AN ASSOCIATE DEGREE IN MINING TECHNOLOGY

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1. INTRODUCTION

When Hurricane Katrina hammered the Gulf Coast states in August 2005, the effects were far reaching. While it devastated the homes and lives for thousands of residents, the disruption of the oil and gas industry has hit us all in the pocket book each time we stop at a filling station. The warnings were broadcast that home heating costs this winter would jump significantly. Most of us can confirm the accuracy of those predictions.

But in a competitive market, there are always alternatives. One of the alternatives to oil and gas (for home heating at least) is coal. While very few people will run out to buy a new coal furnace this winter, they might pick up a portable electric heater. And since about half (EIA, 2006a) of the nation's electricity is generated from coal, the demand for coal will increase. But it would have increased anyway, since the oil and gas reserves in the U.S. are decreasing as shown in Table 1 from the Energy Information Administration (EIA, 2006b)

Table 1 – Projected Reserves by year

Year	Units	1970	1980	1990	2000
Oil	millions of barrels	39,001	29,805	26,254	22,045
Gas	billions of CF	290,746	199,021	169,346	177,427

Currently the United States has 145.3 billion tons of coal reserves (EIA, 2006c), and produces a little over 1.112 billion tons per year. The top four coal-producing states are Wyoming (35.6%), West Virginia (13.3%), Kentucky (10.3%) and Pennsylvania (5.9%) and these states account for almost two-thirds of the U.S. production. Greene County, PA, is the second leading coal producing county in the nation with 37.7 million tons per year (EIA, 2006d) – more than the state of Indiana. With clean coal technology being developed that reduce or eliminate both pollution and global warming potential from coal-fired facilities, coal will continue to play a major role in the energy future of the nation for the foreseeable future.

But the good news of a growing market plays leapfrog with another problem for the mining industry that they are just beginning to come to grips with – an aging workforce. The average age of the 73,886 (National Mining Association, 2004) coal miners today is approaching 55 years old, and within the next few years, about 50 percent (News Stream, 2004) of them – especially those in the supervisory ranks – will be able to retire. How can the mining companies quickly recruit, train and rebuild this work force?

As shown in Table 2, there are 15 universities offering ABET-accredited programs in Mining Engineering. There are at least 20 programs in Mining Engineering Technology in the U.S. listed in Table 3, but only one of them (Bluefield State College, WV) offers an ABET-accredited BSET in Mining Engineering Technology. Our campus goal is to once again offer an ABET-accredited Associate Degree program in Mining Technology.

Table 2 – Universities offering B.S. in Mining Engineering

University of Alaska Fairbanks	University of Nevada-Reno
University of Arizona	Penn State University
Colorado School of Mines	South Dakota School of
University of Idaho	. Mines and Technology
University of Kentucky	Southern Illinois University
Michigan Technological University	University of Utah
University of Missouri-Rolla	Virginia Tech
Montana Tech	West Virginia University

Table 3 – A.S. in E.T. – not ABET accredited

Madisonville Community College (KY)	North Central State College (OH)
Southeast Applied Technology College (UT)	Oklahoma State University (OK)
University of Alaska Anchorage (AK)	Tulsa Community College (OK)
University of Alaska Fairbanks (AK)	Schuykill Technology Centers (PA)
Eastern Arizona College (AZ)	Midland College (TX)
Taft College (CA)	Odessa College (TX)
Wabash Valley Community College (IL)	College of Eastern Utah (UT)
Nicholls State University (LA)	Mountain Empire Community College (VA)
Montana State University-Billings (MT)	Southwest Virginia Community College (VA)
Hocking College (OH)	Glenville State College (WV)

2. HISTORY

In 1973, Penn State Fayette – the Eberly campus offered the first ABET-accredited mining program in the nation. The program was phased out in 1985 due to the rapid drop in demand for graduates. This precipitous drop was caused by the convergence of several factors. New environmental regulations (e.g., EPA and the Clean Air Act of 1970) had reduced the demand for coal, since cheaper and more environmentally friendly alternative fuels (i.e., gas and oil) were readily available at that time. The economic conditions of the early 1980s were flat, again impacting the demand for additional coal. Many of the local mines had simply "played out" and the economically recoverable coal resources were gone. Another major change was in the technology used by the mining industry: the application of the continuous miner and the "room and pillar" mining method of the past several hundred years was giving way to long-wall technology. All of these changes reduced the demand for miners, and resulted in massive layoffs locally from underground mines. The number of underground coal miners in Pennsylvania dropped from about 40,000 in 1977 to about 20,000 in 1987, while production remained fairly stable, only dropping from 80 million tons per year to about 75 million in the same time frame. (DEP, 2004) As with most industries, these layoffs started at the bottom, so fewer older workers and supervisors were affected.

Fast-forward about 20 years to the start of the new millennium. These mining supervisors are now in their mid-50s and after working 20 years with salaries of over $60,000, they are looking forward to retirement. Most of the workers under them are in similar circumstances, and the leaders of the mining industry were beginning to worry how they are going to replace them. Consol, for example, is the nation's fifth largest coal producer and anticipates needing 160 mining supervisors within a 100-mile radius from our campus. Greene County alone will be looking for 400 new miners plus up to 400 replacement miners in the next few years. The leadership of the coal mining industry was definitely worried about this problem.

One of those worried individuals was Joe Sbaffoni, chief of the bituminous mine safety division of the Pennsylvania Department of Environmental Protection. Joe had made national news for orchestrating the rescue of all nine miners from the flooded Quecreek mine disaster in July 2002. As a graduate of the mining program at Fayette, he was familiar with the program content and the capability of the campus to meet this demand. He contacted the Campus Executive Officer at Fayette campus to recommend that the associate degree program in Mining Technology could be reopened.

3. THE CURRICULUM DEVELOPMENT PROCESS

In August 2004, the campus began the process of reconstructing the Associate of Science in Mining Technology. The first step was to pull the original program out of the archives. While the basic concept of what needed to be in the program remained the same, we quickly realized that the technical and organizational content had changed so dramatically that it was easier to start over with a clean sheet.

As a former member of the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET) during the transition to TC2K (outcomes-based criteria), I felt this would be a good opportunity to build an ABET-quality program. We started by writing the draft program objectives and educational outcomes shown at the end of this paper. We also outlined a draft curriculum of courses designed to meet several needs:

1. The program must meet the needs of the local coal mining industry
2. The program must meet the University's curricular requirements
3. The program must meet the state and federal regulations related to the background for mine supervisors
4. The program must meet ABET criteria (TC2K)

Currently, the Commonwealth of Pennsylvania requires that miners must have three years of underground experience within a prescribed distance from the mine face to qualify to take the examination to become certified as a mining supervisor. However if the program is accredited by ABET, the required experience time is decreased proportionally. That is the incentive to ensure that the program becomes ABET-accredited. While presently there are no program specific ABET criteria for Mining Engineering Technology, we plan to work with the Society for Mining, Metallurgy and Exploration and the American Institute of Mining, Metallurgical and

Petroleum Engineers (SME-AIME) to develop appropriate criteria. Until those program-specific criteria are promulgated, the program will meet the TAC general criteria.

Once this framework was established, I met with a former mining technology program coordinator as a resource on what knowledge and skill sets would be appropriate to include as outcomes for each course. Our goal was to prepare a "straw man" course outline that would meet most of the above needs for the industrial steering committee to review. The steering committee consisted of representatives from both union and non-union mines, a union representative, a mining equipment manufacturer, and the state mine safety department. By offering our "best shot" to the committee initially, it was hoped that they could come to consensus quickly. That package of Program Objectives and Outcomes, course sequence, and course outcomes was emailed to the industrial steering committee for their review.

The first review of the proposed curriculum was an exciting event as all participants vigorously questioned the need for various non-technical courses and which sequence was most appropriate. They deliberated on the appropriate math level and science courses that would best meet the needs of the industry (and be acceptable to the University and TAC of ABET). The identified course prerequisites and an optimum course sequence. Surprisingly, they accepted the proposed Program Objectives and Outcomes with only minor editorial comments. One creative (and non-traditional) twist to the proposed curriculum was to include a common 5-week, one-credit course in the basics of rock mechanics for all Mining Technology students at the beginning of the third semester. For those in the production track, the final ten weeks of the semester included a course in methods to stabilize roof and rib (wall) sections. Students in the maintenance track move to a parallel course in how programmable logic controllers (PLCs) are used in mining applications. This mid-semester split is the beginning of the separation between the two tracks.

There are a couple of program features that that should be discussed. Except for the one-credit Mining Technology survey courses in the first semester, all the credits are common to other Engineering Technology programs offered at the campus. So students who decide that Mining Technology is not the appropriate academic program for them can easily switch to a different major without losing too many credits. Included in the first semester is a three-credit computer skills course. Many of the miners in the region are not current with today's computer applications. Given the travel distance to the campus for many of these students (over 50 miles each way), it is anticipated that homework and questions for the instructor will often be transmitted electronically. This course will ensure an even playing field for all students. Finally, we anticipated that many entering adult students will have poor or rusty math skills. Therefore most of the heavily technical content courses are delayed to later in the program to allow all students to strengthen their math skills prior to needing them. One pinch point that we are already experiencing in the first cohort is a weak background in trigonometry that students need to understand the concepts in their Mineral and Mine Surveying course, Mining 23.

As shown in the appendix, the final version of the program includes two parallel tracks with a common core until mid-way through the third semester. The common core includes knowledge and skills that the committee felt were necessary by all students. This includes background in the technical design and equipment function and layout, mine surveying, safety and regulatory issues and basic management skills. The **Production** track prepares students to be front line

managers at the coalface. This track has a stronger focus on managerial skills and additional training in ventilation requirements and methods used to control roof and rib (wall) failures. The **Maintenance** track provides more equipment-focused courses. These include courses in electrical power supply and electrical applications (e.g., wiring, motors and breakers) plus microprocessor technology. Both majors have a capstone practice course that is intended to model "on-the-job" experiences using "real world" data. We anticipate that a majority of the students will take the production track (and 90% of the first cohort are), because that is where the greatest immediate demand is. But both tracks are needed for mines to run successfully and profitably.

The next step was to detail the course content for each of the sixteen proposed new courses. In July 2005, a working committee of mining company management, state mining safety inspectors and others gathered for a one-day DACUM (ATEEC, 2001) experience. This "Develop a Curriculum" process is based on the model developed by Walt Disney, where the progress of individuals and subcommittees are storyboarded and shared with the whole committee in real time. The data was captured electronically at the end of the day and posted on a secure website that all participants could access. As expected, there were some minor follow-up issues that were worked through during a second meeting in August to completely define the content. These issues included translating the material from "industry-speak" to "academic language."

The program then had to be approved by three faculty committees (at the campus, college and University levels) and two administrative reviews. While this process took longer than normal in the "speed of business" it was lightning fast for a large academic institution. We went from a concept to an approved program ready to admit students in under a year.

4. FINDING AN ACADEMIC HOME

Once the draft curriculum was accepted by the steering committee, the University's bureaucracy needed to accept it, and it needed an academic home. The Mining Engineering department in the College of Earth and Mineral Science at University Park supported the development of this program for the industry, but this technology program did not fit with their research mission. The School of Engineering Design, Technology and Professional Programs (SEDTEPP) in the College of Engineering supports a number of TAC of ABET programs, but refused to be responsible for a program that did not have the word "Engineering" in the title. So it was decided that the campus would become the program's academic home, with the support of the University's vice president for undergraduate programs.

5. FINDING FUNDING

If an army runs on its stomach, an academic program operates on money. One of the first questions the administration asked was "How does the campus plan to fund this program?" The campus had experienced a budget reduction of $800,000 over the past few years while expanding the student enrollment at the campus. There was no cash available within the University to ramp this program into existence.

The campus made this financial issue clear to the industrial representatives at the first meeting. At the second meeting the two mining companies had penciled up a support package that ensured the program would be solvent for at least the first few years. The companies were prepared to fund the program development and provide full-tuition scholarships to students that they handpicked from their current employees. As an example, one company planned to offer each new student (in addition to full scholarship) a job in the mine with sufficient work hours to make $32,000 their first year, $36,000 their second year and a supervisory position at $50,000 upon graduation.

When the U.S. Department of Labor heard about our curriculum proposal, they almost requested that they be allowed to fund its development. So in March 2005, the campus submitted a proposal to the department. There were a few iterations along the way, but in December 2005,the campus was awarded a two-year grant for $503,210 to get the mining technology program launched.

In summer, 2005, the Benedum Foundation of Pittsburgh also heard about this program and was very interested in receiving a proposal to support coal mining career awareness and recruiting activities with high school students in the region. In response, the campus submitted a second proposal to that private source. A grant was awarded in December for $145,00 to support these activities for two years. The mining companies have also made substantial cash and in-kind donations to the program already.

6. FINDING STUDENTS

Given the rapid development of this program, little time has been provided to "get the word out" through normal advertising and marketing activities. However we did schedule two "informational events" that were announced within the two major mining companies participating in the development. That effort resulted in an initial cohort of 29 students. As shown in Table 4, the educational background ranged from no college experience to several with BS degrees and three holding MBAs. Math skills ranged from very poor (arithmetic) to calculus (a B.S. graduate in Athletic Training!). By design, the beginning of the program allows one semester of mathematics development before those skills are applied to technical problems. The first several courses are non-mathematical topics like organizational, safety and legal issues and general technical overview of systems and equipment.

Table 4 – Educational Background of Initial Student Cohort

13	High school diploma
6	Some college
1	Associate Degree
6	B.S. degree
3	M.B.A. degree

7. FINDING A COORDINATOR

> ***Wanted****: Mining Technology Program Coordinator with both mining and teaching experience and a PhD in Mining Engineering to develop course curriculum from scratch and teach related laboratories that presently have no equipment in them. Must be willing to teach a wide variety of courses, work long hours for low wages and deal happily with students ranging from no college experience to MBAs.*

The University went through its normal position posting process and generated a pool of 16 candidates that met at least one of the position criteria. The faculty search committee quickly narrowed the field to five candidates with an interesting mix of backgrounds. Three practitioners on the short list declined to interview when they were told the pay cut that would be required. The remaining two were given on-campus interviews and the committee agreed to recommend an offer to one of the candidates and it was accepted. The new program coordinator is one of the first female mining engineering PhD candidates in the nation. She brings 17 years of underground experience as a miner with operating experience on most of the major components. She is certified in mine safety instructor and rescue team member and is a CPR instructor. And she did not have to relocate – she lives about 30 miles from the campus. Some days you just get lucky!

The campus plans to hire a second full time faculty member beginning in Spring 2007. Neither of these faculty positions will be tenure-track since the administration has a concern on the long-term viability of the program.

8. FINDING SOLUTIONS

As with any new activity, there are still lots of wrinkles to smooth out before calling this program a success. Classroom and laboratory space at the campus are at a premium. Currently the mining technology students are meeting in a renovated maintenance building. There are only 16 drafting stools for the 29 students in the drafting class, so some have to move across the hall to another room – definitely not the best academic situation! The campus only owns four sets of surveying equipment, which will need to be augmented or supported by some creative scheduling.

The opportunities for the program continue to expand. This spring representatives from Peabody, the world's largest coal mining company, visited the campus to discuss how to make this program available to their employees around the world. We have also had contact with a university in Kentucky that had a significant slice of their federal grant proposal to develop a mining technology curriculum removed. The message from the federal funding agency was that they should contact our campus, because we already had completed what they were proposing to do. And finally, we got a call from the *International Longwall News* based in Australia. They want to interview our new program coordinator about this exciting program. It appears that our efforts have put our campus not only on the U.S. map, but also the globe.

9. CONCLUSIONS

A new associate degree program in Mining Technology has been developed and classes have started. Industry was heavily involved in defining the details of each technical course, and the development process was fast-tracked through the maze of university approvals. Details of the program content are available on the web at http://www2.fe.psu.edu/~fe2mt.

10. PROGRAM GOAL

To be recognized by the mining industry as a national leader of excellence in preparing graduates to work in production and equipment maintenance areas.

11. EDUCATIONAL OBJECTIVES

Educational Objectives – Graduates from the Mining Engineering Technology program will:

I. Have the technical knowledge and skills to work in the professional sector of the mining industry

II. Use critical thinking skills to solve complex real world problems and applications

III. Communicate effectively using information technology when appropriate

IV. Possess the workplace skills needed to function well in a mining <business> environment

V. Continue to learn and adapt emerging technologies in either formal or informal settings.

12. PROGRAM OUTCOMES

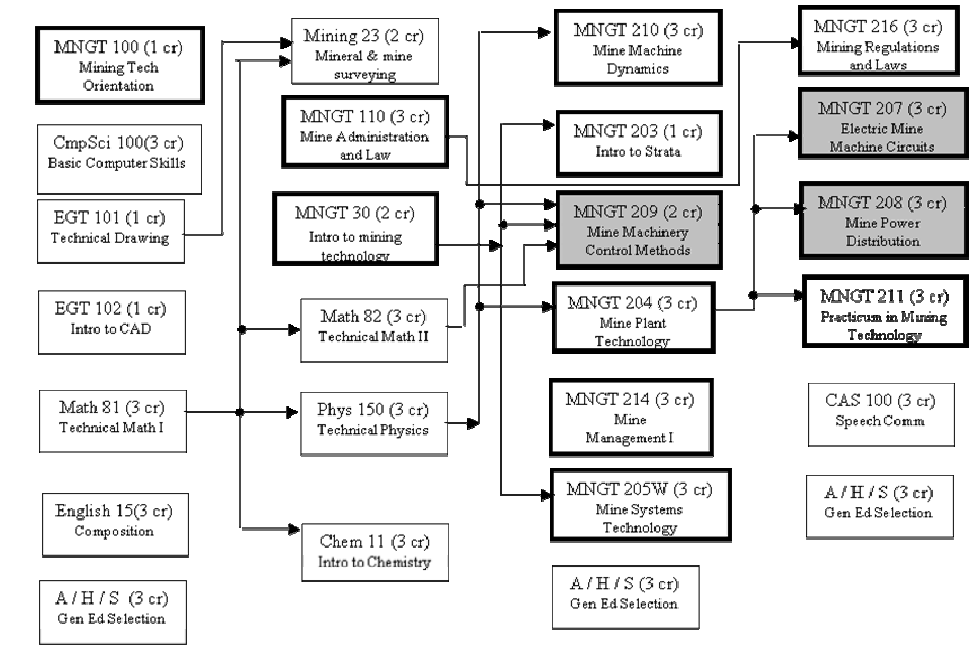
Program Outcomes – Each graduate will demonstrate the following attributes before graduation:

1. Knowledge and skills identified as critical and common to the production and equipment maintenance sectors of the mining industry.

2. Ability to work as a team member to identify and correct equipment failures to minimize production interruption.

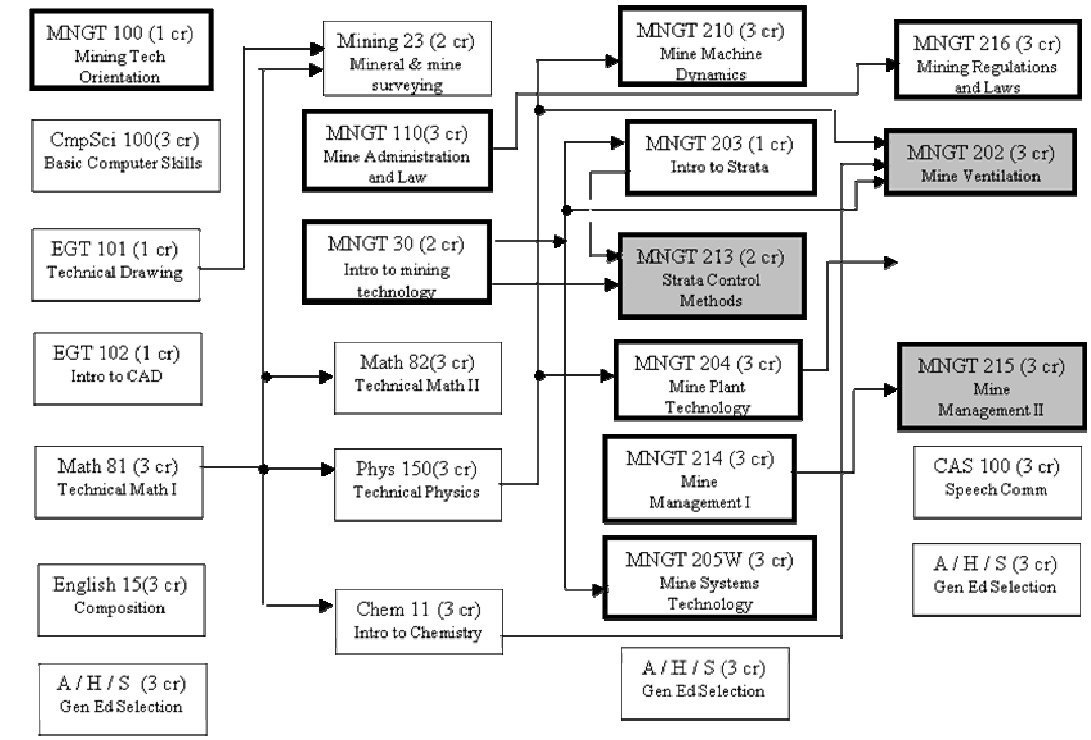
3. Ability to produce written documents, deliver oral presentations, develop, prepare and interpret graphical information, using information technology when appropriate, to a specific audience or client at a level of effectiveness expected of new employees.

4. Demonstrate awareness of project management, the decision making process, applicable federal and state mine safety regulations, appropriate ethics and professional conduct, teamwork and conflict resolution, ability to conduct a literature.



Mining Technology
Maintenance Option
At Fayette Campus 10/5/05

Prerequisite ——▶
Concurrent or Prereq. ----▶



Mining Technology
Production Option
At Fayette Campus10/5/05

Prerequisite ——▶
Concurrent or Prereq. ----▶

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