

Mechanical Engineering

SDSM&T Moonrockers Tackle NASA Systems Engineering Design Project (Dr. Jason Ash)

The SDSM&T [Moonrockers](#) demonstrated their remote-controlled vehicle during the campus design fair on April 21. Pictured (right) from left to right are senior members: Kassidy Kelley (EE), Alyssa Holzer (EE), Andrew Anthony (ME), Tim Lux (ME, team leader), Elizabeth Pierce (ME), Jonah Thune (ME), and Zach Buechler (CENG senior volunteer). Not pictured are Erin McCollough (MEM '14), Louis Heimel (MEM), and John Ziadat (ME '14). The team will participate in the NASA Robotic Mining Competition held at the Kennedy Space Center from May 18-22. The objective is to design a vehicle to collect as much Martian or Lunar regolith (soil) simulant within a 10-minute time period. NASA is interested in regolith collection for in-situ resource utilization. Regolith can be processed to make oxygen, which would provide the means to support Martian or Lunar colonies in addition to creating rocket fuel.



Several innovative features were developed this year by the team. Significant testing and evaluation was completed on the previous vehicle to identify the influence of pulse width modulation on the torque output of the drive motors. A higher gear reduction was implemented to increase the torque and match the desired velocity of the vehicle with the optimum rotational speed of the motors. For the first time in Moonrockers history, Mining Engineering and Management students joined the team and helped guide the design of the

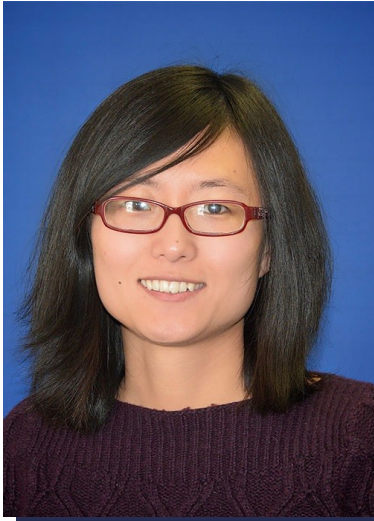
wheels and regolith collection scoops to achieve greater efficiency in moving and collecting regolith simulant. Mechanically, the chassis was redesigned with a central pivot point, which allows the back portion of the frame to rotate to maintain contact between all four wheels and the ground. Electronic components were placed above the conveyor and distributed over a much larger surface area to allow greater accessibility and heat dissipation. System testing has shown promising results in meeting the objectives of the NASA competition. Along with the seniors, Devin Kroeber (EE junior) and Charles Hartman (ME junior) have contributed significantly to the development of the vehicle this year.



Moonrockers posing with Grubby

(Cont'd on page 8)

Faculty Additions



[Dr. Shaobo Huang](#) joined the Department of Mechanical Engineering at the School of Mines & Technology in August 2014 as an assistant professor and the Stensaas Endowed STEM Chair. Dr. Huang holds B.S. and M.S. degrees in Electrical Engineering and a Ph.D. in Engineering Education. She was a Post-Doctoral Researcher in STEM education at Utah State University and the University of Southern California, where she was involved in several NSF and U.S. Department of Education funded projects. Her research interests have two primary foci: Engineering Education and K-12 Science, Technology, Engineering, and Mathematics (STEM) Education. She has published multiple papers in prestigious journals and conferences in Engineering Education from her research work. She teaches Introduction to Mechanical Engineering and Engineering Mechanics Dynamics.



[Dr. Bamdad Lessani](#) joined the Department of Mechanical Engineering at the School of Mines & Technology in August 2014 as an assistant professor. He received his Ph.D. from Free University Brussels (Vrije Universiteit Brussel) in 2003, after which he started a two-year post-doc at Universite Catholique de Louvain, Belgium. He worked as an Assistant Professor at Tehran Polytechnic University from 2005 to 2011. Prior to joining SDSM&T, he was a visiting professor at University of Toronto, serving as a sessional lecturer and collaborating with industrial partners on research projects on reliability of hydraulic systems. His research interests include computational fluid dynamics (CFD), turbulence modeling, large-eddy and direct numerical simulations (LES/DNS) of turbulent flows. He has been involved in numerical algorithm development for CFD solvers, and the applications of those algorithms to detailed analysis of unsteady turbulent flow problems.

Remember Your Alumni Association

The South Dakota School of Mines & Technology Alumni Association promotes communication and interaction among alumni, students, faculty, and administrators of the South Dakota School of Mines and Technology, with the objective of strengthening the school's academic, research, and service roles. Whether through the *Hardrock* or the *Hardrock E-News*, area meetings or reunions, the Alumni Directory or award programs, they are here to help you and to help our alma mater. So please consider supporting your Alumni Association with your contributions and your time. Learn [more](#)!

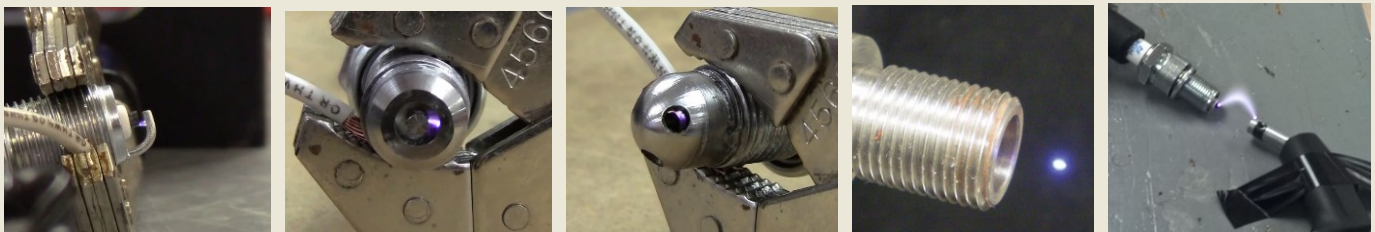
EMIT Technologies (Tyler Nack, MS ME Student)

It is the beginning of a new research team in the Thermal and Fluid Science Laboratory. EMIT Technologies, out of Sheridan, Wyoming, has dedicated to expanding engine research on the university level through the lab, which is now headed by Dr. Duane Abata. EMIT Technologies is committed to funding one graduate research assistantship each year, and students are now bridging the gap between thermodynamics and practical application of engine optimization. To help illustrate the basic concepts, a 1975 Toyota Corolla engine has been cleaned, cut, and put on display for students to examine the basic operation in the Thermal and Fluid Science Lab.



From 2013 to 2014, in the first phase of engine research, Stephen Christensen (MSME14) studied the emissions of a very specific flavor for engine application. In the oil and gas fields, methane is retrieved from the ground source and then pumped through a pipeline to the refinery, which are up to hundreds of miles away. In order to pump the gas, an engine is placed on-site and operates on gas coming out of the ground. While natural gas usually burns very clean, this unrefined “sour gas” contains diluent excess nitrogen, carbon dioxide, and even propane mixtures. Christensen was able to outline and expose the emission risks of certain mixtures at operating points of the engine.

For 2014 to 2015, Tyler Nack, a graduate student in the mechanical engineering department and this project’s sequential research student, has desired to take a step towards cleaner emissions. Novelty ignition sources could dramatically reduce or even eliminate the burden of emission standards under diluent mixtures, which normally produce high amounts of nitric oxide, carbon monoxide, and even formaldehyde. Standard spark plug technology has been around since Robert Bosch patented it in 1902. However, new sources such as kinetic sparks, plasma jets, laser incidences, and corona discharges are new on the horizon, and benefits are being fully examined. Pictures shown below are from preliminary bench testing.



In sequential order: Traditional, Kinetic, Plasma Jet, Laser Incidence, Corona Discharge

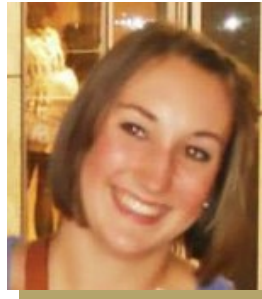
These new ignition technologies require a higher energy source such as a higher energy source such as capacitive discharge and high frequency plus high voltage ignition. However, the benefits of a more aggressive and larger volume ignition source are exciting for emission and lean burn standards. Thorough performance and data acquisition are currently underway.

Outstanding ME Juniors



Michael Kelly is one of two students honored with the 2015 Outstanding Junior award in Mechanical Engineering. Michael is from Rapid City and transferred to Mines in 2013, expecting to graduate from the ME program in December 2016. This summer, he will be interning at Caterpillar. His research interests are in product development and ocean wave energy conversion.

Michael participates in the Hardrocker Hockey Club, coaches for the Rushmore Thunder high school hockey team, and hikes in the Black Hills during his free time. Michael is also active with ASME, which has given him the opportunity to attend Professional Development and Leadership conference in Milwaukee and Madison, WI, and Montreal, Quebec. He is involved in elementary school outreach, technical competitions, and social activities with ASME.



Jena Kreuzer is a mechanical engineering junior from Denver, Colorado, expecting to graduate May 2016. She is interested in the thermal sciences and is currently studying automotives abroad in Munich, Germany. In past summers, she has had internships at Lehigh Hansen and PCS Ferguson and desires to continue working in industrial and manufacturing atmospheres after her graduation. In addition to her focus on academic studies, she is a varsity athlete on the Hardrocker volleyball team and has coached local middle school teams. Jena is also very passionate about increasing women participation in STEM fields and is an active member of Women in Science and Engineering (WISE) and the Society of Women Engineers (SWE).

Jena is an active participant in outdoor activities, and, during her time at SDSM&T, she has really enjoyed hiking and fishing in the Black Hills.

Outstanding ME Seniors



Mohamed Hakeem Mohamed Nizar is a senior mechanical engineering student, who will be graduating in May 2015. Hakeem is from Kandy, Sri Lanka, having transferred to SDSM&T in Spring 2012. He has been actively involved in many on- and off-campus organizations, such

as ASME, CAMP Human Powered Vehicle, Student Association Senate, PDI, Rotaract, Diversity Matters at Mines, and Dacotah Territory International Visitor Program. He works as a tutor at the Tech Learning Center and as an undergraduate research assistant for the ME department. His research focuses on building SolidWorks motion analysis and virtual laboratories for control systems under Dr. Mark Bedillion. He has also been a peer advisor and an international student peer mentor. Hakeem was recently inducted into the Leadership Hall of Fame 2015 and was recognized as the Outstanding Mechanical Engineering Senior 2015. His life goal is to make a positive impact in the community and enhance the life of the less fortunate, especially in education.



Elizabeth Pierce is one of two students honored with the Outstanding Senior in Mechanical Engineering award in 2015. Hailing from Colorado Springs, CO, she started at the SDSM&T in fall 2011 and is graduating in May. Her interests include STEM education and outreach, vocal performance, and WiSE. She has worked as a research assistant in the Additive Manufacturing Lab at SDSM&T and currently conducts research on STEM education with Dr. Shaobo Huang. After interning with Caterpillar in Peoria this summer, she is returning to SDSM&T in the fall to pursue a masters degree in mechanical engineering.

Outstanding ME Graduate Student (Donovan Aguirre-Rivas)



Donovan Aguirre-Rivas is in his third year in the Mechanical Engineering PhD program at SDSM&T. His research interests are in the areas of solid mechanics, composite materials and computational mechanics. For his academic success, Donovan was awarded the Outstanding Mechanical Engineering Graduate Student award at the 2015 Honors Convocation.

Prior to coming to South Dakota School of Mines and Technology, Donovan was the recipient of the prestigious FANTEL academic excellence scholarship and graduated near the top of his class with a Bachelor's of Science degree in Mechanical Engineering from Universidad Centroamericana "Jose Simeon Cañas" (UCA) in El Salvador.

Upon completion of his undergraduate studies, Donovan worked as a Junior Engineer, first at Sustainability and Research S.A., and then at Engineering Company of Central America before joining the PhD program in the Fall of 2012. He worked as a Teaching Assistant during his first two years at SDSM&T and is currently working in the Experimental and Computational Mechanics Laboratory conducting research related to Individual Soldier Protection Technology under the guidance of Dr. Karim Muci-Kuchler, as part of a project sponsored by the Army Research Lab.

Donovan is also conducting research with Dr. Muci on the use of higher order finite elements for the accurate prediction of stresses and temperature gradients and the initial results of this work have already led to a peer-reviewed publication:

Aguirre-Rivas, D.A., Muci-Küchler, K.H., "**Higher Order Finite Elements for the Accurate Prediction of Temperature Gradients in Heat Conduction Problems**", 2014 ASME International Mechanical Engineering Congress & Exposition (IMECE 2014), Montreal, Canada.

Outstanding Recent ME Graduate (Jeremy Banik)



As a senior member of Technical Staff at Sandia National Laboratories in Albuquerque NM, Jacob Koester (BSME '04, MSME '05) works with a premier team of scientists and engineers using state-of-the-art computer simulations to investigate problems of national concern. Jacob leads research efforts advancing the field of computational solid mechanics and guides challenging security projects. He has helped small businesses overcome technical challenges while participating in the New Mexico Small Business Assistance Program. A continued enthusiasm for focused research led Jacob to apply for Sandia's Doctoral Study Program. He was accepted last year and is currently supported and working on his PhD in Structural Engineering at the University of California - San Diego, where he is developing novel numerical techniques enabling rapid computational model development.

ME 125L Alternate Path (Aaron Lalley)

ME125L, Design for Manufacturing, is a freshman course that was developed to train mechanical engineering students in basic manufacturing processes. The course includes both a lecture and a laboratory session. It was taught informally during the 2013/2014 academic year and formally beginning this year (2014/2015). Students receive training in machining, turning, and general fabrication, developing the skill set to manufacture parts on a first-time-right basis. The course also introduces to topics universally valuable to all mechanical engineers such as documentation control, print reading and production, lean concepts and teaming. Additionally, the training helps to ensure a safe working environment in the ME labs while introducing the students to an industrial culture with safety being the number one priority and zero-tolerance regarding critical safety policies. Students participate in small-group lab training sessions during the first half of the semester and student projects (individual and group) during the second half. There is also a large-group lecture once a week.

Not all mechanical engineering students are interested in machining, and not all engineers will work in machining environments, so the department developed an alternate path within ME125L for these students. This alternative path differs from the traditional path only in the labs conducted in the first half of the semester. Topics in this alternate path include marketing, graphic design, and additive manufacturing. 3D modeling, the base tool for both graphic design and additive manufacturing, has been a successful alternate to traditional machining process.

Spring 2015 was the inaugural semester for the alternate path and included about 20 students. As mentioned, the alternate path content differs from the traditional path only during the first half of the semester. During the second half of the semester, the students are organized into groups for two design projects; each student completes one individual and one group project. The groups contain a mix of students from the traditional and alternate paths to enhance diversity of skill, presentation quality, and cross-training. As a result from this semester's success, students not enrolled in the alternative path requested the opportunity to hear the marketing lecture.

Because most engineers will be tasked with marketing in some capacity, the next iteration of ME125L in the Fall 2015 will see the marketing content included in the general lecture for all students. An overview of CNC machining will also be added to the alternate path lab series. The course structure can be seen in Figure 1.

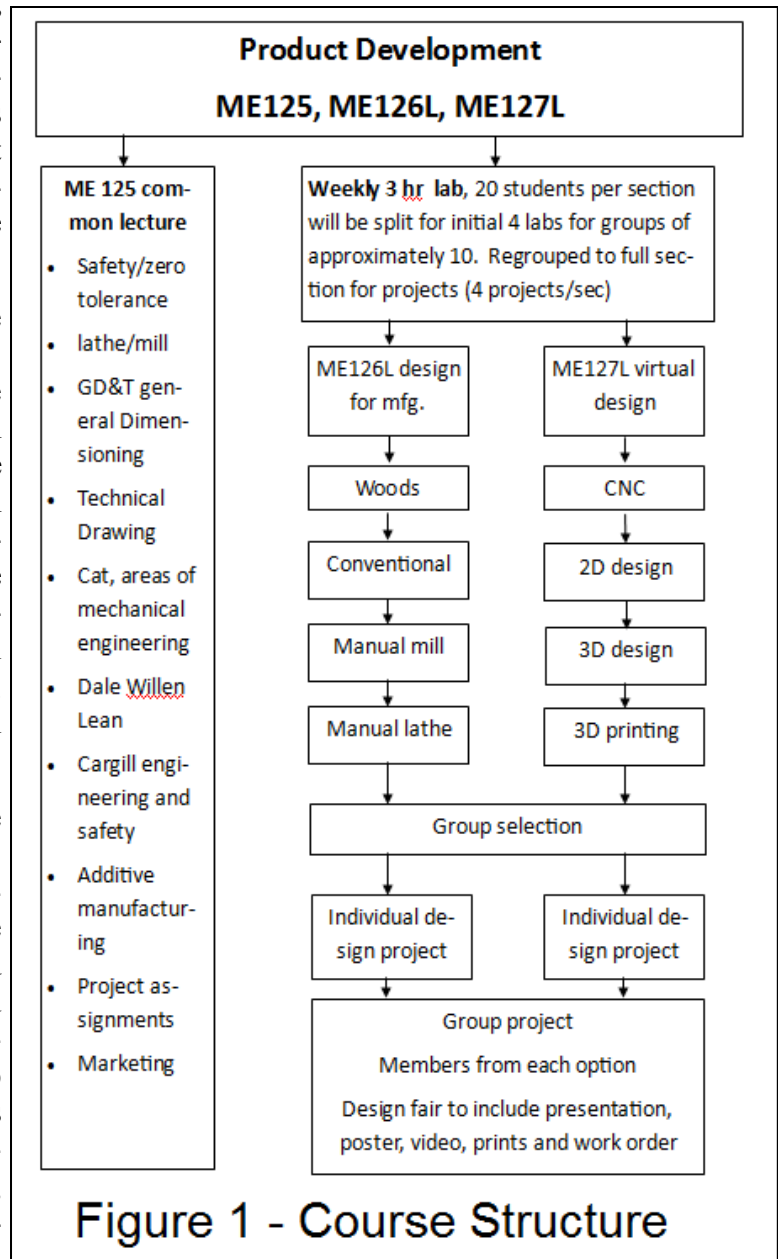


Figure 1 - Course Structure

The semester is not yet complete, but the alternate path seems to be a success. Students display a strong interest in the lab series, and the scope of the student projects has widened to include more real-world simulations. For example, Christian Johnson, an ME freshman, developed a lighting product that included integrated LED lighting and an aluminum extrusion housing. In addition to developing the product model and prints, Christian sourced out extruding services, purchased components, estimated costs, evaluated marketing options, and prepared a product rendering for marketing purposes.



Figure 2 - Student Product Marketing Render

Figure 2 shows Christian's rendering of his light product affixed to a wall in an office environment. Christian's project demonstrates SDSM&T student creativity, artistic ability, and business sense. These attributes, along with technical strength, the hallmark of SDSM&T, will help to prepare our students for the challenges of the future.

CAMP Teams Show Strength in Design (Dr. Daniel Dolan)



CAMP teams have reaped the benefits as the ME Department strengthens design in their curriculum. The Baja SAE team has an elegantly simple machine ready for competition this year. They will compete May 22-24 in Portland, Oregon, and Washougal, Washington. For the past two years, the team has made it into the design finals. Last year, they placed in the top 10 overall. The photo (left) shows the team at the Caterpillar Proving Grounds in Edwards, Illinois, the site of the 2014 Baja SAE Event.

The Alternative Fuel Vehicle team took part in the SAE Clean Snowmobile Challenge in Houghton, Michigan, from March 2-7, 2015. This is a strong,

multidisciplinary team running in the Zero Emissions category with a fully electric sled. They took first place in the Design competition and second place overall. Polaris donated the chassis for the vehicle, and Brammo donated the batteries and the motor. This team has been very active in the community. They were invited to show at the South Dakota Snowmobile Association's Annual Meeting, and they have been invited to show at the National Convention in 2016. The photo (right) shows the team at the SDSA conference.



SDSM&T Moonrockers Tackle NASA Systems Engineering Design Project

(Cont'd from page 1) Tim Lux summarized his experiences with the systems engineering project and multidisciplinary teaming,

“After this project, I can honestly say systems engineering is one of the best experiences that can prepare anyone who is looking at going into industry. It requires a lot of communication and patience to be able to convey information to someone who is not as familiar with a moving system. It can also be very challenging at times when trying to be on the receiving end of learning about different concepts that weren't in our own expertise. The team had many instances where it came into a problem that had many different solutions. These solutions often included something that could have been fixed either in the software, or in the circuitry by adding a limit switch, or even mechanically by changing the mounting location of components. These problems were often solved by constructive conflict between team members to find the solution that would result in getting the robot operational in the quickest turnaround time at the lowest cost.

I believe we had a few stand out members who truly displayed systems engineering, which was shown toward the end of the project when they were able to provide solutions that didn't necessarily pertain to their discipline. In one meeting, we had our CENG drawing up a design on the whiteboard for a bracket to fix a clearance issue between the hopper and the collector. Another time, we had an ME sitting on the computer writing a script file for the motor controllers to handle digital input signals. And we almost always had one particular EE junior who was never afraid to grab the Sawzall and jump into the fabrication side of things. The team as a whole is able to understand the system and, although may not necessarily be able to perform tasks such as write code, they are able to think outside of the box to come up with a variety of solutions to a problem.

I believe the Moonrockers have developed a strong culture of getting away from the ‘that's not the system I'm dealing with’ or ‘that's EE and CENG stuff’ attitude, and show promise for next year with returning members that display excellent leadership skills to instill that culture even more, and have the team work more effectively by having everyone understand the system as a whole.



VEX Robotic Competition at Stevens High School

From my personal experience, I didn't know what I was getting into by joining a multidisciplinary team two years ago. What I can take from the experience is that being part of a multidisciplinary team means that you will sometimes have to get a little out of your "comfort zone" to achieve success. This can be a challenging, exciting, and rewarding experience all at once. I know we haven't competed yet, but I already consider the team to be extremely successful and have made huge bounds in the right direction to be even more successful next year.”

Beyond the design, development, and testing of the vehicle, the Moonrockers volunteered to serve as mentors to VEX robotics teams at Stevens High School, who were taking an introduction to engineering course. The Moonrockers visited the teams for up to two hours each week from October through December 2014 to help provide assistance with the design, construction, and programming of their VEX robots. One of the teams that were mentored went on to place 2nd in the state championship. For his role in leading the Moonrockers this year and coordinating the mentoring activity at Stevens High School, Tim Lux was recognized with the CHAD Award (Caring, Helping, Aspiring, and Developing). Additional recognition for team members include Elizabeth Pierce receiving the Outstanding ME Senior Award and Devin Kroeber receiving the Outstanding Student Member Award for the Moonrockers. The team is advised by Jason Ash (ME Associate Professor), Charles Tolle, (ECE Associate Professor), Christopher Wyatt (MEM Instructor), Lowell Kolb (ECE Research Scientist), and Jeff McGough (CSC Associate Professor). The Moonrockers are grateful for the support from numerous sponsors: Aquarius, AML, CAMP, Cliffs, Dakota High Voltage, Dale's Tires, Misumi, PowerGrid Engineering, RoboteQ, SDSM&T Student Association, SDSM&T ME Dept., and the South Dakota Space Grant Consortium.

A Note From an ME Alumnus Regarding Professor Groves

Professor Groves was a mentor and friend to many ME students throughout his years at Mines. Many of us have fond memories of classes and labs that he taught. Those I remember best are measurements (instrumentation), mechanical vibrations, internal combustion engines, and gas turbines. He was a great teacher whose thorough knowledge and practical experience brought course material to life. His guidance made hands-on learning in labs particularly meaningful and memorable. The things I learned from him put me in good stead when I went to work in the oil industry and ultimately specialized in rotating machinery. I owe much of my early success in that specialty to what I learned in his classes and personal interaction in labs and informal settings.

It's an interesting coincidence that I wound up retiring from the company and location where Bill Groves started his engineering career and his dad worked for many years – Shell Oil's Wood River Refinery (now owned by Phillips). He worked in the engine labs in Shell's research organization here before it was centralized and moved to Houston in the 1970s. I happen to live next door to his home town of Edwardsville, IL. He came to Mines from Shell after getting his masters degree.

Denny Tiede
ME67

ME Industrial Advisory Board

Casey Allen, ME94, MSME01,
H.F. Webster, Rapid City, SD

Wayne Baumberger, ME96,
Caterpillar Inc., Rapid City, SD

Dave Berg, ME73, Rapid City, SD

Pete Birrenkott, ME71, Rapid City, SD

Pete Chikos, CE79,
Boeing Co., Seattle, WA

Randy Clarksean, ME83, PhD,
Kevin Kennedy & Associates, Inc.,
Ottertail, MN

Don Cuperus, ME95,
Rosenbauer America, Sioux Falls, SD

Dennis Deinert, ME70,
Tessier's, Inc., Mitchell, SD

Paul Gnirk, MINE59, PhD,
Table Top Ranch Inc.,
New Underwood, SD

Brian Goetsch, ME98,
Lockheed Martin Space Systems Co.,
Littleton, CO

Patrick Hallauer, ME76,
EAD Incorporated, Omaha, NE

Steven Henning, ME89,
Boeing Co., Kent, WA

Erin Heupel, MET88,
Biogenic Reagents, Sioux Falls, SD

Tim Holleman, ME71,
Medtronic Inc., Ham Lake, MN

Ritch Larsen, ME75,
Chillicothe, IL

Mike Mueller, ME85,
G&R Controls, Rapid City, SD

Larry Pearson, ME72, Bennington, NE

Scott Reisenauer, ME94,
SR Solutions, LLC, Rapid City, SD

Mike Rizer, ME90,
Cargill, Inc., Iowa City, IA

Matthew Schulte, ME09,
Burns & McDonnell, Overland Park, KS

Paul Sheets, ME91,
Mechanized Design, LLC, Wichita, KS

Meredith Silberstein, ME05, PhD,
Cornell University, Ithaca, NY

Ralph Wagner, CE75, Las Vegas, NV

Daniel Weinacht, ME84, PhD,
Ares Corporation, Richland, WA

Dale Wilen, ME85,
City University, Cheyenne, WY

Mike Wood, ME03,
Halliburton Wireline and Perforating,
Midland, TX



Mechanical Engineering Department
501 E St Joseph Street
Rapid City, SD 57701

Phone: 605-394-2401

Fax: 605-394-2405

E-mail: leslee.moore@sdmst.edu

[ME Department Website](#)



ME Department Head's Message



Dear Friends,

The Mechanical Engineering department has concluded another successful academic year. Our enrollment grew, but only slightly, to 620 students from about 610 the previous year. Dr. Benjamin Simmons decided to move on to different pastures and resigned last spring. He has been replaced with a new faculty, Dr. Bamdad Lessani. Dr. Lessani's expertise is in the area of thermal science. We have also filled our new endowed chair position. Dr. Shaobo Huang is our new Stensaas Endowed Chair in STEM Education. Dr. Huang's PhD is in the field of engineering education. Her Bachelor and Masters degrees are in the area of controls. She will join Dr. Korde, the Pearson Chair in Sustainable Energy, as a member of the only department with two endowed chairs and as one of only three endowed chairs on campus.

As discussed in this issue, we are in the process of modifying our freshman and sophomore curriculum. We have formally introduced a new freshman course, Design for Manufacturing (ME 125L). Our year one and year two goal is to cohere projects in the freshman year (ME 125L) to projects in the sophomore year (ME 264/269-Product Development and Design). We will begin work on the logistics next AY, with the long-term goal being project coherence/integration into the junior year with the addition of a junior class in product development and design and finally with coherence to Capstone Design, ME 477/479, in the senior year. Conceptually, once the curriculum is in place, one can imagine a student entering the program in his/her freshman year and working on a single project at increasing levels of engineering design sophistication through to the senior year. Of course the projects will be team-based and team membership will likely be dynamic, with members joining and leaving over the semesters as project needs evolve. We are excited about beginning our development of this innovative curriculum. We will see how the outcomes of this initiative relate with the campus initiative to develop an Innovation Center. More on that subject in next year's newsletter.

Sincerely,

Mike Langerman, PhD (ME 72, MS ME 74)

Professor and Head

Mechanical Engineering Department

SDSM&T