within their long term corporate strategies. On the other hand, however, universities tend to not be proactive or forward thinking in seeking partnership opportunities with industry as well as other universities. Mining programs at universities around the world are facing a range of challenges, particularly financial woes and shortages of qualified

faculty and staff. Industry, however, tends to place a low priority on tracking the variety of opportunities for collaboration with universities and how they can benefit both parties. Moreover, universities could also place greater effort in being proactive to facilitate such dialogue.

Natural resources extraction is more challenging than ever before. Mining engineers are required to possess a wide spectrum of knowledge, skills, and experiences in order to be successful. Many engineers lack the transferable skills to be successful managers and leaders in an industry that is projected to be short in both. A generation gap in the industry has reduced the ability of the experienced to mentor the inexperienced, thereby transferring their invaluable expertise, potentially to be lost through retirement over the next decade. Furthermore, young engineers are continually facing the risk that they may be filling roles for which they may be underqualified, placing both production and safety at risk.

Post-secondary mining curricula may not address the needs of today or the future. Through collaborative features such as co-op work terms students benefit significantly from real world work experience; however, hiring has been inconsistent and overall company spending on training and development has declined over the years. Also, research investment by mining companies in Canada is low compared to that of other industries in this country and even more so when compared to research investment abroad.

The majority of Canadians are unaware of the career opportunities in mining and the industry continues to struggle in attracting new recruits. Financial investment in recruitment and education has not been strategic enough. Scholarships and sponsorship to attract high school students to consider a career in mining or attract new graduates towards full-time employment have led to inconsistent if not poor results.

10 Recommendations

There is no simple solution to addressing the shortage of Highly Qualified People facing the global mining industry and ensuring Canada's mining leadership. The practice of largely ignoring the current problems facing the industry jeopardizes the long term sustainability of Canadian mining overall. This research uncovers the many opportunities of companies and universities to change this fate. The following section discusses four strategic areas that are recommended for industry and university collaboration in order to develop and sustain Canadian Mining Education.

10.1 University and Industry Partnership

Companies need to develop a better understanding of how universities operate, the challenges they face, and how they can help mining schools do what they need to do – that is develop HQP. However, this is a two way street and universities need to be proactive and reach out to industry to seek partnership opportunities as well. No longer can universities rest on their laurels and passively wait for industry to bring to them their technical challenges. Universities, and in particular specific departments, need to prioritize industry collaboration by investing in people to actively seek out business opportunities. Universities need to market the various opportunities for collaboration available and attract companies to commit to long term partnerships.

Companies need to recognize the longer term focus of universities and commit to longer term collaboration, regardless of the ups and downs of the economy. The economic cycles are inevitable and so both sides need to ensure that the partnership is sustainable and can withstand future cycles and the inevitable turnover that results from them.

“Education and training partnerships are important, particularly given the demonstrated gaps and the projected needs for highly skilled and highly educated workers; however, initiatives take time to implement and strategy development requires immediate action”

(Mining Industry Human Resources Council, 2013).

Companies can have an impact on the health of mining schools by having a senior representative actively participating on an advisory board to provide leadership and ensure that mutual goals are achieved. Industry has much to contribute to the educational experience of students at university whether it is through hands-on work term opportunities, financial or in-kind support, networking and professional development opportunities, sharing experiences and knowledge in the classroom, or simply exposing students to industry. The successful track record of mining engineering co-op students and new graduates at the University of Alberta securing work is a testament to the value of a strong industry advisory committee.

Unfortunately, mining schools no longer have the full range of faculty on staff to provide expertise in every area of the mining curriculum and so industry is called upon to supplement this. Licenced engineers have an obligation to pursue Lifelong Learning and Professional Development from which they can gain credit. This should be an area where mining schools can benefit from more industry support. For the variety of challenges facing today's mining engineers the curriculum needs to be flexible enough to incorporate industry experts in a wide range of fields such as CSR, law, or business to ensure that new graduates are best prepared.

Research and technology development is an area where industry needs to invest more money and resources in order to maintain competitiveness. Not only has research benefited companies financially but universities have gained through funding, infrastructure, and equipment, all of which enhances the quality of education provided benefitting the Canadian mining industry as a whole. An increase in research collaboration will benefit all stakeholders on campus: departments, faculty, and students.

Naturally the more positive experiences students have during their time in school then the more likely they are to continue to pursue a career in this industry, and so it is in the best interest of the mining industry to support mining departments at universities. Companies need to determine

which are their key university partners and to consider all of the possible opportunities for collaboration to create a recruitment strategy catered to their organization's specific needs.

“As competition for talent heats up across the mining sector, workforce planning has become increasingly sophisticated. Companies bound to win the race are those capable not only of identifying their global resource requirements, but also of understanding where to source their human capital supply. This extends beyond identifying replacement workers for people slated for retirement to factoring in turnover rates, the number of graduating candidates, requisite leadership skills and potential supplier gaps in each planned or operational geography”

(Deloitte, 2012b).

Inevitably the companies that will end up on top in the war for talent will be those that prioritize attraction and retention by investing resources in recruitment and development of HQP. However, during peak periods of the economic cycles it is imperative not to be tempted to attract talent through unsustainable promises for risk of inflating expectations leading to dissatisfaction on the job.

10.2 Inter-University Partnership

The loss of several mining schools over the past few decades and the shortage of qualified mining educators is a serious concern. With projections of demand for HQP higher than supply projections of new graduates it is critical that educational institutions themselves work more collaboratively to best meet this demand. Joint curricula between educational institutions have proven to be successful. Expertise from industry can be shared amongst schools as well. With advances in communication technology this should be the way of the future to ensure that the best possible education is provided to the widest audience of students, and industry can play a

key role in its implementation by acting as a catalyst, lobbying governments, and providing guidance and support.

Mining is truly a global industry and so mining education too needs to become more international. Many companies are international and have recruitment needs in different parts of the world. Facilitating exchanges between post-secondary institutions through establishing block transfer credits is one route to developing overall educational capacity. Facilitating international student master's level education is another. If mining schools in a particular region struggle to increase student capacity, facilitating international student recruitment in regions of demand may be one answer. Industry can identify high achieving individuals in a particular geographic location and support an academic exchange or master's education for which there is mutual benefit.

10.3 Professional Development

Upon graduating from university new EITs do not possess all of the non-technical skills desired by industry because the current curriculum does not facilitate it. Moreover, many undergraduate students may not yet have gained the maturity or life experience required to develop these skills prior to entering the workforce. Exposing students to the working world through quality co-op and summer work terms has proven that it can be a more effective development strategy than the traditional academic route alone. Universities need to continue to provide students, both co-op and non-co-op, with professional development opportunities and companies need to commit to supporting this by hiring co-op and summer students consistently regardless of the economic cycles, engaging students to participate in industry events, and participating in the classroom, in laboratories, and on projects.

However, the bulk of professional development of HQP inevitably will take place after graduation. On top of technical training there needs to be focus on the non-technical skills such as communication, leadership, and management. The benefit of providing a quality professional development program is not just the development of a high achieving workforce but also an

increased ability to attract ambitious new graduates and attaining a higher rate of retention of employees.

“A key trend emerging is the increased importance both candidates and employees place on career development and progression as a driver of attraction and retention. Nowhere is this more pertinent than in the mining and metals sector where a lack of clear career pathway and opportunities are often cited as a reason for leaving”

(Ernst & Young, 2013).

Many companies are not equipped to provide professional development education to their employees which is an important opportunity for universities to provide a valuable service, increase revenue, and develop stronger ties with industry. Universities are already equipped with the expertise, facilities, and infrastructure, which enable them to provide a wide range of professional development options for companies. Universities simply need to recognize the opportunity and be proactive in seeking business partnerships. It is those schools that evolve and adapt to the new realities of higher education that will survive period of fiscal restraint.

10.4 Mentoring

The retirement of the “Baby Boomer” generation will leave behind a void in both human and intellectual capital. The current population of HQP set to retire over the next two decades possess expertise that the industry desperately needs to retain. There are a number of routes to transferring knowledge to the younger generation but the industry needs to act immediately as the process takes time and the wave of retirement has already begun.

Companies need to commit to knowledge transfer. There needs to be a balance between focussing on near term profitability of an organization and the long term sustainability of the industry as a whole. Companies need to keep the retiring knowledge workers longer. This may be accomplished by offering more flexibility in their roles as they transition into retirement. There

is huge value in pulling these individuals away from operations or management roles and moving them into training, development, mentoring, and recruitment roles. Perhaps the role of the mentor can be part-time or enable them to work remotely. Another option is to have some of these experienced individuals participate in educating students on campus and representing the company, which provides a host of benefits to the organization. Retiring HQP can be utilized to attract young people to pursue a university education leading to mining; they can provide guidance to undergraduate students and facilitate their successful graduation; they can help these individuals secure work during their post-secondary education as well as upon graduation; and they continue to contribute to their development throughout their young career in industry ensuring that the next generation of HQP is best prepared for the challenges of the future.

11 Future Research

This qualitative research and data analysis has focused on the relationship between mining universities and industry and the various factors that influence their ability to collaboratively develop future leaders in the mining industry. This has been a foundation research study with a somewhat limited scope. There are a number of areas that justify potential further research.

This study did not explore the root causes of the economic cycles because of the significant complexity of this phenomenon. It focused on mitigating the issues that the cycles create for mining graduates and those people involved in the industry. Further study from a macroeconomic perspective could provide evidence to motivate industry to adopt a different approach in its long term strategic planning when it comes to attraction, development, and retention of human resources.

With the few remaining mining schools in North America, each struggling to deal with common challenges, it would be valuable to explore the possibility of inter-university collaboration on this continent, similar to the MEA initiative in Australia. Although this topic was touched upon in this study insufficient data was collected to reliably evaluate key questions that would underlie the successful formation of a North American equivalent to MEA.

Providing quantitative data to highlight the positive impact of work experience on job readiness, retention rates, and career advancement would be invaluable to universities, companies, and students respectively. A comprehensive survey was created to gather such data for this study; however, it was not able to be distributed and the data analysed within the timeframe of this study.

Figure 1 illustrates the three stakeholders involved in leading mining education in North America to its current state. This research explored in depth the roles of 'Universities' and 'Industry' however it did not discuss the role of 'Government'. Unfortunately, attempts to arrange interviews with industry experts from government within the timeframe of this study were

unsuccessful. Without a perspective from government there was insufficient data to properly discuss 'Government' in this study.

With countries such as China and India increasing their prominence in the global economy their influence in mining will increase accordingly. Already large numbers of students from these countries are studying mining engineering in countries like Canada. Canadian companies are operating mines abroad while companies from China are developing and operating mines in this country, leading to potential cultural conflicts and challenges. Companies and universities need to be forward thinking by embracing this reality and seeking out ways to overcome the language and cultural differences, which is another valuable area for further study.

These are just five potential areas of further research that can benefit human resources and education in mining. Undoubtedly there are many others. What is important is that more research in this area continues and that the mining industry responds through actions. Canada has an abundance of natural resources and mining expertise as well as the infrastructure and mining legacy to remain a leader in mining education and so it is easy to assume that this will always be the case. However, the mining education system in this country faces considerable challenges putting the health and competitiveness of the industry at risk. The future of the mining industry in Canada is dependent on the commitment of current leaders in mining to developing the next generation of leaders, and this can only be accomplished by ensuring the sustainability of mining education in Canada. Through strategic university and industry collaboration Canada can remain a leader in mining engineering education, research, and technology development, and contribute to the sustainability of global mining leadership.

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Appendix A – Interview Invitation and Questions



June 20, 2013

Research Title: University & Industry Partnership in Developing
Highly Qualified People for the Global Mining Industry

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Norman B Keevil Institute of Mining Engineering

To whom it may concern:

I am contacting you with regards to a research project on University and Industry Partnership in Developing Highly Qualified People for the Global Mining Industry. This research is being undertaken as part of the thesis requirement for a Masters of Applied Science in the Mining Engineering Department at UBC. This letter serves as an invitation to participate in the research project and an overview of the research objectives and the process for participation in the study.

Definitions and Research Objectives: The purpose of this study is to obtain perspectives from industry experts on university and industry collaboration on developing graduate students to become future leaders of the mining industry. For the purpose of this study **“industry experts” are loosely defined as experienced professionals who can provide an informed opinion on university and industry partnership and its impact on the global mining industry.**

The Mining Industry Human Resources (MIHR) Council describes highly qualified people (HQP) as valuable assets to the mining industry that provide organizational leadership, play an important role in education and research, often occupy vital mission critical roles, drive

innovation, and ensure the long-term sustainability of the industry. For the purpose of this research the “global mining industry” is defined as organizations or individuals that work on some aspect of the mining lifecycle including: exploration; extraction and processing of minerals and metals; closure and reclamation of mining lands; and organizations or individuals which support these activities through consultation or other service offerings.

The objectives of the research are as follows:

- Identify the successes and failures of various forms of collaboration between universities and industry in developing Highly Qualified People in mining
- Identify possible solutions to these failures as well as alternate models of collaboration
- Identify what specific individuals or organizations are currently doing (and/or are willing to do in the future) to develop highly qualified people for the global mining industry

Methodology: To gain the information, experts in various positions connected to mining will be invited to participate in 30 - 45 minute structured interviews. Participants will be provided with the interview questions prior to the interview and will be given the choice of location, time, date, and format of the interview. After the interview the participants will receive a written summary of the interview for review and editing as well as be able to choose to remain anonymous or not.

Confidentiality: The structured interviews are entirely confidential, and the interview recordings will be encrypted and securely stored observing the requirements of the UBC Office of Research Services.

The subjects will not be identified by name in any reports of the completed study unless they have otherwise chosen to be identified. This data will not be disclosed to third parties for any further use. The research results will be available to members of the public.

Contact for concerns about the rights of research subjects: If you have any concerns about your treatment or rights as a research subject, you may contact the Research Subject Information Line in the UBC Office of Research Services at 604-822-8598 or if long distance e-mail to RSIL@ors.ubc.ca.

If you have any questions about the research please feel free to contact Masaki Miyoshi or Dr. Malcolm Scoble.

Please read the questions and let us know if you agree to be interviewed, in which case it will be assumed that consent is given. You will have the opportunity to review and edit a summary of the interview that will be provided to you by the interviewer. Furthermore, participation in this research is voluntary and participants can withdraw at any time without any consequence to them.

Thank you in advance for your participation!

Sincerely,

Masaki Miyoshi



June 20, 2013

Structured Interview Questions

- Who are you?
- What is your experience?
- Regarding university and industry partnership in addressing the human resources challenge of developing highly qualified people...
 - ...what do you feel is working?
 - ...What isn't working?
 - ...What would you change?
 - ...do you know of a better model, possibly in a different industry?
 - ...what are you/your company doing to address this and what else might you/your company be willing to do?
- What other thoughts do you have on this topic?
- Who else should I interview?