



News from Holden Hall

Department of Mining and Minerals Engineering
Virginia Polytechnic Institute and State University

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Spring 2014

The Mill Report —*Dr. Greg Adel, Professor and Department Head*

Spring semester 2014 has come to an end and it is time once again for the latest issue of *News from Holden Hall*. The department continues to produce new mining engineers at a record pace, with 56 graduates in the Class of 2014 (a new record!). In fact, over the past six years we have graduated our three largest classes (2014 - 56, 2009 - 54, 2013 - 47), and we are on track to set another record with the Class of 2015. I am also pleased to report that despite the downturn in the coal industry, 85% of our graduating seniors were placed at graduation time, largely as a result of improvements in the aggregates industry. The remaining graduates are likely to be placed over the summer. Likewise, our graduate program has doubled over the past six years (from 5 graduate degrees per year to 10 graduate degrees per year) largely as a result of an increase in our Ph.D. program. This is particularly important with the impending retirement of many mining engineering faculty members throughout the world. In fact, over the past ten years, 40% of our Ph.D. graduates have gone into academic positions. As you might expect, an increase in graduate degree productivity is generally tied to an increase in research, and that is exactly the case here. Our research expenditures per faculty member have also more than doubled over the past six years from \$315,000 to \$700,000.

While we are proud of the growth in this program, it is important to note that it comes with a price. We are severely stressed for resources, including research space, teaching space, office space, faculty positions and staff positions. The faculty and staff are working very hard to make do with what is available. We look forward to taking over 5400 square feet of space in Randolph Hall at the end of the summer once Chemical Engineering vacates this space to move into the new Signature Engineering Building. We were also pleased to learn that the renovation of Holden Hall has now become the number one renovation priority of the University. Of course, much has to happen before this renovation becomes a reality, but becoming a number one priority is certainly a good start.

Clearly, numbers can never tell the whole story, and we continue to be blessed with outstanding students. In fact, this issue of *News from Holden Hall* focuses on our students and our student organizations. You will hear about the Burkhart Mining Society and their plans for next year. You will learn about our SME/NSSGA Design Team which was once again victorious in the national competition. You will hear the latest adventures of our mucking team in this year's competition at Rolla, Missouri. You will learn about our newly-formed mine rescue team and their needs as they look forward to becoming a competitive team. And finally, believe it or not, you will learn how mining engineering students are teaming with aerospace students to develop a robotic device for mining asteroids or the Martian surface. In fact, our "Astrobotics" Team is currently competing at the Kennedy Space Center as this newsletter goes to press.

In this issue of *News from Holden Hall* we are also pleased to recognize several of our award recipients from this past year, including Mike Karmis (AIME Presidential Citation), Emily Sarver and her graduate student Rachel Sellaro (SME Environmental Division Outstanding Technical Paper), and Heather Dougherty (SME Coal and Energy Division J.W. Woomer Award). In addition, we introduce our two latest additions to our Distinguished Alumni list: Mike Brown (Class of 1983) and Tony DiRico (Class of 1979). Finally, we offer a special recognition for Susan Harwood, past national president of WAAIME and one of our most loyal supporters in helping provide Virginia Tech mining students with WAAIME scholarships. If any of you had assistance from a WAAIME

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The Mill Report

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scholarship back in your college days, it is likely that Susan had a hand in helping you get this award.

As always, none of our successes would be possible without the loyal support of our alumni and corporate donors. Thanks so much for all you do to help keep this department strong. I hope you enjoy this latest issue of *News from Holden Hall*.

Dr. Greg Adel
Head, Department of Mining and Minerals Engineering
Virginia Tech

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Department of Mining and Minerals Engineering
at Virginia Polytechnic Institute
and State University
100 Holden Hall
Blacksburg, Virginia, 24061-0239
Phone: (540) 231-6671 | Fax: (540) 231-4071
Email: mineinfo@vt.edu | www.mining.vt.edu

Department Head: Greg Adel
Editing/Layout: Angelo Biviano
Contributors: Cassandra Brown, Dilley Hughes

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Brown, DiRico Join Ranks of Department's Distinguished Alumni

Mike Brown graduated from the department with B.S. (1983) and M.S. (1986) degrees in mining engineering, and one of his first jobs was working as distribution clerk, coal broker and operations analyst for Pittston's marketing group in Greenwich, Connecticut. He was later promoted to Manager of Operations Optimization for Pittston Coal Group in Lebanon, Virginia, and between 1987 and 1991 he worked "hands-on" to interface mining, processing and sales to develop methods for enhancing product performance and profitability. Mike was again promoted in 1995 to Vice President of Technical and Affiliated Operations, with duties expanded to include oversight of Pittston's timber and natural gas business units. Two years later he accepted the position of Group Vice President of Metallurgical Operations. From 2000-03, Mike served as Vice President of Development and Technical Services, where he negotiated multiple property dispositions for Pittston as they exited the coal business. These transactions included the major sale of Virginia properties in 2002 to a newly formed startup company called Alpha Natural Resources. After completing the disposition in 2003, Mike accepted the position of Vice President of Operations with Alpha, serving as Chief Operating Officer tasked with consolidating three companies across five states. His work was instrumental in growing Alpha from a small private company with just 7 employees to what it is today—an \$8 billion multinational corporation with 14,000 employees. In 2007 Mike finally left the industry and undertook his "dream job" as a retiree who enjoys playing music and spending time with his wife Susan and their kids.



Mike Brown receives the Distinguished Alumni Award from Dr. Jerry Luttrell

William A. (Tony) DiRico is the President of Martin Marietta Materials Inc., Southeast Division in Augusta, Georgia. Born and raised in Pembroke, Virginia, Tony earned his B.S. in Mining Engineering from Virginia Tech in 1979. He began his career with the Consolidation Coal Company, working first as an underground miner at the Itmann Coal Company and then as the Southern Appalachia Region Environmental Engineer in Pocahontas, Virginia. Tony went on to manage several surface contract mining operations as an engineer and supervisor until 1984 when he joined the Arch Mineral Corporation. At Arch, Tony served in a number of positions, including Surface Mine Supervisor at the Captain Mine in Percy, Illinois; Mine Manager for the Wylo Surface mine in Logan County, West Virginia, and Ruffner Surface mine; and he was named Division President. For much of the 90s, Tony was the owner and president at Acme Limestone Company, Inc. and Superior Concrete, Inc., both in Lewisburg, West Virginia. In 2000 he joined Martin Marietta, serving first as Vice President and General Manager for its Southeast Division, and currently as the division's President. Tony is a Professional Engineer in both Virginia and West Virginia and is a Licensed Surveyor in West Virginia. He is a member of numerous professional organizations, to include SME, the International Society of Explosive Engineers, the American Society of Civil Engineers, and the National Stone, Sand and Gravel Association. A former Eagle Scout, Tony serves on the Georgia Construction Aggregates Association's Board of Directors and as its Vice President, and he is an advisory board member for Virginia Tech's Department of Mining and Minerals Engineering. Tony and his wife Teri, have two sons, Kaleb and Tyler.

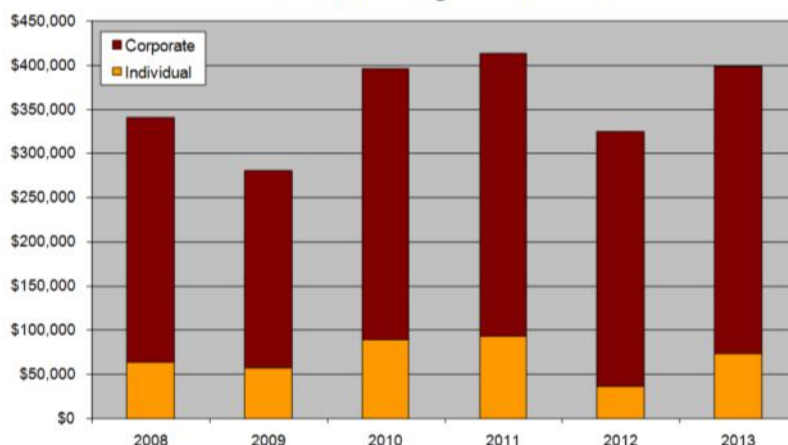


Tony DiRico is presented with his award from Dr. Michael Karmis

Thank You to Our Donors

We continue to be amazed at the support we receive from our donors. Even during times when major segments of the mining industry are experiencing a downturn, we consistently see 40-50 individual donors and nearly 25 corporate donors contribute to this program on an annual basis. It would be virtually impossible to operate this department without the generosity of the individuals and corporations who help support us. In addition to scholarships, donations are used to fund faculty and staff salaries, student activities, equipment purchases, lab renovations, and much more. With the addition of 5400 square feet of space in Randolph Hall, our need for renovation funds continues to grow. Thus, the support we receive from individuals and corporations is more important to us now than ever before. We would like to extend a heartfelt thank you to the following donors for their support during calendar year 2013.

Overall Annual Giving - Calendar Year



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Lagesse, Melissa Bucklen (Daughter of the late Ellis P. Bucklen, Class of 1954)
Lucas, Eric (Son of the late J. Richard Lucas, Former Dept. Head)
MacCormac, Michael (Father of Brendan

MacCormac, MinE Student)

Massey, E. Morgan (Chairman, Evan Energy)
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Stephenson, Bill (Former Dean, College of Engineering)
Wiler, Marianne (Mother of Jeff Wiler, Class of 2007)

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If you donated to the Department during Calendar Year 2013 and your name is not listed above, please contact us. We strive to ensure that our information is accurate, and we want to know if a mistake has been made. It is also helpful if you specify "Mining Engineering" on your check so that your donation goes directly to this Department. Likewise, if you donated to the Burkhart Mining Society or one of our other student organizations, these donations do not come through the Department. Nevertheless, these donations are important to us and we thank you for helping with student activities. Finally, if you prefer to donate online, we have established a link on our website for giving to the Department. Go to <http://www.mining.vt.edu/sponsors/giving.htm> to donate online via credit card, and be sure to follow the instructions provided so that your gift goes to Mining and Minerals Engineering.

Susan Harwood Honored for Longtime Support of Program

During the 2014 Scholarship and Awards Banquet, a special award was presented to an individual who, according to Department Head and Professor Dr. Greg Adel, “has provided unparalleled support to mineral-related education programs around the world.” **Susan Harwood**, past national president of the Women’s Auxiliary to the American Institute of Mining, Metallurgical and Petroleum Engineers, Inc. (WAAIME) and Vice Chairman of its West Virginia Southern Section, was recognized for “her tireless support of Virginia Tech mining engineering students and her strong advocacy on their behalf in her role with WAAIME.”

Since 2000 WAAIME has awarded over \$750,000 in scholarships to Virginia Tech mining engineering students. While many members of WAAIME make this possible, none has represented the face of the organization in the Appalachian region and at the national level like Susan Harwood. In addition to securing scholarships, Susan has been a strong advocate for getting extra support for students in difficult financial situations at risk of losing their college educations. Numerous mining engineers today attribute their success to Susan’s help. In recognition of this support as well as her contributions to the program, its students and its graduates, Susan was presented with a Gary Prazen bronze statue entitled “Dedicated.”



Dr. Greg Adel presents Susan Harwood with a Gary Prazen bronze statue.

WAAIME is a division of the Society for Mining, Metallurgy and Exploration (SME). Its missions are to serve the country and the community through all that pertains to the interest of the profession of Mining, Metallurgical, and Petroleum Engineering and to secure and maintain a fund for the purposes of assisting promising young men and women in obtaining a technical education in mining, metallurgical and petroleum engineering, or allied subjects.

Faculty, Students Honored at SME Annual Exhibit

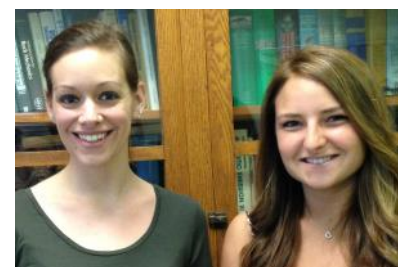
Department faculty and students were recently recognized for their achievements during the SME Annual Meeting and Exhibit held in Salt Lake City, Utah, in February.

Dr. Michael Karmis, Stonie Barker Professor in Virginia Tech’s Department of Mining and Minerals Engineering and Director of the Virginia Center for Coal and Energy Research (VCCER), was awarded the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME) Presidential Citation for his dedicated service as AIME President and United Engineering Foundation Trustee. The award further recognized Karmis for his commitment to the ideals and traditions of the institute by promoting the advancement of collaborative efforts in cross-cutting areas, such as sustainability and government relations.



Dr. Michael Karmis

Dr. Emily Sarver, Assistant Professor in the Department of Mining and Minerals Engineering, and Rachel Sellaro, a Virginia Tech graduate student pursuing an M.S. in Environmental Engineering, were presented with the SME Environmental Division’s award for Outstanding Technical Paper. Emily and Rachel’s paper, “*Characterization of Dust in Underground Coal Mines and Implications for Occupational Health*,” has been submitted for publication in *Mining Engineering* and is currently in revision. Their work responds to recent data suggesting increased incidences of lung disease among underground coal miners in specific regions, including Central Appalachia, and develops a new methodology for carrying out comprehensive particle-level analysis on dust samples obtained from underground coal mines. The results of their research have the potential to allow workers and mine operators to make better decisions regarding exposure, enhance worker safety, and aid in other applications involving occupational dust exposures and lung health outcomes.



Dr. Emily Sarver and Rachel Sellaro

Heather Dougherty, a Virginia Tech mining and minerals engineering Ph.D. candidate, was awarded SME’s J.W. Woomer Young Engineering Award. Heather was recognized as an exceptional young mining engineer whose research on air flow and methane monitoring, numerous publications and work on several SME committees made her deserving of the award. Currently a mining engineer with the Office of Mine Safety and Health Research for NIOSH, Heather has worked in health and safety research for over 5 years. She earned her B.S. (2002) and M.S. (2014) in Mining Engineering and her MBA (2005) from West Virginia University.



Heather Dougherty

Always Evolving: Burkhart Mining Society Looks to the Future

By Dilly Hughes, Burkhart President

Getting “involved” in college is something students hear from day one of their freshman year because of the connections and friendships campus organizations offer. When engineering students join the Mining and Minerals Engineering department, usually in their sophomore year, it is crucial that they immerse themselves in the department and its activities. One of most rewarding ways to get involved is by joining the **Burkhart Mining Society**, the student chapter of the Society for Mining, Metallurgy, and Exploration (SME). With 75 students in the senior class, new members now find it easier than ever to become involved with the chapter while receiving excellent mentorship and guidance from “seasoned” classmates.

The Burkhart Mining Society—named after the department’s first head in 1908, Dr. Otto Cornelius Burkhart—has evolved over the years by widening the experiences it offers its members. This past year, through donations and sponsorships, Burkhart was able to take 31 students to the SME Annual Meeting and Exhibit in Salt Lake City; six students to the SME/PCMA Coal Conference in Canonsburg, PA; and 25 students to a calcite mine in Maryland. Burkhart also increased participation in the nationally recognized Minerals Education Coalition (MEC) outreach program, giving its members the chance to visit area public schools to teach about mining. In addition, Burkhart supported numerous social initiatives throughout the year, including camping, tailgates, recreational and intramural sports, and dinners for large groups of members.

Conferences have helped our members tremendously, allowing students to interact and make connections with industry professionals. Our members have the opportunity to network with alumni and a variety of companies, mining associations, and mining support organizations. Our students come away from these conferences with internships, co-ops and even full time jobs just by engaging in conversation with company representatives.

This past year we implemented two new mentor-mentee programs within the department. One joined underclassmen with upperclassmen to bridge the gap between grade levels as well as offer academic help while also making new connections across the department. The second program coupled Virginia Tech mining engineering alumni, with wide-ranging mining specialties, to upperclassmen trying to break into a particular field. These new Burkhart programs have been great for members and have given students a head start on their careers as mining engineers. The mentor-mentee programs have been well received, and all parties are excited to continue their participation.

One of the last things being put into place is a new Burkhart website, which is designed to keep our audience up-to-date on our activities and features images, events and news from throughout the year, to include SME Annual Meeting trips, Virginia Tech’s “The Big Event,” and our annual Golf Tournament. The site also allows individuals or companies to donate and/or purchase Virginia Tech Mining & Minerals Engineering apparel and merchandise using PayPal. The site showcases our other student teams as well, such as the new Mine Rescue Team, the Mining Competition Team and the SME/NSSGA Student Design Team.

The Burkhart Mining Society has been a great experience for so many of its members, and the connections, mentors and opportunities it has given our students have been a great resource for learning more about the varied and exciting field of mining engineering. On behalf of Burkhart, I would like to invite students, industry members and alumni to check out our new site at <https://sites.google.com/a/vt.edu/burkhart-mining-society/> to learn more about what our organization has done and what we have in store for the upcoming academic year!



Rising Burkhart Officers (from left): Ryan Curtis (Treasurer), Aubrey Athey (V. President), Dilly Hughes (President), and Randy Bernard (Secretary)

Design Team Takes First Place in Annual Competition

The Department's Student Design Team took first place at this year's SME/NSSGA Student Design Competition, marking its fourth first-place win in the annual academic mining event. In addition, Virginia Tech is the only school to have made the finals in all 10 years the event has been held and has also garnered 4 second-place and 2 third-place wins.

This year's team, *Holden Aggregates*, competed against 17 other challengers from three continents. The event consisted of two phases, with the first requiring a full-length, comprehensive mine design project based on actual data provided by competition organizers. Judges selected six finalists from the first phase to compete in Phase II, which takes place during SME's Annual Meeting and Exhibit.

"Phase II presented our team with significant alterations to permitting requirements, design constraints, and updated market potential," says this year's team captain, Tyler Faulkner. "We had less than 48 hours to incorporate new information into our mine design and modify our original plan." As if this weren't enough pressure, further modifications were imposed on teams' Phase II problem statement with less than 24 hours remaining. When time was up, each team gave a 50-minute presentation to a panel of judges, who commented on their solutions and recommendations.

Members of this year's winning team included seniors Chelsea Cady, Kevin Douglas, Will Gimbel, Tyler Faulkner and Meredith Skaggs as well as junior Tyler Daugherty. The winning team was awarded a cash prize and were invited to give a technical session on their design during the exhibit. "It was a lot of hard work, especially during the intense hours in Phase II," adds Faulkner, "but it was a great feeling proving once again that the Hokies know mining!"



Members of team *Holden Aggregates* stand with competition organizer, Andrew Storey ('09) of Luckstone



Keep Calm and Muck On!

The International Mining Competition Team

by Cassandra Brown, Team Co-Captain

Each year the Mining Competition Team represents the department at the International Intercollegiate Mining Competition, normally held in the spring. The team gets to face off against college

and alumni teams from Arizona to Australia. Not only is this a competitive event, it is a great way for students to network with other students and industry leaders who may one day become coworkers and bosses. Such relationships are invaluable in the close-knit mining industry. The competition consists of seven events based on traditional mining practices, scored for both skill and speed, and include hand steeling, track standing, mucking, swede sawing, surveying, gold panning, and jack legging.

I was fortunate to serve as co-captain with fellow classmate Christian Rodrigue for the 2013-2014 academic year when we sent both a co-ed and a men's team to Rolla, Missouri, to compete against over 30 international mining schools. I'm happy to report that our teams represented the department admirably. The men's team took home a medal for *Mucking*: filling an ore cart with loose material and pushing it along rails. The co-ed team locked down third place in *Surveying*, which uses antiquated transit-style surveying equipment.

One of our challenges to training continues to be finding a time when the whole team can practice together since we have members from different classes with different course schedules. Fortunately, the faculty is very supportive of our need to train. Resources and finances are also a challenge. While we have ample equipment to practice mucking and trackstanding, we use up quite a bit of wood getting in shape for swede sawing. Our jackleg also broke down this year, so we are hoping to repair or replace that. Fortunately, companies such as Salem Stone and Foresight Energy contributed in ways to help us train and make it to the competition.

With next year's competition being held in Australia, and in order to again send two teams, we are planning to raise significant funds. Each year we rely on the generous donations of companies, alumni and individuals in the mining industry. Our donors have been very generous, and in return we feature their logos on the team shirts worn during the competition. Those wishing to learn more about how they can help the team should contact team faculty advisor, Dr. Nino Ripepi, at nripepi@vt.edu.



Mining Competition Team (from left, back): John Purcell, Kendall Herring, Charles Pitek, Jeff Lokerson. (middle) Christian Rodrigue, Ross Plastina, Matt Janow, Connor Buzzeo. (front) Jenna Spencer, Meredith Scaggs, Casey Brown.



Virginia Tech Mine Rescue Team

Knowledge, Skill, and Commitment

The Department of Mining and Minerals Engineering is proud to announce the newest member of its student teams lineup: Virginia Tech Mine Rescue. Mine rescue is the specialized job of rescuing miners and others trapped or injured in underground mines due to accidents, roof falls, explosions or other disasters. Several organizations, such as the National Mining Association, organize competitive events to validate teams' training and ensure readiness.

The Virginia Tech team was formed in February 2014 and is the initiative of Dr. Kray Luxbacher, department Associate Professor, who also serves as the team's advisor. Mine Rescue competitions are unique in that they require strong hands-on skills coupled with an ability to solve complex technical problems. "Students really have to understand underground coal mine ventilation, but the team aspect, ability to think on your feet, and navigate under the apparatus are also equally important," says Luxbacher.

The department's team currently consists of twelve students who make up two sub-teams: Team Orange and Team Maroon. "Mine Rescue is a great fit for us engineers," explains Tyler Daugherty, the new team captain. "It combines a problem statement, knowledge of procedures, teamwork, and competition. Cooperation, trust, cohesiveness, and mutual accountability are essential."

While the team has yet to compete in its first official event, members are already learning the mechanics of moving through the competition rescue courses, working through typical competition problems on paper and outside, and learning to troubleshoot and maintain their mine rescue apparatus. Don Hager, President of the Virginia Mining Institute and a retired mine rescue captain from Consol's Buchanan No. 1 Mine, serves as the team's coach and trainer and is frequently joined by Gerald Saunders and Reggie Lambright—two other mine rescue veterans.



Virginia Tech's new Mine Rescue Team (from left): Kray Luxbacher (advisor), Sam Sydnor, Kevin Pan, Eric Watkins, Don Hager (trainer), Tyler Daugherty, Brittany Conley, Elizabeth Van Nostrand, Carolyn Kosloski, Austin Duvekot, and Wesley Edge

This past April, VT Mine Rescue attended the MTTCC Pennsylvania Regional Mine Rescue Skills Contest to observe the competition. The goal of the team is to be competition-ready for the CSM Student Competition in February 2015, as well as be able to participate in one professional level competition.

Mine Rescue teams depend on a variety of critical and sensitive apparatus. Through the generous support of individuals and companies, the Virginia Tech team has been building its suite of equipment. Eight Biomarine breathing apparatus units were contributed by Arch Coal, and Suncoke has generously committed gas detectors and uniforms. Alpha Natural Resources supplied the team with stretchers and communications equipment. Don Hager and the Virginia Mining Institute have graciously provided the training, as well as lifelines, taglines and map boards. The remaining tools and safety equipment have been largely acquired by the team. There remains, however, a growing need for financial support that will enable the team to travel to competitions, obtain needed supplies and maintain the apparatus, which is expensive.

Luxbacher explains that while the testing of knowledge and skills is an important aspect of the competition, students recognize an even stronger spirit behind competitions that is best summed up in a quote from MSHA's guide on mine rescue training: *"Throughout history, miners have traveled underground secure in the knowledge that if disaster strikes and they become trapped in the mine, other miners will make every possible attempt to rescue them. This is the mine rescue tradition."*

To Boldly Go Where No Continuous Miner Has Gone Before... Students Create Robot for 5th NASA Robotic Mining Competition

Eight Mining and Minerals Engineering students are taking part in a competition aimed at developing future technologies to mine on Mars or asteroids. The Virginia Tech Astrobotics Team, comprised of both mining and aerospace engineering students, has developed a mining robot for NASA's 5th Annual "Robotic Mining Competition," held at the Kennedy Space Center in Florida. Members from the mining and minerals engineering department are Nathan Hoisington, Patrick Marrazzo, Amber Schaffer, Kevin Becker, Greg Mahon, Ben Munster, Ross Plastina and Kara Savage.

NASA's Robotic Mining Competition aims to engage and retain students in Science, Technology, Engineering, and Math in a competitive environment which may result in innovative ideas and solutions for terrestrial excavation. The robot must be able to mine and deposit a minimum of 10 kilograms (22 pounds) of simulated Martian regolith in 10 minutes. Scoring requires teams to consider a broad range of design and operation factors, such as dust tolerance, communications, vehicle mass, energy/power required and autonomy.

The 8 mining engineering students are seniors and use the competition—which consists of a yearlong process to design, produce and compete with the robot—to fulfill the requirements of their Senior Design Project, the department's capstone course. The team also consists of 4 Virginia Tech Aerospace Engineering students and eight non-team members from other engineering departments to assist with specialized aspects of the design process.

For the 2014 competition, the team used a continuous miner methodology for their robot, which employed lightweight groused wheels, a carbon fiber bucket, and an aluminum bucket-wheel type paddle. According to Nathan Hoisington, mining and minerals engineering senior and team sub-group captain, mining the material was just a small part of the problem. "An important factor in the competition is the actual weight of the robot. Teams can lose points for excess kilogram weight or bandwidth use, or they can gain points for dust control," explains Hoisington. "It's not just about the amount of material mined; it's about efficiency."

A key takeaway of the yearlong design process is the experience to work as a multidisciplinary team. According to Hoisington, the two departments sometimes had differing design approaches, which occasionally led to challenges in the first semester. "Mining engineers seem to favor prototypes and getting started with something physical, as opposed to just relying on a computer-aided or theoretical model," says Hoisington. However, coming out of the turn in January, the team learned to work together and capitalize on everyone's strengths. "When things start coming together and you actually are producing components, it gets fun," says Patrick Marrazzo, a mining and minerals engineering senior who built by hand the robot's carbon fiber bucket.

Other challenges included the prioritization of work. "The first semester seemed like design limbo," recalls Hoisington, "but after the [winter] break we created subgroups to handle major functions of the robot." The subgroups proved to streamline the ability to work as a team, and progress on the actual building of the robot took off.

Taking part in the Astrobotics Team proved to be a great experience for the students, who noted the many courses and concepts they had to call upon, including surface mine design, load haul cycling, and statics. The team set off for Florida in late May and, at the time of this publication, was preparing to face off against 36 college and university teams from across the nation.



Team members Ross Plastina, Cody Crofford and Nathan Hoisington put the finishing touches on the bucket wheel paddle.



Patrick Marrazzo applies a layer of carbon fiber to the bucket using epoxy.



The final VT Astrobotics Mining Robot is loaded for the competition in Florida.