Missouri S&T - Ma’Aden - TVTC
Cooperation for the Saudi Mining Polytechnic

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The 2020 Vision in the FY2010-20 Strategic Plan states, "Missouri S&T will be recognized as the global university of choice for mining engineering education, research and graduate employees for the mining industry." In line with this vision, the Department made progress in capacity expansion for research and education in FY-2011-12. The 2006-12 Mining Engineering enrollment growth is as follows: (i) total enrollment is 88% from 155 (2006) to 291 (2012); (ii) undergraduate enrollment is 50% from 123 to 184; (iii) graduate enrollment is 84% from 32 to 107; and (iv) PhD enrollment is 317% from 6 to 25. Missouri S&T has the largest mining engineering program in the United States based on the 2011 Enrollment Statistics published by SME. The Department also ranks 7th out of the 20 academic departments at Missouri S&T based on the End of 4th Week Enrollment from the Office of the Registrar in spring 2012.

The graduation rate also increased by 267% from 15 (in 2006-07) to its largest of 55 (in 2011-12), with 100% placement and the highest average starting salary of $73,000. In addition to academic and professional excellence, our students also made impressive achievements in collegiate mining competitions. At the 2012 International Collegiate Mining Competition at Rolla, Missouri S&T’s Gold Team won the Undergraduate Competition, beating all 12 industry teams and Missouri S&T’s Black Team.

Building on the success of the Master Science in Explosives Engineering that was approved in April 2010, the Department is currently working on a proposal to implement a PhD degree program in Explosives Engineering. The Department is also leading an effort to establish a Master of Science degree in Mineral Process Engineering in collaboration with Chemical and Metallurgical Engineering. As part of an effort to increase the faculty size, Dr. Nassib S. Aouad (PhD, Missouri S&T), Assistant Teaching Professor, with specialty in Mine Mechanical Engineering, and Dr. Lana Z. Alagh (PhD, University of Texas-Dallas), Assistant Professor, with specialty in Mineral Processing were added to the Department. The faculty, in collaboration with faculty members from Missouri S&T, other universities, research organizations and industry are leading multi-million dollar research efforts to expand frontiers and advance knowledge.

The Department took specific initiatives to expand its research and education capacity. As part of its capacity expansion and renewal initiatives begun in 2009, the Department completed the Virtual Surface Mining Simulator, which was unveiled by Chancellor Schrader on April 08, 2012. This facility will be used for research and education. Significant progress was also made on the Energetic Research Facility and the new Experimental Mine Building. Upon completion, these two facilities will expand our education and research capacity in mining and explosives engineering.

The Department also expanded its global footprints within the last 5 years into China, Indonesia and Saudi Arabia. In China, the Department will establish a new Department of Mining and Mineral Process Engineering at Sichuan Missouri University in Sichuan Province. In Saudi Arabia, the Department will establish a new Saudi Mining Polytechnic (SMP) to train professionals for the emerging mining industry. The efforts in Indonesia will focus on establishing the Department of Mining and Environmental Engineering at the State Islamic University of Indonesia. These efforts will yield enormous dividends to expand S&T’s Mining Engineering Program and provide opportunities for global exposure to our faculty, staff and students.

Missouri S&T has succeeded in producing highly qualified graduates for the industry and we take pride in their achievements. The faculty and staff members have created environments, which contribute to student success. The contribution by the Board, Academy, industry and alumni has been outstanding.

As it embarks on the AY2012-13, the Department will continue to be guided by its five strategic initiatives in the FY2010-20 Strategic Plan. These initiatives include (i) maintaining and expanding outstanding mining education portfolio; (ii) enriching the student experience; (iii) broadening mining engineering research; (iv) expanding S&T’s mining engineering capacity; and (v) strengthening national and global partnerships. The vision of global leadership will be achieved through our core values (excellence, ethics, experience, exposure, leadership, passion, and tradition) that form the basis of Missouri S&T’s tradition of excellence. Thank you for your support!!

Samuel Frimpong, PhD, PENG
Professor and Chair
Robert H. Quenon Endowed Chair

Sustaining Growing Programs with a Critical Mass of Faculty and Staff

The Department offers BS, MS/ME, PhD, and DE in Mining Engineering and MS in Explosives Engineering. We are currently developing a proposal to offer a PhD program in Explosives Engineering, as well as a future graduate program in Mineral Process Engineering. One of the essential ingredients for sustaining strong program growth is a critical mass of highly qualified and dedicated faculty with research and education capacity. Another important ingredient is a critical mass of staff members who provide important services critical to the core mission. Traditionally, mining engineering programs have been very small with few faculty and staff positions. Missouri Set’s Mining Engineering has grown significantly within the last six years. Our global footprints have extended from Australia, Brazil, Botswana, China, Ghana, and Indonesia to Saudi Arabia. In Botswana, China, and Saudi Arabia, our efforts are substantial. Our annual research capacity has been between $2 and $4 million and is expected to increase to between $5 and $7 million within the next year. With the growing programs, the number of faculty has increased slowly from 7 (in 2007) to a complement of 11 (with a potential for a 12th position if the program for the Sichuan Missouri University in China program is implemented). The Table below shows the additional faculty with increasing program expansion. Given the amount and the intensity of work, we still need additional faculty members to sustain the growth of the education and research programs. Despite this small number, the faculty members have worked hard with a collective understanding of excellence in research and education.

### Periodic Faculty Additions with Growth

<table>
<thead>
<tr>
<th>YEAR</th>
<th>FACULTY POSITION</th>
<th>RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>One (Explosives Eng)</td>
<td>Growing Capacity in explosives research and education and the introduction of the MS degree program</td>
</tr>
<tr>
<td>2009</td>
<td>One (Mining Eng)</td>
<td>Resulted from the Missouri S&amp;T – University of Botswana academic program, will be filled in the specialty area of Mineral Process Engineering</td>
</tr>
<tr>
<td>2010</td>
<td>One (Mining Eng)</td>
<td>Resulted from the retirement of David Summers, Curators’ Professor Emeritus and former Director of the Rock Mechanics and Explosives Research Center; will be filled in the specialty area of Underground Mining</td>
</tr>
<tr>
<td>2012</td>
<td>One (Mining Eng)</td>
<td>A future Endowed Chair position that comes from the Missouri S&amp;T – SMP Program in Saudi Arabia</td>
</tr>
<tr>
<td>2013</td>
<td>One (Mining Eng)</td>
<td>A potential faculty position in Mining Engineering upon the inception of the Sichuan Missouri University</td>
</tr>
</tbody>
</table>

One of the core strengths of S&T Mining and Explosives Engineering is the set of attributes that qualify the administrative and technical staff in the Department. The S&T Experimental Mine is the consummate laboratory for the Mining and Explosives Engineering programs. The laboratory sessions for several courses in the programs are taught at the Mine, as well as providing environments for research initiatives, mine rescue and mucking competitions and haunted mine activities. The leadership provided by the Mine Supervisor and Assistant Mine Supervisor has been superb. In addition, the two leaders have been great counselors and mentors to a number of undergraduate students in the programs in the areas of summer and COOP internships and career placements. The Department has outstanding administrative staff, which works hard beyond the call of duty to support its education, research, and service mandate. Despite the growth, Missouri S&T support only one and half technical staff positions and one administrative position in Mining and Explosives Engineering. The rest are supported on soft dollars (i.e., non-budgeted dollars).

Meet the people who are responsible for shaping the Department’s education, research and service mandate!!

### RESEARCH AREAS: Surface Mining, Excavation Engineering; Machine Dynamics, Health and Longevity; Machine-Formation Interactions; Formation Deformation Mechanics; Novel Oil Sands Mining; Stochastic Processes; Risks and Hazards Engineering

Samuel Frimpong, PhD, PENG
Professor and Chair
Robert H. Quenon Endowed Chair

Stewart A. Gillies, PhD
Professor and Director, RMERC
Rocky Mountain Energy Prof.
**Expanding the Enrollment Capacity of Missouri S&T’s Mining Engineering**

The capacity of the Mining Engineering program at Missouri University of Science and Technology (Missouri S&T) has grown significantly over the last decade. Table below shows the enrollment growth trends for the Mining Engineering program from fall 2006 to fall 2012. Within this period, the growth rates are: (i) 88% from 155 (in 2006) to 291 (in 2012) for total enrollment; (ii) 50% from 123 to 184 in graduate enrollment; and (iii) 234% from 32 to 107 in graduate enrollment; and (iv) 317% from 6 to 25 in PhD enrollment.

This growth resulted from strategic and tactical initiatives undertaken by the Department. These initiatives include marketing and recruiting, explosives engineering graduate program, internships and permanent placements, financial aid, industry-university programs, international programs and student-oriented programs. Since the summer of 2005, the Department has hosted between two and three explosives summer camps for high school students. These camps bring an average of 60 students to explore the exciting adventures in mining and explosives. The Department recruits over 70% of students to explore the exciting adventures in mining and explosives. The Department recruits over 70% of the campers into the mining engineering program.

The availability of internships and permanent placements for graduates are strong incentives for attracting students into the program. The graph to the left shows the reported 2012 summer internship opportunities for the Missouri S&T’s mining engineering students. A number of the internships were not reported, and thus, not captured in this graph. For example, CONSOL energy had 14 interns, but only 10 interns were captured in the graph. Mining Engineering also enjoys about 100% placement after graduation. Rolla graduated about 50 students in December 2011 and May 2012 with 100% placement and an average starting salary of $73,000.

Financial aid has been a vital component toward attracting and retaining qualified students into the mining engineering program. The Department awarded a total of $215,000 in financial assistance to mining engineering students in the academic year 2011-12. Sixty percent of this amount came from the mining industry, SME, ISEE, and other individual donors and 40% from endowed scholarship. The Department was able to provide assistance to several students and no student dropped out for due to financial burden to our knowledge. Overall, the students in the program have served as our ambassadors to the undecided undergraduate engineering students as they continue to market the program on campus. The industry, the faculty and staff, the Board and the students continue to play a vital role in ensuring a full pipeline of highly qualified high school and transfer students, transfer students into mining engineering at Missouri S&T.

Other recruiting programs include the Jackling Intro Engineering Camps, the Mining/Aggregate Industry Nights and high school visits by the students and faculty. The MS program in Explosives Engineering has aided the growth to a significant degree. There are 21 students enrolled in the MS program and 11 students in the graduate certificate program. The Department hopes to strengthen its enrollment capacity with a future introduction of the PhD program in Explosives Engineering. The Missouri S&T – University of Botswana (UB) 3+2 program also brings an annual stream of 12 to 15 students into the junior year of the program.

**Distribution of Fall 2012 Mining Eng Enrollment**

Under the program, students complete all the fundamental science, mathematics and engineering courses at UB and complete the last two years of the BS degree program at Missouri S&T. The Department is pursuing two similar programs in Indonesia and the Dominican Republic.

**How to build this building:**
First, you call DeWayne and Jimmie! DeWayne Phelps is operating the lift on the ground - he doesn’t like heights. Jimmie Taylor is secured in the bucket and securing the panels. The result is the building shown. We can now work on our equipment inside.
Missouri S&T to make impact on Saudi mining industry

ROLLA, Mo. – Missouri University of Science and Technology (Missouri S&T) has won a $24 million award from Saudi Arabia to train and educate personnel for the Saudi mining industry.

Missouri S&T was selected to be a partner with the Technical and Vocational Training Corp. (TVTC), a Saudi government entity, and the Saudi Arabian Mining Co., Ma'aden to establish the Saudi Mining Polytechnic (SMP). Under the agreement, Missouri S&T and partners from industry will train personnel at SMP during an initial five-year period. The award is potentially renewable for another five years.

Missouri S&T's partners in this venture include Canadian Petroleum Services, Caterpillar Global Mining, The Doe Run Co., Immersive Technologies, Orica Inc. and P&H Mining.

In January 2011, a Missouri S&T delegation visited Saudi Arabia in preparation for the final bid submission. The contract was signed during a second visit by the Missouri S&T delegation in July 2012.

"This partnership provides Missouri S&T a great opportunity to shape the direction of the mining industry in Saudi Arabia," says Dr. Samuel Frimpong, chair of Missouri S&T's mining and nuclear engineering department.

With Missouri S&T leading the way, SMP plans to educate an average of 200 professionals annually in mineral processing, as well as surface and underground mining.

"Missouri S&T has a proud heritage of supplying the world with great mining engineers – a heritage that dates back to our founding in 1870 as the Missouri School of Mines and Metallurgy," says Missouri S&T Chancellor Cheryl B. Schrader. "We're pleased to be a part of this important partnership, as we believe it will transform the mining industry in Saudi Arabia."

"Developing the skilled pool of talent needed to support the expansion of mining in the Kingdom is one of the biggest challenges we face," says Ma'aden President and CEO Khalid Al Mudaifer. "We are delighted to be partnering with Missouri S&T to deliver world-class training at Saudi Arabia's first specialist training institute for the mining industry. Missouri S&T has a long history of excellence and international partnerships, and we look forward to welcoming their team to Saudi Arabia."

"Due to the significant developments taking place in Saudi Arabia, the TVTC has a new vision for the future of its training that will compete with global standards," says Fahd Al Dohish, TVTC's general manager of the Strategic Partnerships National Center (SPNC). "We are partnering the private sector to establish advanced polytechnics that will graduate skilled Saudi nationals in well-paying technical jobs, thus helping reduce unemployment and contributing to community and economic growth."

Dr. Wray is holding a gift presented by Eng Abdullah Al-Saif.

News from the Experimental Mine

Greetings from the Experimental Mine: Jimmie and DeWayne say hello. Our summer was busy with preparation of the new mine building site and the annual explosives camp. Jimmie just completed 20 years with Missouri S&T.

Some additions to the mine include a new Bobcat, 30 Koehler lights, a 5 Ton dump truck and the erection of the student design building that was taken down on main campus. With the addition of the donated 30 cordless Koehler lights, we can now have 2 full classes at the same time underground. We also have a 2 person Kennedy Chamber for mine rescue training and Mine Health and Safety classes.

We recently started a decline in the Wheeler mine. This will accommodate the drilling and blasting classes and ensure that they will always have space for drilling and blasting. The plan is to use a 1973 JOY Air Track to drill in the mine.

Jimmie went to England for the 2012 Mucking competition and acquired an appreciation for the meaning of FLAT ROCK. Dr. Worsey will run around spouting "Flat Rock" and describing the difference between flat rock and round rock!! While traveling with the Mucking Teams, the group visited London, Stonehenge (the real ONE), Buckingham Palace and old tin mines in Cornwall. The 2012 competition was held at the King Edward Mine. Dr. Worsey, Mrs. Worsey, Jimmie and his wife took advantage of a free day and traveled to Paris by train. While in Paris, Mrs. Worsey was the tour guide and walked the legs off the group.

Delwayne accompanied the Gold Mine Rescue Team to New Iberia, LA and the tram came in 8th from a field of 14 teams.

We have gained a few new items at the mine that have improved the training that is provided to the students. However, we have a growing need for a newer truck that would be used for traveling to Mucking and Mine Rescue competitions. The Missouri School of Mines and Metallurgy, and the students, have a number of long distance trips on the horizon. These trips would be essential for our mining students to see what is happening in the mining industry.

New Shop at Mine Moved from Main Campus.

When you are in the Rolla area, we would like to show you all the improvements at the Exp. Mine. Please call 573-341-6406 or email Jimmie at ltaylor@mst.edu or DeWayne at phelpscd@mst.edu.

Dr. Wray is holding a gift presented by Eng Abdullah Al-Saif.
Building Capacity for Expanding Mining and Explosives Engineering Programs

Mining and Explosives Engineering programs at Missouri University of Science and Technology (Missouri S&T) have grown substantially in enrollment and research capacity over the last decade. The enrollment growth rates within the 2006-12 period are: (i) 88% (total enrollment); (ii) 50% (undergraduate enrollment); (iii) 234% (graduate enrollment); and (iv) 317% (PhD enrollment). These growth rates are significant given industry demand for mining engineers driven by the mining industry boom and aging workforce, and closure and marginalization of several global mining engineering programs. Strategic Objective 4 focuses on Expanding S&T’s Mining Engineering Capacity. Specifically, this objective aims at (i) Completing the new Experimental Mine Building; (ii) Expanding Existing Laboratory Capacity; (iii) Building new Laboratories; (iv) Creating Endowment Positions; (v) Increasing Personnel Resources; and (vi) Maintaining Strong Enrollment and Recruiting Efforts. The Department and its Development Board launched the Capacity Renewal Efforts in September 2009 to advance this strategic objective. The sections below provide updates on the progress achieved to date on various facets on the program.

1. Updates on Capacity Renewal and Expansion Initiatives

This section highlights the capacity renewal and expansion initiatives on the new Experimental Building, the Energetics Research Facility and the Virtual Surface Mining Simulator.

The New Experimental Mine Building: Expansions are currently underway on the new Missouri S&T Experimental Mine and the Explosives Research Facility. The graphic below shows the 3-D layout of the new Experimental Mine Building.

The existing facility has a capacity of 20 students, which does not allow concurrent laboratory classes to be held at the mine. Multiple sections must be held to complete a laboratory session for a large class with current facility. The new Mine Building will have 3 classrooms with a total of 180-seat capacity. The new facility also has space for three laboratories, mine rescue and mucking stations, dry rooms, and offices for students, faculty and staff. It will allow concurrent laboratory sessions of large classes to be taught at the mine. As part of expanding the mine facilities, the old student design building has been relocated at the Experimental Mine. This facility will provide additional space for important activities at the Mine. New Experimental Mine Building requires additional $600,000 for completion.

Missouri S&T Energetics Research Facility: The development of the Energetics Research Facility has been underway for about 4 years. This facility is located in Building No. 4 (previously used by the US Bureau of Mines). The facility houses two explosive chambers for research and education. The Missouri S&T Energetics Research Facility (ERF) has modern facilities for the engineering design, test, and evaluation of blast mitigation and defeat concepts, commercial rock blasting techniques and systems, and modern explosives performance. The ERF (Fig.1) comprises blasting chambers (one rated for 1kg of explosives in Fig. 2 and the larger one for 4 kg in Fig. 3), machine shop, computing facilities, and explosive magazines. The ERF also contains explosion imaging equipment, which includes the ultra-high speed Cordin 10-A framing camera (capable of 1,250,000 frames per second (Fig.4), high-speed video cameras (one, a Phantom V5.1, capable of 90,000 frames per second), a gated ICCD camera (capable of single exposures down to 55 nanosecond exposure times), and flash x-ray equipment. The Experimental Mine also contains explosives research facilities including an underground blast chamber rated at 10 kg TNT net equivalent weight (NEW) of explosives, a 3 kg TNT NEW-rated surface blast pad with instrumentation bunker, a large format (~50 ft long) explosive-driven shock tube for instrumented testing of full-scale glazing and wall panels (up to 6 ft x 8 ft), assorted storage and heavy equipment, and magazine storage for over 3,000 lb of explosives and detonators. Miscellaneous equipment also includes velocity of detonation measurement equipment, sixteen-channel synergy data acquisition system, pressure transducers, and eight seismographs.

Funding from industry, university and individual donors has addressed the capital expenditures to finish construction projects at the Laboratory. The remaining work to complete the facility include: (i) Replacement of the Cordin ultra-high speed camera, which is mid-1960s vintage. The technology is obsolete and is not supported by the manufacturer. The Cordin is a “draw” for many of the research initiatives currently being pursued in the facility. Current cameras with similar capability are in the $180k to $225k range. (ii) The flash x-ray system is also of the same vintage as the camera system and has a similar replacement cost requirement. Currently, Dr. Baird supports this research through his SRI account, funded by reimbursements from other research projects. Many of these unfunded projects resulted from the particular student’s interests, because there were no explosives engineering requirements from industry to offer to the students. We are very willing to tailor research to suit industry desires/requirements that have a promise of funding to support the associated research.

The Virtual Surface Mining Facility: A new laboratory, the Virtual Surface Mining Simulator (VSM5), was completed and unveiled on April 08, 2012 by Chancellor Schrader. The VSM5 Facility comprises 2 AES Base Simulators, Dragline Console, Shovel-Truck Console and a Command Center. This facility was funded by Caterpillar Global Mining, Luminant Energy, Joy Global and Immersive Technologies. The facility will be used for research and education in surface mining engineering. It will
also be used to help K-12 students understand technological innovations in the mining industry for education and recruitment. The facility will introduce K-12 students to surface mining operations via virtual environments. It will also provide them with an appreciation of mining engineering and how they can be controlled with a touch of a button. It will also demonstrate to young students that engineers can have fun on the job. The facility will also allow mining engineering students to interact with large scale surface mining operations with heavy machinery in the classroom. It will sharpen students understanding of engineering design associated with heavy machinery deployment. The VSMS Facility will help students appreciate the magnitude of the challenges associated with these machines and sharpen their critical thinking and problem solving skills to manage and improve such systems in real life. It also provides additional hands-on laboratory that improves enhanced experiential learning. Specific courses will be developed for training and educating equipment operators to improve their operating skills. These courses will include (i) risks and hazards control and mitigation; (ii) planning and deployment of heavy machinery to rugged terrain; (iii) surface mining methods and equipment; and (iv) tracking and improving key productivity indices of heavy machinery use.

2. Funding the Capacity Renewal and Expansion Initiatives

This capacity renewal and expansion initiative was put together by the Department and the Development Board under the leadership of Paul A. Lang, Executive Vice President and Chief Operating Officer for Arch Coal Inc. The cost associated with this initiative was estimated at about $6.9 million. The Department and the Board have raised $3.5 million toward the capacity expansion and renewal efforts, as illustrated in Table 1. The outstanding balance of $3.4 million for specific laboratories is illustrated in Table 2. I want to thank all our donors who have contributed towards this major effort. Special thanks go to Paul A. Lang, Bill Kennedy, Bruce Neil, Jeff Rosychk, Chris Curfman and Jarolbn Bekkering, Steve Kopenitz, Bryan Galli, Michael DeCola, Stephen A. Lang, Gregory A. Lang, Ted Ruppert for their leadership, contributions and support for this major effort. Special thanks also go to Arch Coal, Caterpillar Global Mining, Jaya Global Inc, Kennedy Metal Products, The Doe Run Company, Mississippi Lime Company, Barrick Gold North America, and Immersive Technologies for their contributions. The second phase of this initiative will raise the remaining $3.4 million to complete the expansion initiatives. Your support is key to the future of Rolla Mining Engineering.

### Funded Laboratories/Facilities ($3.5 M)

<table>
<thead>
<tr>
<th>LABORATORY/AIAD</th>
<th>DONORS</th>
<th>AMOUNT</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Experimental Mine Building ($2.5 M)</td>
<td>Kennedy Metal Products, The Doe Run Company, Mississippi Lime Company</td>
<td>$5.18 M</td>
<td>Remaining funding is $650,000; Construction is underway with projected finish date of Fall 2013</td>
</tr>
</tbody>
</table>

### Unfunded Proposals ($3.3 M)

<table>
<thead>
<tr>
<th>LABORATORY</th>
<th>AMOUNT</th>
<th>IMPORTANT FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral Processing</td>
<td>$0.8 M</td>
<td>Mining Engineering has hired 2 faculty in mineral-coal processing and is combining efforts with Chemical Engineering and Extractive Metallurgy to develop mineral-coal processing, tailings management and sustainable systems. This research facility will provide a core capacity for advancing research in these areas.</td>
</tr>
<tr>
<td>Rock Mechanics</td>
<td>$0.5 M</td>
<td>Additional funding required to complete the new Experimental Mine Building</td>
</tr>
<tr>
<td>New Experimental Mine Building</td>
<td>$0.6 M</td>
<td>Additional funding required to complete the new Experimental Mine Building</td>
</tr>
<tr>
<td>Mine Ventilation</td>
<td>$0.5 M</td>
<td>Expansion of the old Ventilation Facility to incorporate new equipment for research and education</td>
</tr>
<tr>
<td>Virtual Underground Mining Simulator</td>
<td>$0.5 M</td>
<td>Similar to the Virtual Surface Mine Simulator. This facility will be used for education and research in underground mine production systems.</td>
</tr>
<tr>
<td>Mine Survey</td>
<td>$0.2 M</td>
<td>State-of-the-art technological environment for mine survey</td>
</tr>
<tr>
<td>Explosives</td>
<td>$0.4 M</td>
<td>Additional funding required to complete the new Experimental Mine Building</td>
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2012 SME/NSSGA Student Design Contest

S&T Design Team participated in this contest after being absent for a couple of years. The team made it into the finals and presented their design at SME in Seattle, WA. While our team did not place in the top three, it gives us an opportunity to rebuild a good design team and get back into the competition. From left: Matthew Ortel; Matthew McHale; Sean Steagall; Tyler Leithauser; Greg Gibson and Benjamin Sutton.

Two of our faculty received Outstanding Teaching Awards in 2012. Dr. Richard Bullock (fourth from the right) and Dr. Maochen Ge (first from the right) received the award from Chancellor Schrader and Provost Wray.
Update from the S&T Mine Rescue Team

May 7-11 2012 saw the Mine rescue teams travelling to New Iberia, Louisiana for the Southern Regional Mine Rescue contest. The Missouri S&T team competed against 15 other industry teams. The Missouri S&T team performed well even though they did not earn a trophy. The competing team was: Captain - Casey Slaughter, Gas Man - Jacob Morris, Map Man - Eric Wesel, First Aid - Katie Sewester, Co-Captain - Andrew Krump, Fresh Air Base - David Stine, Fresh Air Base Assistant - Spencer Evans, Team Alternates - Dana Resmini and Jenna Freese. Below are a few photos from the SE Mine Rescue Competition in New Iberia, Louisiana. As you can see, our team is hard at work. This team placed 1st in the SE Missouri Mine Rescue Competition in Rolla in September 2012.

34th International Intercollegiate Mining Competition, Cornwall, England 2012

By: Amanda Baker and Lindsay Brandt

The Missouri S&T Mucking teams had a fantastic year; four teams were sent to Cornwall, England for the 34th International Intercollegiate Mining Competition. Members of the womens A-team included: Maggie Newsom, Jenna Freese, Katherine Stockdale, Sara Tipton, and Elizabeth Hunt; while members of the womens B-Team included: Lindsay Miller, Lindsay Brandt, Amanda Baker, Kelsey Garrett, and Deanna Fitzgerald.

The two week adventure started at the Gatwick airport south of London. After a few relaxing days in London, the group set out for Stonehenge, to be followed by Falmouth. During the six-hour bus trip, there were many naps and a few gas station stops. The entire group got to go and visit the historic Stonehenge Ruins. Once again everyone got on the bus for the final leg of the trip to Falmouth, where the competition events started. During the first night, the teams were left to explore the city. The next day, all the teams went on a historic mine tour that went from the picturesque shorelines of England to the underground tin mines. The old tin mines are unique in construction; the mines were dug out under the ocean.

The competition events started the next day. A practice day for all the teams was held to get familiar with the equipment and the terrain. The following day was the womens competition day. The Mucking Competition day consisted of seven events: hand steel, swede saw, jackleg drilling, survey, gold pan, trackstand, and as the name implies, mucking.

Between both teams, gold was taken in 4 out of the 7 events. Womens A-Team earned Bronze medal in the overall standings while Womens B-Team brought home the title of International Intercollegiate Mining Champions back to Missouri S&T. To celebrate the achievements of both teams, the next week was spent touring Dublin and London.

In 2013, the competition will be held in Golden, CO at Colorado School of Mines. Both womens teams are working together to reclaim the title in 2013.
NSSGA Student Chapter Update
by Greg Gibson, President

The Missouri S&T Student Chapter of the National Stone, Sand, and Gravel Association is off to a good start this year. We recently hosted the Second Annual Aggregate Industry Night. This year there were four companies in attendance: Lehigh Hanson, APAC Central, Austin Powder, and US Silica. The event was hosted on September 20th in the McNutt Hall Commons. Food was catered from Bandannas BBQ and the students ate and chatted with industry representatives. After dinner, representatives from each company, many of which were UMR or S&T Alum, had presentations that informed students on what students could expect as a newly-hired engineer. Overall it was a good event that should be continued in the future.

The entire leadership for NSSGA is new this year, and with that we plan on bringing some new ideas to the organization. We are currently planning a shooting social. The plan is to bring students out to the Rolla Shooting Club and shoot trap and sheet, rifles, and pistols. This will be a member only event and NSSGA will supply ammunition and guns. We have a feeling that this event will encourage students to join NSSGA and become a yearly event.

ISEE Student Chapter Update

Our Student Chapter had another very active year. A large group of students attended the 2012 Annual Conference of ISEE in Nashville, TN. But this was not the only conference. Several of our chapter members attended the Best in the West in April 2012. Two of our students presented a paper. We want to thank for the financial support we received to attend these conferences.

For several years members of this chapter have provided great pyro displays for campus activities. We continued this over the past year. This Fall we have two displays at night football games. The Annual SUB Block Party is always closed with a big firework. Our students are building a reputation of very great shooters! We work with the other student organizations in the department by hosting socials, providing callers for Phonathon and working Haunted Mine. The explosives program on this campus is “exploding”.

Dr. Worsey and the students posing for a photo in Nashville during the 2012 ISEE Annual Meeting and Conference.
It has been a very busy year for the ventilation group.

**Australian Trip**

Current NIOSH project on fire and fire simulation requires us to visit major mining countries to examine their mine safety practices and emergency procedures. Up till now, we have visited mine sites and safety facilities in Poland, India and China, the last one on the list is Australia.

Australia is one of the more advanced major mining countries with a booming mining industry. The high labor costs and first-world safety regulations, distinctive geology and the importance placed on mining research by government and businesses, has resulted in a mining sector that is quite technologically advanced, including mine ventilation network modeling, fire-fighting and mine rescue techniques. Dr. Stewart Gillies and I visited Australia in summer 2012.

In Australia we visited three mines (two gold mines and one gassy coal mine), Queensland Mines Rescue Service, and safety devices testing centers and extensive discussions for their best safety practices, mine rescue operations, underground refuge chambers and safety regulation.

**Mine Rescue Short Courses in China**

JCT and Casey Slaughter conducted two 3-day safety short courses at University of Science and Technology-Beijing (USTB) and Xi’an University of Science and Technology (XUST), Shaanxi Province. Both are comprehensive universities with tradition and strong emphasis in mining engineering.

Lecturing at Xi’an University of Science and Technology, Xi’an.

The title of the short course is: "Mine Emergency Response, with Special Emphasis on Escape under Mine Fires," combined over 500 undergraduate and graduate students at both institutions attended these two lectures. It appears the short course is well received, we have been requested to convert the lecture notes into a formal book on mine rescue.

**Center Wrap up**

The Western U.S. Mine Safety and Health Training and Translation Center was consortium of four universities (Colorado School of Mines, University of Utah, Montana Tech started back in 2004).

The Western Mining Safety and Health Training & Translational Center (Center) was funded by the National Institute of Occupational Safety and Health (NIOSH), Center for Disease Control and Prevention, Department of Health and Human Services. When it was established in 2004, it was a four-member consortium consisting of University of Missouri-Rolla (at the time of creation), Colorado School of Mines (CSM), Montana Tech of the University of Montana (Montana Tech) and the University of Utah. In 2005, Montana Tech withdrew from the consortia.

The Center is physically located in the Department of Mining and Nuclear Engineering, Missouri S&T and all projects were
coordinated and managed through the Center by Dr. Larry R. Grayson, who left Missouri S&T in 2007 and the Center was later transferred to Dr. Jerry C. Tien. This project has multiple subprojects and the primary aim of this project is to reduce the number of injuries to miners through an integrated program of training intervention and translational research.

Over the six years of operation, the Center has taught seven workshops on DPM training reaching 232 students from the mining industry. Most of the trainees were from the metal and nonmetal mining in the Western United States. Two short courses on mine ventilation had 42 students in two years. Small mine miner training reached 436 miners, including 53 mines in both initial training and follow-up visits or a total 189 miners reached. CSM’s trained a multiplier of 4 to have reached 5,203 trainees in six years. The progression among years of miners trained (without a multiplier) has been 161 in Year 1; 372 in Year 2; 478 in Year 3; over 500 in Year 4, over 545 in Year 5 and around 610 in Year 6, including the DPM project and the Hazard Identification and Risk Assessment projects.

The six-year project funded a total of eight students (four Ph.D., two M.S. and two B.S. students, published 16 papers and a 178-page DPM Emissions Control training manual (with a DVD). The Center officially ended August 31, 2011.

**Refuge Chamber Project**

After the Sago mine disaster, the MINER Act of 2006 mandated that all underground coalmines must install and maintain refuge chambers. Missouri S&T’s Ventilation Group was awarded a project by NIOSH to examine the CO purging process and to determine total air quantity and time necessary to lower the CO concentration to safe levels inside the chamber for different inlet/outlet configurations using 3D numerical simulation technique. This research can provide useful guidelines in developing an efficient strategy for purging refuge chambers.

**What’s New from Rock Mechanics**

The Rock Mechanics & Explosives Research Center (RMERC) has been buzzing with activity this past year – new projects, new researchers and staff, and new equipment.

Dr. Greg Galecki added a third post-doctoral researcher from Turkey to his team. Over the summer, Dr. Sedat Buyuksalı arrived from Afyon Kocatepe University to work on waterjet-assisted rapid excavation of rock. He joined Dr. Gul Akar and Dr. Sedat Sön from Dokuz Eylül University, who have been working with Dr. Galecki for the past two years on coal-water-fuel characterization.

Two post-docs have also been doing research with Dr. Norbert Maerz (Geol. Eng.). Over the summer, Dr. Ahmed Youssef – an S&T grad (MS CE’04, PhD Geo’04) – traveled from the Saudi Geological Survey to work with Dr. Maerz on natural hazards. And, continuing his project from the previous year, Dr. Ahmed Dellarmançt from Dokuz Eylül University in Turkey worked with Dr. Maerz on issues related to the Graniteville Quarry.

**2012 Old Timers Award**

The recipient of the 2012 Old Timers Award is Michael Shuman.

Mike worked every summer in the coal industry and is now working for Jim Walter Resources in Alabama. Mike received the award at the Annual Student Awards Banquet in April 2012.
Expanding Global Frontiers in Mining Engineering Education

Expansions in the domestic and global mining industry have fueled greater interest in mining and explosives engineering research and education all over the world. Missouri S&T has strong and leading programs in mining and explosives engineering, and is therefore, positioned to play a vital role in meeting the global demand for technological innovations and the production of highly qualified personnel in these disciplines. Over the next 10 years, the Department has laid down strategic objectives, goals and action plans to expand and grow its research and education initiatives at home and abroad. Missouri S&T’s global presence will expand the capacity of its mining engineering program and provide our students with opportunities to experience diversified portfolio of students and cultures abroad. It will also provide opportunities to experience the global mining industry for great career opportunities. The global presence will broaden the research capacity to cover several industries in several countries. The resulting experience and exposure will allow Missouri S&T to serve the US mining industry with distinction. Toward these important objectives, Missouri S&T is expanding its global presence into several mining countries, including Australia, Botswana, Brazil, China, Dominican Republic, Ghana, Indonesia and Saudi Arabia. Below are highlights of our presence in Botswana, China, Saudi Arabia and Indonesia. Today, these programs have the potential to add 4 faculty members to the mining engineering faculty at Missouri S&T.

Global Presence in Botswana, Southern Africa

Botswana produces 35% of the global gem diamonds. It also produces copper, gold, and coal. However, the country does not have a mining engineering program. In 2007, Missouri S&T signed a Memorandum of Understanding (MOU) with University of Botswana (UB) and a specific Implementation Agreement to offer a 3+2 program in Mining Engineering. Under the agreement, UB students will complete 1-year pre-university and 2 years university education and transfer into the junior year at Missouri S&T. These students will then complete a 2-year program leading to the Bachelor of Science degree in Mining Engineering. Since its inception in the Fall of 2008, this program has produced 33 graduates with a current enrollment of 24 students. The photos show a group picture of the Botswana students, a visit to the Okavango Delta Safari by a delegation from Missouri S&T and a picture with Her Excellency Ma Seretse, the Botswana Ambassador to the United States.

Global Presence in China

In 2010, Missouri S&T along with University of Missouri – Saint Louis (UMSL) completed an MOU with Tianfu College of Southwestern University of Finance and Economics (TC-SWUFE) to establish four engineering programs, nursing and hospitality schools. Under this agreement, Missouri S&T will develop Mining and Mineral Process Engineering, Materials Science and Engineering, and Engineering Management. TC-SWUFE, located in Sichuan Province, was founded in 1925 in Shanghai. During WWII it moved to Chengdu Province. In 1952, Sichuan College of Finance and Economics was formed by merging 17 colleges, universities and institutes for higher education. In 1985, its name was changed to Southwestern University of Finance and Economics. TC-SWUFE is one of the top 100 independent colleges of China. It was recognized in 2010 for its excellent graduates by Sichuan Province and awarded “21st Century Innovation Demonstration Site of Education Reform” nationally. This region has the largest concentration of rare earth minerals in the world. New faculty members will be hired to administer and teach the programs.

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Global Presence in Saudi Arabia
In 2012, Missouri S&T completed a contractual agreement with Ma’aden, The Saudi Arabian Mining Company and the Technical and Vocational Training Cooperation (TVTC) to establish the Saudi Mining Polytechnic (SMP). This Saudi Mining Institute, located in Arar, Saudi Arabia, will educate and train professionals in surface and underground mining and mineral processing plant operations. Saudi Arabia has diversified its economy into mining with strong emphasis on gold, bauxite, phosphate, copper and zinc and other industrial minerals. Its multi-billion dollar bauxite-alumina and phosphate-ammonia-fertilizer complexes presents state-of-the-art technologies that present bold initiatives into the next century for its mining industry. Alongside this bold initiative is the establishment of a comprehensive institution to prepare professionals for the mining industry. Ma’aden and TVTC initiated a global competition via an RFP and Missouri S&T was selected as the partner for executing this important assignment. This assignment presents a great opportunity for shaping the mining industry of Saudi Arabia.

Global Presence in Indonesia
In October 2012, Missouri S&T signed an MOU with Syarif Hidayatullah Islamic State University (UIN) in Indonesia to establish a School of Mining and Environmental Engineering at UIN. Indonesia has large reserves of precious, base, ferrous and fossil fuel minerals and its home to several multi-national mining companies. The School will be a vehicle to produce highly qualified graduates to meet the talent needs of Indonesia. Under the agreement, the two universities will undertake a 2+2 BS in Mining Engineering program, distance education and faculty training and development. It will also create research partnerships between Missouri S&T and Indonesia’s mining industry and opportunities for international exposure to our students.

These initiatives are part of the FY2010-20 Strategic Plan for the Department of Mining and Nuclear Engineering to expand its global footprints. Under the Strategic Objective 5 (Strengthen National and Global Partnerships), the Department seeks to engage national and global universities, industries and research organizations as partners in education and research. The specific goals under this strategic objective include (i) Maintenance of a Strong Development Board; (ii) Enhancing Missouri S&T-UB Partnership; (iii) Developing S&T-Saudi Initiative on Mining Education; and (iv) Developing Other S&T International Initiatives. Toward these goals, we seek to grow in strength and capacity.

2012 Phonathon
Fall is coming to the Ozarks and the annual Mining Engineering Phonathon is coming up. Our students will work the phones from November 4 to 8, 2012. We hope you will take their call and continue your generous donation to the Department. Remember that all the Phonathon donations come to the Department and are split between scholarships and department activities. All four student organizations, as well as mine rescue, mucking and the student design team benefit from the Phonathon.

News about the Explosives Program
by Dr. Paul Worsey
We have just finished our second year of the explosives masters and have now graduated a total of 9 masters to date with 27 enrolled students in hot pursuit and 8 others in the postgraduate certificate program. By the end of the second year we exceeded our 4th year goal and we are now at a sustainable level.

The graduation statistics today are:

Table Showing Graduates with qualifications 1997 thru May 2012, Explosives emphasis through Masters

<table>
<thead>
<tr>
<th>Graduates</th>
<th>U Emphasis</th>
<th>U Certificate</th>
<th>U Minor</th>
<th>G Certificate</th>
<th>G Minor</th>
<th>M.S.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>13</td>
<td>71</td>
<td>13</td>
<td>2</td>
<td>9</td>
<td>144</td>
</tr>
</tbody>
</table>

The emphasis was approved in 1997, the minors in 2005, certificates in 2006 and masters in 2010. We now have 13 separate explosives classes being given plus “postgraduate cooperative experience”, “industry project”, “special problems” and “research”. Also we should have an additional class added this spring. The classes span rock blasting, explosives theory, instrumentation, safety, manufacture, pyrotechnics and demolition.

We are currently in the midst of the submission of a proposal for a PhD in explosives engineering catering for our masters’ students that would like to continue. The Masters and PhD are both in house and distance, full and part time and a hybrid of all four, catering both for traditional students and those in industry, unable to attend the university for an extended period of time because of their work and family commitments.

Congratulations to Dr. Braden Lusk
Some of you will remember Braden Lusk (BS 200 and PhD 2006) from when he was a student here. We are pleased to announce that this February he received the International Society of Explosives Engineers President’s award and was promoted to Associated Professor of Mining Engineering with tenure at the University of Kentucky. Braden will be helping us with the explosives masters, joining us as adjunct associate professor in the near future and be teaching a distance class on blast vibration engineering.

The name is Worsey, Paul Worsey. He likes his Martini shaken - not stirred.

Dr. Worsey ready to attend the Mining Hall of Fame Induction Banquet in Las Vegas, NV.
Engaging Our Constituencies for Strong Mining Engineering Education

One of the greatest constituencies for Missouri S&T’s Mining Engineering Program is the Mining Industry of the United States. We are proud of industry’s contribution to the social fabric and economic security of the nation captured in the following statements from the National Mining Association. In keeping with the above contributions by the industry, Missouri S&T educates future mining engineers with industry as a partner. Every year, Missouri S&T interacts with industry leaders to understand the factors that affect the direction of its mining engineering education.

In 2008, the mining industry paid approximately $45 billion in taxes, royalties and fees to federal, state and local governments combined. Nearly $107 billion was paid to mining industry employees in direct and indirect wages and benefits. The total direct and indirect impact of U.S. mining is valued at $1.9 trillion - mining produced $80 billion of finished mineral, metal and fuel products that were then transformed by consumer industries into goods creating an additional $3.8 trillion in value added. According to U.S. Geological Survey analysis, the value added to U.S. GDP by major industries that consume processed mineral resources is estimated at $2.1 trillion in 2010, 14 percent of U.S. GDP. Minerals and materials processed from mineral resources account for exports worth as much as $87 billion per year.” (National Mining Association, 2012)


The Board meets once a year in April. At the April 08, 2012 Board Meeting, Chancellor Schrader provided a vision for the future of Missouri S&T, followed with the state of Missouri S&T’s Mining Engineering by Samuel Frimpong, Chair of Mining and Nuclear Engineering. Updates on capacity renewal efforts were provided by Paul A. Lang (Executive Vice President and COO for Arch Coal), Bill Kennedy (President and CEO for Kennedy Metal Products), Nasib Aoud (Assistant Teaching Professor) and Paul Worsey (Professor and Director of Explosives Engineering). The Mining Engineering faculty members also provided highlights of major research initiatives. The Board also focused on summer internships and COOP opportunities for the students and scholarships for students in the program. Chairman Schrader unveiled the new Virtual Surface Mining Simulator for research and education in mining engineering at this Board meeting.
Luminant on "Professional Development: Frontiers of Luminant Mining" Conference on July 11 and 12, 2012 in Dallas, invitation by Luminant Energy, Dr. Frimpong attended the broadening the education and research experience. Upon the exposure of students to operating practices in industry as part of enhancing our industry networks, alumni relations, to industry by the faculty, staff and students over the past year August 09, 2012. Several presentations were made by senior Frimpong attended the Barrick’s Interns Day in Elko, NV on and August 03, 2012. Upon the invitation by Barrick, Dr. Program at the Luminant Academy in Tyler, TX within July 30

Accenture Alberici Constructors, Inc. APAC‐Missouri, Inc Arch Coal, Inc.
Cliffs Natural Resources Cloud Peak Energy Drummond Co., Inc. Galius Biopharmac., LLC
Epic ExxonMobil Freeport‐McMoRan Inc. Halliburton
Jacobs Joy Global - Surface Mining Lehgh Hanson MEMC Electronic Mat, Inc.
Meramec Elect. Prod Co. Mississippi Lime Company Orica USA Peabody Energy
Perceptive Software ProEnergy Services Schlumberger Shannon & Wilson, Inc.
Specialty Granules Inc. TD Missouri Corporation The Doe Run Company U.S. Silica
DEWILN Corp. Navel Oceanic Corp. Walter Energy Canada Westmoreland Coal Co.

A number of visits were made to industry by the faculty, staff and students over the past year as part of enhancing our industry networks, alumni relations, to industry by the faculty, staff and students over the past year August 09, 2012. Several presentations were made by senior intern on specific projects these interns completed over the summer of 2012. Drs. Frimpong, Galecki and Krishnamurthy also visited Ma‘aden and SMP in Saudi Arabia for signing an agreement between Ma‘aden and Missouri S&T. During that visit, we had the opportunity to visit Ma‘aden’s corporate office in Riyadh for signing the agreement, the SMP Campus in Arar and the aluminum and phosphate industrial complexes in Al Jubar, Saudi Arabia. Field trips are important assignments for the experimental learning process. During these trips, students become familiar with difficult and challenging concepts in the classroom. These trips are essential in the mining engineering curriculum. Table 3 shows the field trips undertaken by the faculty, staff and students in the Mining Engineering Program. Overall, 18 field trips were undertaken to several surface and underground mining operations involving a total of 610 students.

Mines and Metallurgy Academy Meetings: The Academy comprises distinguished alumni of the seven programs in Departments of Mining and Nuclear Engineering, Geological Sciences and Engineering and Material Science and Engineering. The Academy meets twice a year in April and October. During the October 2001 and April 2012 Meetings, Dr. Frimpong attended the opportunity with the two other Chairs to share the enrollment growth, research and education and the capacity expansion initiatives ongoing the Department.

MASHRAK and NIOSH Visit: As part of the Mine Safety and Health Research Advisory Committee (MASHRAK), appointed by the US Health and Human Services Secretary, Dr. Frimpong attended a two-day meeting in Pittsburgh on research and technological advances in mine safety and health by NIOSH within August 19 – 21, 2012. The charter of MASHRAK are as follows: “MASHRAK shall advise the HHS Secretary, the Director of CDC, and the Director of NIOSH, on the conduct of mine health research including grants awards and research contracts (30 U.S.C. ' 812 (b)(2), (Public Law 91-173, ' 102(b)(2)). The shall provide advice on the conditions that have a significant effect on mine safety and health, and 3) the research activities produce intended results in addressing important research questions in mine safety and health both in conjunction with other ongoing activities inside and outside of NIOSH, to Federal scientific instructions in accomplishing objectives in mine safety and health; and 3) the research activities produce intended results in addressing important research questions in mine safety and health both in conjunction with other ongoing activities inside and outside of NIOSH, to Federal scientific instructions in accomplishing objectives in mine safety.” The committee members include the following:

Table 1 2011-12 Companies Recruiting Through the Department

<table>
<thead>
<tr>
<th>RCT #</th>
<th>Date</th>
<th>Company</th>
<th>Info Session</th>
<th>Responsible Chapter Society</th>
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<tr>
<td>1</td>
<td>09/06 – 07/2011</td>
<td>BHP Billiton</td>
<td>YES</td>
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<td>2</td>
<td>09/07/2011</td>
<td>US Gypsum</td>
<td>NO</td>
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<td>3</td>
<td>09/20 – 21/2011</td>
<td>Martin Marietta</td>
<td>YES</td>
<td>National Stone, Sand and Gravel Association</td>
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<tr>
<td>4</td>
<td>09/26/2011</td>
<td>UNIMIN Corp</td>
<td>YES</td>
<td>Mining</td>
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<td>5</td>
<td>09/26/2011</td>
<td>Alberici Group</td>
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<td>6</td>
<td>09/26/2011</td>
<td>Luminant Energy</td>
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<td>Newmont Mining</td>
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<td>Cloud Peak</td>
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<td>14</td>
<td>10/12/2011</td>
<td>Cargill</td>
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<td>16</td>
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<td>Women in Mining</td>
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<td>19</td>
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<td>Vibra-Tech</td>
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<td>US Steel</td>
<td>YES</td>
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Table 2 Fall 2012 Career Fair Employers seeking Mining Engineering Graduates

<table>
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<tr>
<th>RCT #</th>
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<td>4</td>
<td>04/08/2011</td>
<td>Mi Eng 326</td>
<td>Surface Mining &amp; Equip</td>
<td>54</td>
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<td>5</td>
<td>04/12/2011</td>
<td>Mi Eng 324</td>
<td>Underground Mining &amp; Equip</td>
<td>52</td>
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<td>6</td>
<td>04/15/2011</td>
<td>Mi Eng 003</td>
<td>Principles of Mining Engineering</td>
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<td>7</td>
<td>04/15/2011</td>
<td>Mi Eng 303</td>
<td>Aggregates Material Size</td>
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<td>8</td>
<td>11/12/2011</td>
<td>Mi Eng 317</td>
<td>Mine Power and POE</td>
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<td>Min Proc I Flotation &amp; Hydrometallurgy</td>
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<td>Underground Mining &amp; Equip</td>
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<td>13</td>
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<td>Mi Eng 324</td>
<td>Underground Mining &amp; Equip</td>
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<td>14</td>
<td>04/11/2012</td>
<td>Mi Eng 241</td>
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<td>15</td>
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<td>Mi Eng 350</td>
<td>Blasting Design and Technology</td>
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<td>Mi Eng 324</td>
<td>Underground Mining &amp; Equip</td>
<td>48</td>
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</table>

Dr. Cecile S. Rose, Professor & Director, Occupational and Environmental Health Clinic, University of Colorado
Dr. Brent Chamberlain, Director of Human Resources, Safety, and Health, General Moly, Inc.
Mr. Dennis O’Dell, Administrator for Occupational Health and Safety, United Mine Workers of America
Dr. Syd Peng, Director, Longwall Mining and Ground Control Research Center, West Virginia University
Mr. Emmett Russell, Director, Department of Safety and Health, International Union of Operating Engineers
Mr. Bruce Watzman, Vice President of Safety, Health, and Human Resources, National Mining Association
Dr. Lawrence Bank, Program Director, Structural Materials and Mechanics, US National Science Foundation
Dr. Jeffery Kravitz, Chief, Special Projects/Mine Emergency Operations, MSHA
Dr. Darryl Zeddin, Senior Investigator, National Institute for Environmental Health, NIH
Dr. Jeffery L. Kohler, Executive Secretary to MASHRAK, Associate Director for Mining and Director, Office for Mine Safety and Health Research (OMSHR), NIOSH
Coal Rush!
by Dr. Greg Galecki

When I received a call from a colleague at the 2012 SME Annual Meeting to visit Pioneer Pump Incorporated’s booth, I thought of another good application of waterjets for the mining industry. After getting closer to the booth, I was pleasantly surprised. I recognized a few faces from a TV documentary standing in front of the booth, so I shouted, “Gold Rush!” After a short explanation that I like gold but I am deeply involved in coal cleaning, we all came up with “Coal Rush!”

Let me tell you more about my passion for coal. For the past two years it has been my great pleasure to work on coal slurry characterization with post-doctoral fellows Gul Akar and Sezai Sen. After the first year of their stay, funded by TUBITAK and YOK, Drs. Akar and Sen spent one additional year researching coal slurries in my Mineral Processing Laboratory. I felt honored by their request to continue to work under my supervision, so I came up with funds to continue work on coal-water-fuel characterization. By the time you read this article, both of them will be back to Dokuz Eylul University, in Izmir, Turkey to continue their research on mineral processing; specifically coal. We have discussed our future plans and can say that our two years of joint research marked the beginning of long term cooperation between Missouri S&T and Dokuz Eylul University.

At the beginning of July, Mrs. Yaqing Li defended her M.Sc. thesis “Effects of Coal Comminution in Relation to Waterjet and Selected Feed Properties”. I believe her professional life will include further studies involving the cleaning of emissions from coal burning power plants in her home country of China.

With these short descriptions of my research involving coal, you can understand why, with a smile, I can say “Coal Rush!”

Dr. Greg Galecki is an Associate Professor of Mining and Nuclear Engineering Department, Missouri University of Science and Technology. If you would like to talk more about coal for power generation, you can reach him at ggalecki@mst.edu or by phone at 573.341.4938.

Research on Mechanical Properties of Frac Sand
Dr. Maochen Ge

“The frac sand” is a high-purity silica sand with very durable and very round grains of a specific size (Figures 1 and 2). The term frac sand, comes from its critical role in the hydraulic fracturing process, the technique that is used for recovering tight gas and shale gas. Shale gas is considered a major component of the future energy for the United State.

The primary source for frac sand in the United States is the St. Peter sandstone. The St. Peter sandstone is very different from the minerals and rocks, which have been studied extensively in mining. On the one hand, it is brittle, characterized by an unusually high friction angle. On the other hand, it is friable, possessing extremely low, and in most cases zero cohesion. The scarcity of the ground control techniques for this particular mining environment has created many difficulties for the mine operators.

In order to resolve these problems, Dr. Ge and his research group have conducted an extensive research to investigate the basic geotechnical properties of the St. Peter sandstones during the past two years. One of the major achievements resulting from this investigation is the theoretical elucidation of the mechanics of the extremely high friction angle associated with the St. Peter sandstone, which is about 60˚ on average and can be as high as 70˚. Figure 3 shows the friction angle determined from the triaxial tests and Figure 4 is the triaxial test equipment utilized for this research.
The phenomenon of the extremely high friction angle associated with the St. Peter Stone suggests a fundamental question regarding the mechanical properties of St. Peter Stone, “What are the underlying mechanics for this very high friction angle?” Investigations to date have attributed the high angle to be caused by the various surface properties of the sandstone particles. We, however, hold a very different view on this problem as none of these surface properties would be significant enough to cause such a large increase in friction angle. We believe that the structure of the sandstone particles is the cause and a rhombohedral model (Figure 5) was developed to simulate the sandstone structure.

The model shows that the particles have to climb to the top of the other particles during the shear displacement. This process is illustrated by Figures 6 and 7. According to the model, the average climbing slope is 15°. In other words, the shear test under a low confining pressure condition will result in an increase of the friction angle by 15°. This result is an accurate prediction of the extremely high friction angle observed for the St Peter sandstone. In addition to its accuracy, the model also explains two other important phenomena associated with the St. Peter sandstone: very large dilation under low confining pressures and very small or even no dilation under high confining pressures.

**Fig. 5 Rhombohedral packing, a structure model for the St. Peter Sandstone**

The trip was funded in response to a proposal to collaborate with these two institutions on mutual research interests. Dr. Petrik, an associate professor of chemistry at UWC, and Dr. Alan Brent, a professor of sustainable development at SU. The Sustainable Mine Modeling Group (SMMG), Kwame’s research group, continued its research on (i) mining and energy sustainability assessment and modeling; (ii) spatiotemporal variation of soil CO2 fluxes; (iii) operator and mine production impacts on mining energy efficiency; and (iv) mine design and production planning. Kwame continues to teach undergraduate and graduate students and advise the SME/NSSGA student design competition teams.

This past year, Missouri S&T entered three teams in the SME/NSSGA design competition, which saw fourteen teams overall. For the first time, a Canadian school (McGill University) participated extending the global reach of the competition. One of our three teams made it to the second phase in Seattle and came in sixth overall. We were very proud of all our teams who had to take on this task in addition to their academic work and all the other extra-curricular activities. We are happy with our progress in this competition and hope to do better this year.

The competition has already started for this year. And again, Missouri S&T has three teams participating. We look forward to the learning and networking that will occur over the course of the competition. We are always delighted to see our students grow as they tackle real-life problems and receive mentoring from the industry judges. While we understand the aggregate slant of the competition (it is after all sponsored by mostly aggregates companies), we will encourage more involvement by professionals in coal and metal mining to expand the mentoring opportunities the competition offers.

This summer, Kwame was funded by the University of Missouri South Africa Education Program to visit University of the Western Cape (UWC) and Stellenbosch University (SU), both near Cape Town, South Africa. He was hosted by Dr. Leslie Petrik, an associate professor of chemistry at UWC, and Dr. Alan Brent, a professor of sustainable development at SU. The visit was a success in various ways. The interaction with these collaborators was very successful. Kwame was part of a one-day workshop led by the collaborators and attended by researchers from UWC, SU and the Cape Peninsula University of Technology. He also visited the Council for Scientific and Industrial Research (CSIR) offices in Pretoria and Johannesburg and met with a representative from MINTEK. He also visited the Komati Power Station, a coal-fired power plant, to observe fly ash management and disposal practices.

**Robben Island - above**

Kwame also got to visit Robben Island (where Nelson Mandela was imprisoned for 18 years) and Table Mountain. These visits added to the fun and made the visit even more pleasant.

**Update from Dr. Kwame Awuah-Offei**

It has been another great year for Dr. Kwame Awuah-Offei [Dr. Kwame] with teaching, research and service all presenting interesting challenges and fulfilling outcomes.

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The visit was a success in various ways. The interaction with these collaborators was very successful. Kwame was part of a one-day workshop led by the collaborators and attended by researchers from UWC, SU and the Cape Peninsula University of Technology. He also visited the Council for Scientific and Industrial Research (CSIR) offices in Pretoria and Johannesburg and met with a representative from MINTEK. He also visited the Komati Power Station, a coal-fired power plant, to observe fly ash management and disposal practices.

**Table Mountain - right**

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Kwame looks forward to the coming year with excitement and hopes to continue to aid the Department’s vision to become the global choice for mining engineering education and research.
An Angelina Anani, PhD student  
Ms. Anani joined the Group in January 2012. She obtained her BS in mining engineering from Missouri S&T, in May 2011. Angelina will be working on accounting for pillar extraction in underground mine sequence optimization. Her research will develop an algorithm that determines the optimal sequence of extraction in underground room and pillar operations, while concurrently accounting for pillar recovery and mining risk. Room and pillar sequencing will be expressed as a mixed integer linear programming optimization problem and solved using a novel branch and bound algorithm. The model will be validated using real coal and metal mine data.

Maryam Abdi Oskouei, MS student  
Maryam Abdi Oskouei has been with the Group since Fall 2011. Maryam is modeling dragline energy efficiency under uncertainty, in order to understand the effect of operator practices and operating conditions. The main research activities are data collection, modeling, and verification and validation. She has acquired data from an actual mine using data acquisition equipment; conducted statistical analysis; and formulated a modeling framework. She is currently working on stochastic models of dragline energy efficiency. The outcome of this research will increase understanding of the dynamics of energy efficiency in excavation and material handling operations leading to advanced technologies to reduce the energy intensity of mining operations.

Moabago J. K. Mathiba, PhD student  
Moabago J. K. Mathiba has been with the Group since Summer 2008 and is ready to graduate. Mr. Mathiba has a BE in mining engineering (Technical University of Nova Scotia, Canada) and MS in environmental science and engineering (Colorado School of Mines). Moabago has been modeling soil CO2 fluxes generated by acid mine drainage (AMD) neutralization reactions with carbonates (mainly limestone) on reclaimed mine land. He has measured CO2 fluxes for three reclaimed mine lands in Missouri, Indiana and Pennsylvania, and used various statistical tools to evaluate correlations with soil moisture, soil temperature and sample elevation and explored the nature of the spatial variability. The aim of the research has been to understand the behavior of CO2 fluxes measured with chamber accumulation flux measurement so as to evaluate the effectiveness in delineating this emerging hazard to post-mining land use.

Mark Boateng, MS student  
Mark Boateng joined the group this semester (Fall 2012). Mark is working on using agent-based modeling to characterize dynamic interaction between social acceptance and a mining project. The interaction between community acceptance and mining projects is dynamic and not static due to changes in community demographics, expectations and notions about the mining project from one stage to the other within its cycle. There are currently no approaches to account for the effect of changing charactersitics of the mine over its life cycle (exploration, exploitation, closure, post-mining land use) and how that affects the communities perception of mining. The goal is to provide a simulation program that will help stakeholders evaluate mining projects based on dynamic interaction between community acceptance and the mining projects. This will aid better decision making by all sides.

Sisi Que, PhD student  
Ms. Que’s research is on determining the drivers of community acceptance of mining projects. The goal is to advance sustainability science by understanding the drivers of community acceptance using discrete choice modeling. This approach will help the industry and regulators understand characteristics of individuals and mining projects that control the level of community acceptance.
Welcome and Congratulations to Board Members

On behalf of the Department and the Board, I welcome the following new members to the Board: (i) Jerry Pyatt, President and CEO for The Doe Run Company; (ii) Bill Ayers, President and COO for Mississippi Lime Company; (iii) Chance Allen, Vice President and General Manager, Martin Marietta, and (iv) Richard Goodridge, Manager of Global Technologies, Orica Inc.

In addition, I would also like to congratulate the following for promotion: (i) Paul A. Lang to Executive Vice President and COO for Arch Coal Inc, and (ii) Pat Risner to President BHP Billiton’s San Juan Mine.

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<th>MEMBERS</th>
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<tr>
<td>Jerry Pyatt</td>
<td>President and CEO</td>
<td>The Doe Run Company</td>
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<td>Stephen A. Lang*</td>
<td>Chairman of the Board and Former President and CEO</td>
<td>Centerra Gold</td>
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<td>William Kennedy</td>
<td>President and CEO</td>
<td>Jack Kennedy Metal Products</td>
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<td>Michael T. McCall*</td>
<td>Former CEO and Chairman</td>
<td>Luminant Energy</td>
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<td>Gregory A. Lang*</td>
<td>President &amp; CEO</td>
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<td>Dennis N. Kostic</td>
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<td>Weir International</td>
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<td>Richard Marston</td>
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<td>John E. Cramer</td>
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<td>Casper Stolle Quarry</td>
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<td>Pat Risner</td>
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<td>Paul A. Lang*</td>
<td>Executive Vice President &amp; COO</td>
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<td>Jeane Hull</td>
<td>Executive Vice President, Technical Services</td>
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<td>Steve Kopenitz</td>
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<td>David Webb</td>
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<td>Cliffs Natural Resources</td>
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<td>Lehigh Hanson</td>
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<td>Jeffrey A. Roschky</td>
<td>Vice President – Marketing/Prod. Mgmt</td>
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<td>John Cash</td>
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<td>Richard Goodridge</td>
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<td>District Engineering Manager</td>
<td>Kiewit Mining Group</td>
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<td>Bruce Jones</td>
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<td>Cloud Peak Energy</td>
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<td>Terry Bush</td>
<td>Engineering Manager</td>
<td>Newmont Corporation</td>
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<td>Greg Gajewski</td>
<td>Technical Manager</td>
<td>Goodyear Company</td>
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<td>Richard Bullock</td>
<td>Quenon Chair &amp; Professor Emeritus</td>
<td>Missouri S&amp;T</td>
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Call for Extended Abstracts & Dates:
September 30, 2012 – Abstract Submission Opens
March 30, 2013 – Abstract Submission Deadline
April 30, 2013 – Acceptance Notification
May 30, 2013 – Presentation Submission Deadline

Innovations in Mining Engineering

Study theme: “Exploring Global Mining Frontiers: Challenges & Opportunities for Winning the Competition.”
Finally, we want to thank you for all your support during this past year. As you have seen in this newsletter, our students, faculty and staff are very active and new projects or events seem to come out of nowhere. However, all these activities help us to “produce” the best young mining engineer possible - and we see that we are on track by increased numbers of companies looking to us for their mining engineers. The formula we use to mix curriculum, student and professional activities is working and we will keep on track. You can be proud of your “Old School” and the new generation of mining engineers.

We have some mining companies come directly to the Department to interview. A large number of companies are looking for mining engineers at the Fall 2012 Career Fair. S&T/MSM mining engineers have an excellent reputation in the industry and we are committed to keep the tradition going.

The Faculty and Staff of the Mining Engineering Program