

Subcommittee of Energy and Mineral Resources  
Committee on Natural Resources  
U.S. House of Representatives

H.R. 3734 (Rep. Crescent Hardy)

To amend the Surface Mining Control and Reclamation Act of 1977 to provide support to mining schools, and for other purposes. "Mining Schools Enhancement Act"

Testimony by:

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Chairman Lamborn, Ranking Member Lowenthal, and members of the Committee, I would like to extend my sincere thanks for the opportunity to address you regarding the long-term challenges that threaten the sustainability of U.S. Mining and Extractive Metallurgy/Mineral Processing degree granting programs. My name is Hugh Miller and I am an Associate Professor in the Mining Engineering Department at the Colorado School of Mines (CSM). I have nearly 30 years of combined professional experience in both industry and academia. I also have the pleasure of serving as the Chair of the Education Sustainability Committee (ESC) for the Society for Mining, Metallurgy, and Exploration (SME). The ESC is a committee comprised of academicians and experts in higher education that was formed with the expressed mission to develop specific actionable recommendations to address the daunting challenges facing these academic programs.

I would also like to welcome you to the CSM Edgar Experimental Mine; a unique laboratory focal to the development of undergraduate and graduate students and cutting edge research in a wide variety of mineral and earth related disciplines including Mining, Metallurgical, and Geological Engineering, as well as Economic Geology, Underground

Construction and Tunneling, Explosives Engineering, Environmental Engineering/Science, and Petroleum Engineering.

This morning you will hear testimony from several experts on the importance of domestic mineral production as it pertains to our economy, standard of living, and national security, and the dire implications of disruptions to the production of these raw materials as a consequence of future shortages in skilled labor and professional talent. Contrary to public perception, and what's often portrayed on television and in the media, mining and mineral exploration in the developed World is pushing the limits in terms of technology and innovation that extends from equipment and operating systems to processes and environmental controls. Furthermore, due to the economic pressures associated with declining ore value, increasing operating and capital costs, and growing regulatory oversight, companies are heavily dependent upon continuous improvement and the use of technology to remain viable. This is particularly true in the mining of unit value commodities, where U.S. operations are often at a competitive disadvantage relative to foreign producers. As such, the future viability of the U.S. Mining Industry and the domestic production of raw minerals is directly dependent upon the availability of a skilled workforce which must possess technical capabilities and competencies that far exceed those needed a mere decade ago. This supposition is supported by a workforce study produced by The National Academies in 2013 titled "Emerging Workforce Trends in the U.S. Energy and Mining Industries: A Call to Action". Mr. Leigh Freeman served on the Committee responsible for this critical study and will provide testimony later this morning.

This study, and several others, identified significant threats to the stability of this skilled workforce. The aging demographics of the Mining Industry has long been a major source of concern that impacts both hourly and salaried labor, where there are simply too few workers available to adequately replace those that are retiring. In addition, the increasing technical sophistication of job assignments and the requisite competencies these younger workers must have represents another challenge. The current labor pool does not have the skills and education necessary to adequately meet these workforce needs now, or in the future.

With regards to professional talent, one of the most ominous threats facing the industry is the steady decline in the number of accredited U.S. Mining Engineering programs over the last 30 years. In 1982, there were 25 degree granting programs in Mining Engineering. Today, there are 14 accredited departments, of which only half can be considered healthy. Of these, only 12 of these remaining programs offer Ph.D. graduate degrees. Since these programs are largely responsible for educating the next generation of professionals who will assume technical and leadership positions in all sectors of the industry, the loss of these engineering programs will have immediate and long-lasting impacts. Beginning with the rise in commodity prices in the early 2000s, industry began to experience significant labor shortages in technical and supervisory positions. With regards to entry level engineers, there was insufficient capacity within the remaining mining programs to provide the new talent that these companies desperately needed. Driven by their constituencies, this “talent crisis” prompted action within professional organizations, such as the Society for Mining, Metallurgy, and Exploration (SME), to quantify the causation factors responsible for the deterioration and loss of these academic programs and find ways for the remaining programs to become stable, and effectively increase the number of graduates being produced. A great deal of work was conducted by many throughout the decade to collect and analyze the data and to formulate strategic plans intended to stabilize and advance U.S. minerals education. These activities facilitated a unique collaboration between industry, academia, and government that resulted in numerous committees and task forces, workshops, symposiums, and related research activities. The consequence of these efforts led to formalized studies produced by The National Academies and SME, papers written by distinguished members of the academic mining community, and proposals regarding the promulgation of potential legislation.

Building upon the contributions derived from these numerous sources, SME leadership created the ESC in fall 2013 with the expressed mandate to formulate meaningful, actionable recommendations to mitigate the prevailing challenges that threaten the survival and long-term viability of U.S. academic programs in Mining Engineering and Mineral

Processing/Extractive Metallurgy. The primary intent of the Committee wasn't to rectify all the threats and challenges facing these programs, but to focus on addressing those critical factors where interventions could have a direct and substitutive impact. The first step was to quantify the underlying factors jeopardizing the short-term and long-term sustainability of the current programs. This was performed by analyzing data and information previously collected through SME and other sources, where potential deficiencies were assessed. Additional information was then collected as deemed necessary. The Committee attempted to develop causation factors that correlated with the trends seen in the data. While the threats to specific academic programs vary by university, there were commonalities inherent to each of these degree programs. It's important to note that these challenges are complex and interrelated, where many of the underlying threats identified are symptomatic of larger changes that have occurred in higher education and are difficult for an individual department or an external entity (e.g., professional organization or a company) to remedy or facilitate meaningful change. These issues are often driven by state mandated university policies and institutional economics, where student enrollment, the physical footprint, and cost per student associated with mineral engineering programs greatly contribute to their vulnerability. That said, the Committee was able to identify several common, underlying factors that significantly contributed to the current dilemma facing these mining programs. Paramount among these challenges includes faculty scarcity and insufficient sources of support for faculty research. While seemingly independent, these two issues are intimately related.

### Faculty Scarcity

As discussed previously, the labor shortages endemic to the Mining Industry also extend to academia. Of immediate concern is the absence of a viable means to address the current number of faculty vacancies as well as the looming future labor deficiencies associated with retirements over the next decade. Two fundamental studies conducted by McCarter (2007) and Poulton (2012) analyzed the demographics of U.S. mining engineering faculty and provided quantitative evidence of the pending crisis <sup>(1)</sup> <sup>(2)</sup>. The results of these studies showed that of the 74 tenured track faculty reported in the 2009/2010 academic year, 100% of the senior faculty in

the U.S. (39 mining professors) will be eligible for retirement by 2020. Compounding this situation is that few qualified professionals are entering academia as new faculty, where only 13.5% were 40 years of age or younger. These factors have resulted in 14 open faculty positions being reported by 12 of the 14 U.S. Mining Department Heads in the 2009/2010 academic year (Poulton, 2012). This study went on to estimate that an additional 18 faculty positions would be needed in 2015 and 21 more openings would occur by 2020. These ominous predictions were largely substantiated at the 2013 SME Annual Meeting in Denver, where a survey of the 14 mining departments indicated that there were 18 faculty positions either currently open or planned in the immediate future, including 5 department head positions<sup>(3)</sup>. To put this in context, the average nation-wide graduation rate for Mining Ph.Ds. has historically been less than 15 annually, where a vast majority of these graduates are International students. In the event that even 25% of these individuals had an interest in pursuing a career in academia and possessed the skill-sets necessary to be successful as tenure-track faculty, it would fall far short of the number of faculty needed to sustain the current programs.

The situation facing the six remaining U.S. Extractive Metallurgy/Mineral Processing Departments appears to be even dire as a consequence of the limited number of key faculty keeping these programs stable. An examination of these programs reveals a population of approximately 22 tenured or tenure-track faculty, where 10 of these professors will be eligible for retirement within the next 8 years<sup>(2)</sup>.

The problem associated with faculty scarcity is cumulative and extends from recruiting appropriate candidates with a desire for pursuing a career in academia and the ability to successfully complete a Ph.D. degree, through the tenuous process of achieving tenure at a given academic program. The overall success rate of developing faculty from graduate school to tenure is extremely poor, with estimates as low as 20%. While this low success rate is probably consistent with the national average of other engineering disciplines, the very limited candidate pool of potential faculty only compounds the current difficulties associated with

mineral engineering departments maintaining a critical mass of faculty because of the low Ph.D. graduation rates and the lack of qualified candidates.

To address this challenge in a meaningful way, the ESC recommended to SME leadership, and its industry constituencies, that the organization focus its efforts on several complimentary actions related to rebuilding what is often referred to as the faculty pipeline. The pipeline represents the mechanism through which individuals have traditionally acquired the experience, skill-sets, and qualifications necessary for employment as tenured-track faculty at an accredited university and then to go on to successfully earn tenure. As part of these efforts, the ESC recommended the following actions: (1) the development of a 4-year graduate fellowship for qualified Ph.D. students who are committed to pursuing careers in academia and (2) the awarding of Career Grants intended to assist new faculty in establishing research and publication records necessary to achieve tenure and promotion. Both of these initiatives were strongly endorsed by the SME and SME Foundation Boards. The structure, guidelines, and budgets of these academic grants were formalized in 2014 and fundraising efforts began shortly thereafter. The success of these activities, and the necessary industry buy-in to financially support them, led to the formal solicitation of applications in March 2015, and the awarding of 3 Ph.D. Fellowships and 2 Career Development Grants in August 2015. The 2016 solicitation for these grant programs was released by SME in November. When full participation of the combined grant programs is reached in 2018, the total annual financial commitment will be \$1.48 Million and will be entirely supported from donations derived by SME members and industry partners.

Beyond the Academic Grant programs, the ESC also outlined a full agenda of activities and recommendations intended to address challenges related to the availability of research funding, the recruiting of qualified industry professionals into both M.S. and Ph.D. degree programs, activities designed to mentor new faculty on topics critical to tenure (e.g., teaching, research, publication, and service), and the development of a campaign to educate industry on the realities and threats facing higher education. These activities are active and on-going.

## Research Support

The importance of research funding to the health and welfare of an academic program is often not well understood outside of academia, even among a department's industry advisors and constituencies. While research is usually a primary criterion used to assess faculty performance and is intimately tied to promotion and tenure, it is also the driver that enables programs to recruit and retain graduate students, acquire and maintain laboratory equipment and facilities used for both education and research, and generate peer-reviewed publications. In addition, with the significant declines in state funding, most public universities have become increasingly dependent on research overheads to offset the costs associated with department operations and support staff. While others have documented the increasing reliance of universities on tuition and in-direct financial support derived from research, I wanted to focus on the importance of research as it pertains to the challenges facing faculty scarcity, the re-development of the talent pipeline, and the overall health of academic departments. With the exception of the large, multi-national "majors", most mining companies want to employ our graduates but see little value in supporting funded research despite their dependence on technology. Research, student enrollment, and the number and productivity of faculty, however, are all interdependent. Put succinctly, without research academic programs in minerals engineering will simply cease to exist. Departments are generally evaluated by university administrators relative to their performance as measured by criteria such as research volume, scholarly work (publications), student credit hours, and the number of Ph.D. students that are produced. University resources (financial, space, and personnel) are subsequently distributed to individual departments on the basis of these criteria. By their very nature, mineral engineering departments are generally small, high cost programs with a significant footprint as a consequence of laboratories. These characteristics make them highly vulnerable. As such, research provides the catalyst for promoting stability and growth by creating the means to attract students, construct and operate labs, and justify the hiring and retention of faculty. The pipeline that recruits and funds graduate students, provides opportunities to hire new

faculty and enables them to achieve tenure, and hence, teach and mentor undergraduate students, is all facilitated by research.

With the closure of the U.S. Bureau of Mines in 1996, it's become increasingly difficult for faculty to find federal sources to support mining related research. With the exception of CDC NIOSH, which is solely focused on occupational safety and health, there are very limited opportunities available to fund mining research at levels comparable to other science and engineering disciplines. Furthermore, access to government and industry sponsored research is often tied to faculty expertise and program facilities, which make it very difficult for new faculty or departments that are under financial stress or below critical mass in terms of faculty. As such, the development of new federal sources of research funding is critical to the well-being of current and future academic programs in Mining and Extractive Metallurgy/Mineral Processing.

In summary, mineral education is at risk. The continued loss of these programs, and the talent they generate, will have a profound impact on the nation's economy and security. Without immediate intervention and significant near-term investment, academic programs in mineral engineering will not have the capacity to produce the graduates necessary to sustain industry demand. Issues related to faculty shortages and limited availability of federal research support are interrelated and among the most significant threats facing these programs. There are opportunities, however, where the federal government can make a substantive difference by investing in meaningful research initiatives that encourage industry/university collaborations and provide needed support for graduate students and promote faculty development and tenure. Efforts to amend the Surface Mining Control and Reclamation Act of 1977 (H.R. 3734) in order to provide support to mining schools is a monumental step in the right direction and will undoubtedly have significant, long-term impacts that will benefit the nation. I would like to thank the Committee for its time and interest in this important topic and it would be a pleasure to answer any questions you might have. Thank you.



## References

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- (3) Department Survey, Mineral School Department Heads Meeting, 2013 SME Annual Meeting, Denver, CO, February 24, 2013.
- (4) "Federal Support for U.S. Mining Schools", Society for Mining, Metallurgy & Exploration, Position Paper, 2014