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People Skills for Mining Engineers, an Important Addition to the Curriculum

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Abstract: Engineering education is very effective at training students in critical thinking and analytical skills however, these engineers often transition into management in their organization. These roles require an additional set of skills. Obviously an understanding of business and finance is required but even more important is the ability to work effectively with people. Based on their experience in industry and academia the authors have developed methods to introduce these skills to engineering undergraduates. The mining safety and health management course that has been offered for several years at the University of Utah has been modified to include such topics as emotional intelligence, leadership, and corporate culture development. This paper describes those changes and students' reactions to them.

Keywords: management, leadership, education, emotional intelligence

1 Identification of the Need

The Center for Mining Safety and Health Excellence at the University of Utah is conducting a four-year study to assess the implementation effectiveness of safety and health managements systems. The study is funded by the Alpha Foundation for the Improvement of Mine Safety and Health.

A safety and health management system (SHMS) implements a series of protocols and procedures which if followed are expected to reduce the risks and improve safety for employees. However, protocols and procedures alone are unlikely to make lasting improvements in safety and health, so SHMSs also include processes to change behaviors and lifestyles.

The current study will assess the effective of safety and health management in several mines, each of which is in a different stage of implementing an SHMS. This is done by making two or three visits to each mine, assessing the status of the SHMS by observation and discussions with management, and assessing the perceptions of the workforce by administering a detailed survey. The results of each visit are analyzed statistically and compared with the pertinent safety data for each mine—incidence rates, near-miss rates, and citations.

During the initial round of mine visits, it became clear to the authors that, for improving and maintaining excellent safety performance, an SHMS could be very useful, but was neither necessary nor sufficient. The most important things in good safety management were clearly the relationships among the mine's employees, and especially between management and the hourly workers.

The importance of these relationships is recognized in all SHMSs, by the inclusion of components like "culture" and "leadership," but in at least some instances, the SHMS was not successful in developing these characteristics in the organization. Thus the need for including some training in these skills in the undergraduate curriculum was evident.

2 Safety and Health Management Systems

In a cross-sectional, structural comparison of SHMSs, Seiter (2017) examined eight international and national safety and health management system models, including : (1) National Mining Association (NMA) CORESafety, (2) International Organization for Standardization (ISO) 45001–draft, (3) International Labour Organization Occupational Safety and Health (ILO-OSH) 2001, (4) Occupational Safety and Health Administration (OSHA) Voluntary Protection Program (VPP), (5) Occupational Health and Safety Management System (OHSAS) 18001, (6) American National Standards Institute (ANSI) Z-10, (7) Canadian Standards Association (CSA) Z1000, and (8) British Standards (BS) 8800-2004.

Seiter used a modification of the analysis by Dalrymple et al (1998) to identify and classify the components of a complete SHMS, in what he called the Modified Dalrymple Scheme. It begins with the key element of all SMHSs, the "Plan, do, check, and act," (PDCA) process. The scheme includes five categories of additional SHMS components: Initiation, Formulation, Implementation/Operations, Evaluation, and Improvement/Integration. Included in these five categories are 35 detailed SHMS elements. Table 1 on the next page shows the Modified Dalrymple Scheme.

Seiter conducted an industry-specific, cross-sectional study of SHMS elements, including the eight international SHMSs mentioned above and SHMSs from 10 mining companies that are implementing a mining-specific SHMS such as CORESafety.

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Seiter examined each SHMS for its implementation of each of the 35 elements of the Modified Dalrymple Scheme, using rankings of Present, Partially Present, and Not Present.

Table 1 Modified Dalrymple scheme for an SHMS
Source: After Seiter (2017)

	Plan, Do, Check, Act
Inputs	**INITIATION**
	Scope, Purpose, Application
	Initial Review
	Management Commitment and Resources
	Regulatory Compliance and HSMS Conformance
	Accountability, Responsibility, and Authority
Process	**FORMULATION**
	Occupational Health and Safety Policy
	Goals and Objectives
	Performance Measures
	System Planning and Development/Implementation
	Baseline Evaluation and Hazard/Risk Assessment
	OHSMS Manual and Procedures
	IMPLEMENTATION/OPERATIONS
	Training System
	Technical Expertise and Personnel Qualifications
	Hazard Control System
	Process Design/Management of Change
	Emergency Response
	Hazardous Agent Management
	Preventive and Corrective Actions
	Procurement and Contractor Selection
Feedback	**EVALUATION**
	Communication System
	Document and Record Management System
	Evaluation System
	Audit and Self-Inspection
	Incident Investigation and Root Cause Analysis
	Medical Program and Surveillance
Open System Elements	**IMPROVEMENT/INTEGRATION**
	Continual Improvement
	Integration
	Management Review
	Supplementary Information
	Success Factors
	Culture Enhancement
	Reinforcement and Recognition
	Behavior Optimization

Table 2 summarizes Seiter's results numerically, thus: Present = 2, Partially Present = 1, and Not Present = 0. The value shown as "Average Presence" for each category is the average for all of the elements in each category for each SHMS evaluated.

Table 2 Presence of components in 18 safety and health management systems

SHMS Category	Average Presence
Plan, Do, Check, Act	1.94
Initiation	1.83
Formulation	1.85
Implementation/Operations	1.81
Evaluation	1.87
Improvement/Integration	1.22

It is important to note that all of the systems reviewed by Seiter had near-complete inclusion of the components in the first five categories, while the inclusion of the components in the last category is much lower. The components in the first five categories are primarily procedural and routine when implemented correctly. The components in the last category also require carefully designed procedures, but their implementation requires skills in working with people.

3 Two Telling Examples

The effects of the discrepancy just noted were observed in several mine-site visits made by the authors. The two most prominent examples will be referred to as Mine #1 and Mine #2. Both sites are coal mines; Mine #1 has approximately 250 employees and Mine #2 has approximately 185. Mine #1 has implemented CORESafety from its beginning and has received many safety awards, while Mine #2, when asked if they had an SHMS, replied that they did not.

When visiting Mine #1, the authors had the opportunity to observe a semi-annual SHMS audit. We accompanied several auditors around the site, with clip-boards in hand, asking all of the questions required. This was done very systematically, one question at a time, with each requiring a yes or no answer. Based on these observations, we would have given the mine and its SHMS a positive review. However, as we shadowed the auditors, some of our team members would linger and talk with the employees. From this, we found that things weren't what they seemed at this mine. Several employees commented on how bad the safety culture was, noting that many incidents were unreported because employees feared that they would lose their jobs if the reported incidents. One employee in particular cut off his finger while on shift, and instead of following the proper procedures of reporting, wrapped it up and finished his shift then went to the hospital on his own, to take care of it later.

At Mine #2 we had a completely different experience. The management stated at the beginning of our visit that

they had no formal SHMS. As we surveyed the hourly employees, we also asked them for their opinions on the safety culture at the mine. Several workers stated that they felt like they were all a large family, and noted how well the company took care of them. The mine manager told us that he makes time for a one-on-one meeting with *every* employee on site, at least once per year. He noted that, during these meetings, he gets a lot of feedback and uses that information to plan projects and activities to use in continue building the feeling of family and mutual support among employees.

Analysis of the data from the first visits to these mines indicates that the respective employees had vastly different perceptions of the Leadership, Culture, and Risk Management practices and execution at their workplaces, and that Mine #1's safety performance was not as good. Why is this the case? What is the missing piece?

4 A Clear and Present Need

When managing a mine, and also managing people, emotional intelligence is key. Emotional intelligence is the capacity to be aware of, control, and express one's emotions, and to handle interpersonal relationships judiciously and empathetically (Goleman 1998).

As technology continues to change how people live, our communication and people skills are often not as well developed. We have seen evidence of this at every mine site and in every classroom—it is a common problem that all industries are encountering. Employees who are intelligent and well-educated often don't know how to use their strengths or improve on their weaknesses, and most importantly, they don't know how to communicate with others.

As mentioned above, our research indicates that a rigorous, well-implemented SHMS almost always helps, but by itself it won't make a difference. Why is that? Because systems are run by people, and a system is only as good as the people using it. This means that the implementation, communication, and leadership components of any system are critical to its success.

5 Teaching Human Skills to Engineers

Teaching these skills to future engineers is of utmost importance, and will greatly improve their professional and personal lives. Based on the above observations, we restructured our safety and health management course to be more hands-on and discussion-based, moving away from the typical PowerPoint lecture approach.

Every week the students are given several articles to read and are required give a written critical response to those articles. Then in class there is a semi-structured discussion about the articles, where assigned student discussion leaders guide the class through main points and many side topics. During the next class period the students participate in a hands-on activity where they learn how to approach and deal with common problems on the subject. These activities not only help them learn about the subject at hand but they are also learning very important communication, leadership, emotional intelligence, and people skills.

6 A Sample Syllabus and Some Preliminary Results

A sample syllabus of the restructured safety and health management course is in Table 3.

Table 3 Syllabus for safety and health management

Week	Class	Planned Topic
1	1	Introduction and Concepts
	2	Organizations and Management
2	1	Martin Luther King Jr. Holiday
	2	Wellness and Mindfulness
3	1	Personal Safety
	2	Personal Safety
4	1	Safety in Mining--Historical
	2	Safety in Mining--Present
5	1	Occupational Health and Hygiene
	2	Hazard and Risk
6	1	Mining Hazards
	2	Risk Management
7	1	Presidents' Day Holiday
	2	Midterm Exam
8	1	SME—no class
	2	SME—no class
9	1	Risk Management Systems
	2	Incident Investigation
10	1	Review and discussion
	2	Midterm Exam
11	1	Spring Break—no class
	2	Spring Break—no class
12	1	Five Whys
	2	Root Cause Analysis
13	1	Ethics Discussion
	2	Ethics Exercise
14	1	Culture Discussion
	2	Culture Exercise
15	1	Leadership Discussion
	2	Leadership Exercise/Final Project
16	1	Final Project
	2	Reading Day- no class
17	–	Final Exam

The course was taught with the new approach in Spring Semester 2018, to a group of 14 students. After the first two weeks, it was clear that the more articulate and communicative students in the group were enjoying the

course, participating actively in discussions and bringing in additional material for considerations. The more reserved students took some time to adapt to the new structure, but by the end of the semester, all 14 students were thoroughly engaged in the process.

It is also interesting that some students at first skeptical that this approach and these subjects were appropriate for, or even needed in an engineering curriculum, but by the end of the semester, those students were participating as actively and enthusiastically as the others.

In an informal evaluation in near the end of the semester, the students unanimously expressed their satisfaction with the course and the manner in which it was conducted. As instructors, we were pleased with this result, but we also came away with many ideas for future improvements in the materials and the methods.

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