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WELCOME

Welcome to the 2010 edition of the South Dakota School of Mines and Technology Research Report. This year, the report provides a glimpse into the research activities of the university with particular emphasis on the activities of the many research centers and laboratories on campus.

I am pleased to report that Fiscal Year (FY) 2010 (July 1, 2009 – June 30, 2010) was another record-breaking research award year here at the School of Mines. In FY 2009, awards amounted to $20.9 million, more than twice the amount received in FY 2008. In 2010, awards topped $35 million, an increase of nearly 70 percent. The awards for these grants and contracts came from 22 different sponsors, including the National Science Foundation, various components of the Department of Defense, NASA, and others. The research awards this year included funding for 55 undergraduate students and 102 graduate students. The involvement of students in research is extremely important as it enhances their education by exposing them to real problems that complement their classroom work, and provides them with the invaluable hands-on experience in solving challenging problems. In other words, research is an important component of a modern engineering and science education and, at the School of Mines, research and education are intimately tied together.

In 2010, the School of Mines initiated a research strategic planning effort that led to the establishment of four major research areas that will be the focus of the future. These research areas have an initial critical mass of facilities and personnel that provide credibility to their designation as a major research area; possess the ability to foster the future development of major new research activities within five to 10 years; enable the development of special niches of national excellence; are highly important for the state or nation, and well-supported with competitive grants and contracts by one or more components of federal funding agencies; and enable significant growth in graduate programs.

These research areas not only define our current strengths, but they also enable us to understand the interrelationships among present research activities. This allows us to plan for growth in ways that are synergistic. Strategic research planning is continuing here at the School of Mines and has become only one component of a comprehensive, university-wide strategic planning effort that will culminate in a School of Mines strategic plan by the end of FY 2011.

This past year has been an exciting one here in research affairs. We have had a good year, but the work of building a research enterprise that makes full use of the inherent strength of the university has just begun. As I look forward to next year, I hope to see steady progress in the development of a research environment fully integrated within the educational community and alive with vibrant faculty researchers sharing their knowledge and skills with undergraduate and graduate students. I am truly excited to participate with the faculty in events that will allow the South Dakota School of Mines and Technology to become one of the nation’s premier science and engineering universities.

Sincerely,

Ronald J. White, Ph.D.
Vice President for Research
The South Dakota School of Mines and Technology’s dynamic research program attracts the attention of funding agencies and prospective faculty members, researchers, and students alike. Recently, the School of Mines formed a task force to define a vision for the future of this highly successful and rapidly growing research program. After university-wide discussion, the task force identified four areas of emphasis. These research endeavors identify areas where there is a solid and credible basis for major development in the future. The defined criteria require that each area of emphasis support growth; find a niche of national excellence on a level with other institutions—regardless of size—engaged in similar work; and that the area be highly important to the nation, state, and university.

“The university has reached a crossroads and has made a determination that growth in its research and graduate programs will be a primary focus for the future. Creating this vision is an essential step to knowing what path we should take to create our future.”

**Energy and Environment**

Energy and environment research focuses on the generation, storage, and efficient use of renewable energy and natural resources, and the assessment of the interaction between the environment and renewable energy technologies. Research on the interaction between renewable energy technologies and the environment (natural resources) is essential to understanding and establishing sustainable practices. This research embodies the interrelation between atmospheric and environmental conditions and the production and utilization of clean, renewable energy. Research on improved solar, wind, and bio-energy, and the interaction of these technologies with water resources, weather, and climate, defines this focus.

**Materials and Manufacturing**

This research area includes the basic science of materials, applied sciences related to materials, and advanced manufacturing technologies related to both military and civilian applications. Included are electromagnetic, energetic, and bio-materials as well as advanced composites and nanomaterials used in regular and novel devices. This research area extends from mathematical modeling of fundamental processes to advanced manufacturing technologies.

**Science, Technology, Engineering, and Mathematics (STEM) Education**

STEM education research is multi-disciplinary research in learning and teaching, specifically for STEM students and professionals. STEM education implementation is the development, execution, and assessment of the learning environment that encourages and supports this specialized education. The primary goal of this thrust is to become the national leader in integrating the research and learning environments for STEM education. In a certain sense, the entire school is the laboratory for this research.

**Underground Science and Engineering**

Underground science and engineering research covers all current or future work related to underground research and technology. This includes research that can answer fundamental questions in physics, geology, geological engineering, and biology and that can be addressed best in an underground environment. This research area also involves research in the fields critical to working and living underground, such as civil and mining engineering, as well as other supporting engineering and technology disciplines.
When President Robert A. Wharton, Ph.D., joined the South Dakota School of Mines and Technology in 2008, he identified growing the research enterprise as one of four key strategic focus areas that would guide the university in the years ahead. With annual research and development funding standing at $10.1 million in fiscal year 2008, Wharton set the specific goal of $25 million by fiscal year 2013.

Fast forward to the recent close of fiscal year 2010, when School of Mines researchers were awarded more than $35 million, the highest in the history of the university. Fiscal year 2010 saw 91 awards averaging approximately $388,276 from federal and state agencies, corporations and direct Congressional appropriations. The awards represent 23 departments, centers, or laboratories and were awarded to 47 principal investigators.

“Reaching this remarkable milestone is a result of the stellar level of faculty, researchers, and students on this campus and the dynamic nature of the work that they are undertaking,” Wharton said. “This impressive growth showcases the caliber of our research enterprise and strengthens our status as one of the nation’s premier science and engineering universities.”

The National Science Foundation (NSF) accounted for approximately 72 percent of total research funding for fiscal year 2010. Individual awards ranged from $12,000 for a supplement to an NSF Research Experience for Undergraduates grant to more than $21 million of NSF funding for the design of a Deep Underground Science and Engineering Laboratory, proposed to be located in the former Homestake Mine in Lead, South Dakota. The School of Mines has been awarded a total of $27 million by the NSF for the project to date.

“The current growth is just the beginning. The School of Mines has great potential for expanding its research program by tapping into the enormous strength of its faculty and students,” said Vice President for Research Ronald J. White, Ph.D. “The real beneficiaries of this growth are the undergraduate and graduate students who are learning the importance and value of developing knowledge and cutting-edge technology in the modern world.”

**External Sources of Fiscal Year 2010 Project Funding**

- Federal: 95.7%
- State: 3.5%
- Other: 0.6%
- Private: 0.2%
### External Sources of Fiscal Year 2010 Project Funding

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<th>Source</th>
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<td>National Science Foundation (NSF)</td>
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<tr>
<td>National Aeronautics and Space Administration (NASA)</td>
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<td>U.S. Environmental Protection Agency (EPA)</td>
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<td><strong>Federal Total</strong></td>
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<td>Private</td>
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<td><strong>Grand Total</strong></td>
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Research has served as a foundation for the South Dakota School of Mines and Technology throughout its 125-year history. Established in 1885, the School of Mines was created to meet the growing research needs of the mining industry, led by the former Homestake Gold Mine in Lead, South Dakota.

The scope of research activities quickly broadened, and today the School of Mines is a global leader in engineering and science research, investigating solutions to complex challenges in areas from bioenergy and advanced materials to environmental quality, national defense, and more.

In recent years, the longstanding connections between the School of Mines and Homestake have come full circle, with the university championing the conversion of the former gold mine into the Deep Underground Science and Engineering Laboratory (DUSEL), a project that provides the opportunity for exceptional research and discoveries not yet imagined.

Pioneers, both literally and academically, founded the School of Mines to be a place of exploration and discovery. Our faculty, staff, students, and alumni carry on that legacy today.

1885 – GILBERT BAILEY lends his collection of more than 5,000 fossil and mineral specimens to the School of Mines, laying the foundation for the future Museum of Geology. The collection now stands as one of the largest of its kind in the U.S. and contains some of the best scientifically documented specimens in the world.

1891 – FRED R. BROUGHTON, mathematics teacher and engineer at the School of Mines, does the original surveying and engineering plans of the Crouch Railroad Lines, now on display at the university’s Devereaux Library.

1899 – Geology professor and future university president Dr. C. C. O’HARRA leads the first organized expedition to the Badlands. The researchers traveled to their destination by wagon, spending five weeks collecting fossils.

1900 – Student HOWELL CLEVENGER utilizes a newly-devised cyanide process to extract gold from tailings remaining from a defunct chlorination plant. Clevenger, who builds a cyanide plant to process the tailings, nets nearly $4,000 in profits.

1903 – Mining Experiment Station is created. Known today as the Engineering and Mining Experiment Station, this research center boasts the longest history of any on campus.

1904 – The School of Mines receives a diploma and gold medal from the World’s Fair for its exhibit of Black Hills minerals, ores, and fossils. Two maps, relief models of the Black Hills, received the grand prize at the Fair and are still on display, one in the Museum of Geology and one in the Devereaux Library.

1905 – School of Mines students make the journey underground at the Homestake Mine for the first time.
1961 – The Bureau of Reclamation awards $30,000 to the School of Mines, initiating the first funded research for the Institute of Atmospheric Sciences (IAS). In 1965, IAS launches the first and only cloud seeding project of its kind in the world, funded by the National Science Foundation, the State of South Dakota, the State Weather Commission, and Rapid City Independent Insurers.

1962 – Graduate programs established in civil engineering and paleontology. Today, the M.S. degree in paleontology offered by the School of Mines remains the only one in the country.

1966 – Graduate programs established in mechanical engineering and meteorology.

1967 – Ph.D. programs established in electrical engineering, geology, geological engineering, and physics.

1968 – School of Mines students are involved in planning and building the 290-foot-long Keystone Wye, the largest laminated timber arch bridge in the U.S.

1969 – The Institute of Atmospheric Sciences acquires armored T-28 aircraft used to penetrate thunderstorms.

1970 – The South Dakota Board of Regents approves proposal to organize and maintain the Black Hills Natural Sciences Field Station. Today, students from more than 40 universities participate in geology, geological engineering, paleontology, ecology and environmental sciences field programs in Wyoming, South Dakota, Turkey, India, and the Himalayas.

1976 – Research funding reaches $1.7 million, up from only $100,000 in 1964. Projects include research related to a local coal gasification plant, a solar energy demonstration project at Mount Rushmore, hail suppression, the effect of fossil fuels on rainfall, and more.

1978 – Cooperative Ph.D. program in meteorology established.

1981 – Dr. JAMES MARTIN collects bones of mammoth that show signs of scrape marks, indicating butchering. Only 26 similar sites had been discovered, and this site is among the best documented.

1981 – School of Mines faculty members Dr. A.L. RIEMENSCHNEIDER and Dr. MICHAEL BACHELDER, develop TEMP (Tech Educational Microprocessor), a computer in a briefcase program to teach faculty and students how to use microprocessors.

1984 – Mechanical engineering students design and build an adapted bicycle for a handicapped child with no thighbone in either leg.

1989 – Master’s program in technology management established (now engineering management).

1993 – Ph.D. program in atmospheric, environmental, and water resources established.

1997 – The Center for Advanced Manufacturing and Production (CAMP) is created. The program is built on multidisciplinary teaming to enhance engineering education, giving students the opportunity to research, design, build, and compete in projects like the Formula SAE, Supermileage, Unmanned Aerial Vehicle, and more.

2003 – Advanced Materials Processing and Joining Laboratory (AMP) established. AMP becomes a world leader in friction stir welding and related technologies.

2004 – Tech Development Laboratory opens and becomes home to several cutting-edge research activities and projects.

2004 – The School of Mines is selected as the home institution for the Center for Friction Stir Processing, a National Science Foundation Industry/University Cooperative Research Center (I/URCR).

2004 – The Composites and Polymer Engineering Laboratory (CAPE) established.

2005 – Ph.D. program in nanoscience and nanoengineering established.

2006 – Museum of Geology unveils most complete juvenile plesiosaur specimen to come out of Antarctica.

2006 – Master’s and Ph.D. programs in biomedical engineering established.

2006 – The Center for Bioprocessing Research and Development (CBRD) is created through the State of South Dakota’s 2010 Initiative.


2008 – Master’s degrees in physics and construction management established.

2008 – The School of Mines selected as the home institution for the Center for BioEnergy Research and Development, a National Science Foundation Industry/University Cooperative Research Center (I/URCR).

2009 – Renewable Energy Research Facility established overlooking campus. The center provides modern technology for researching wind and solar energy opportunities.

2009 – School of Mines receives $6.9 million in the 2010 Defense Appropriations Bill to apply advanced materials processing technologies to repair Navy equipment, to develop strong and lightweight future combat vehicles, and to explore biocconversion technologies for the Air Force.

2010 – Ph.D. program in mechanical engineering established.

2010 – AMP renamed Arbegast Materials Processing and Joining Laboratory.

2010 – The School of Mines is actively involved in research at the DUSEL facility. Research areas include thermophilic bacteria, hydrology, blast monitoring, robotics, coupled processes, and more.

2010 – Research funding reaches $35 million, the highest in the university’s history. Much of the funding comes from the National Science Foundation for the design of the Deep Underground Science and Engineering Laboratory.

2010 – Paleontology Research Laboratory opens. The new facility ushers in the future for one of the world’s finest fossil collections and provides state-of-the-art facilities for research, preparation, and education.
he Additive Manufacturing Laboratory (AML) at the South Dakota School of Mines and Technology provides material-addition manufacturing research and development in size scales ranging from microns to meters. AML, established in 2004 through a grant from the Army Research Laboratory (ARL), specializes in laser powder deposition (LPD) and direct write (DW) technologies.

LPD, a technology utilizing a focused laser beam to fuse powder metal to a previously existing metal substrate, is useful for building metal prototype parts, modifying existing parts for a longer lifespan, and repairing broken or worn out parts. AML houses a sophisticated LPD system and also contains a micron resolution laser additive manufacturing system to support fabrication of biomedical devices. The LPD system allows for laser cladding, solid free-form fabrication, and graded alloy development of both metallic and non-metallic materials. AML also supports the development of laser ultrasonics for in-situ defect detection during cladding operations.

Projects include component repair, development of laser cladding wear resistance materials, material property response, thermal and stress modeling of laser clad materials, and unique component direct laser fabrication.

AML also houses state-of-the-art DW technology, supporting the printing of mesoscale materials, such as metals and ceramics for conductors, dielectrics, ferroelectrics, and ferromagnetics. Equipment in this facility allows for aerosol deposition, slurry/paste syringe deposition, and photonic curing.

With the materials handling capability and precision of this technology, the AML is able to manufacture conformal antennas, integrate circuitry with biomaterials, perform research involving tissue engineering and integrated lightweight electronics, and support the development of difficult and conventionally expensive-to-construct products.

AML works to develop these technologies and to move them from applied research to production. The center is currently collaborating on projects with private industry, such as Black Hills Nanosystems and Lockheed Martin; educational facilities, such as the University of North Dakota; and Department of Defense (DOD) entities, such as the ARL and the Army Armament Research, Development, and Engineering Center.

James Sears, Ph.D.
Director, AML

James Sears, Ph.D., holds bachelor’s, master’s, and doctoral degrees from the University of Illinois. He joined the School of Mines in 2002, where he currently serves as director of the Additive Manufacturing Laboratory. He also serves as the executive director of Western Illinois University’s Quad City Manufacturing Laboratory and chief technology officer of Black Hills Nanosystems Corp, a startup company working on safe armament.

Sears’ research focus areas include advanced materials processing in the areas of near net shape manufacturing, advanced joining technologies, rapid solidification processing, powder metallurgy, plasma and laser processing, spray deposition, and fabrication with nanoparticles. He has published more than 80 papers and holds one U.S. patent. He is a board member for the Minerals, Metals and Materials Society and chair for their Material Processing and Manufacturing Division. Sears has given invited keynote and plenary lectures on advanced material processing throughout the United States and in England, France, China, Australia, Korea, and Canada.
ADDITIVE MANUFACTURING LABORATORY

Material-Addition Research, From Microns to Meters
AMP is now officially recognized as the Arbegast Materials Processing and Joining Laboratory in honor of the center’s founder and director, who passed away in November 2009. William J. Arbegast was considered a pioneer and leader in the world of friction stir processing. During his career, he published more than 50 papers in national and international journals and was invited to present his research on four continents. He held six patents and generated millions of dollars in research funding related to friction stir processing. His procedures for leading a multi-university I/UCRC prompted the NSF to invite him to write a book on the topic so that all I/UCRCs could model his concepts.
The Arbogast Materials Processing and Joining (AMP) Laboratory at the South Dakota School of Mines and Technology provides research and development opportunities in state-of-the-art materials joining and processing, parts fabrication, and materials repair technologies.

AMP provides a unique opportunity for research ranging from basic solid-state joining and laser fabrication technology development to the creation of new materials and the test and evaluation of prototype structures, bringing together highly specialized equipment in a laboratory environment to perform research and development projects in friction stir processing.

AMP was created in 2003 under a grant from the Army Research Laboratory. The advanced friction stir welding and processing equipment at the School of Mines was designed and installed by industrial partner MTS Systems Corporation. This equipment provided AMP with the most versatile, fully-instrumented research and development tools found anywhere in the world. Since its inception, AMP has added state-of-the-art supersonic cold spraying, ultrasonic spot welding, refill friction stir spot welding, pulsed friction, cryogenic materials properties testing, and virtual reality joining equipment.

The 5-axis friction stir welding and processing equipment provides the capability to join three dimensional, large, curvilinear structures in ferrous and non-ferrous alloys. This solid-state material processing technology is being investigated to join previously un-weldable materials, including metal matrix composites, and as a fusion weld and riveted joint replacement technology to reduce weight, costs, and to increase performance. It is also being investigated as a microstructural modification tool that can induce super plasticity in materials.

AMP projects involve students from a number of graduate programs and sponsors several undergraduate senior design projects. Sophomore, junior, and senior undergraduate students are employed as undergraduate research assistants to support research efforts. Collaborative outreach programs have been developed with the local Oglala Lakota College through the involvement of Native American summer student interns. The center also collaborates with the Welding Group at Western Dakota Technical Institute to increase student understanding of the manual and semiautomatic fusion welding processes. These multi-disciplinary projects not only involve students and faculty members at the School of Mines, but also include other major academic institutions, industrial partners, and government laboratories.

A major achievement for AMP has been the establishment of the Center for Friction Stir Processing (see page 15), a National Science Foundation (NSF) Industry/University Cooperative Research Center (I/UCRC).
Robb Winter, Ph.D.
Site Director, CBERD

Robb Winter, Ph.D., earned his doctorate in chemical engineering from the University of Utah. Winter is the head of the Department of Chemical and Biological Engineering (CBE), which includes the biology education and research efforts at the School of Mines. He was the co-founder of the Composites and Polymer Engineering laboratory and the South Dakota 2010 Center for Bioprocessing Center for Research and Development. Recently, he was an East Asia and the Broadening Participation Program Manager in the Office of International Science and Engineering at the National Science Foundation.

He joined the School of Mines in 1989 and has actively been involved in developing the CBE department, including initiating the Chemical and Biological Engineering Ph.D. program, a National Science Foundation-supported Research Experience for Teachers Site, and a Research Experience for Undergraduates Site with an international sister-site at the Mongolian University of Science and Technology. He and his students have explored questions in nano- and micro-composites and biomass combustion and pollution formation and mitigation.
n 2008, the National Science Foundation funded the creation of the Center for BioEnergy Research and Development (CBERD), an Industry/University Cooperative Research Center (I/UCRC) headquartered at the South Dakota School of Mines and Technology.

CBERD’s mission is to conduct collaborative research focused on delivering technology solutions that enable widespread commercialization of biofuels and bi-products, and to assist government and industry in achieving the U.S.’s goal of augmenting petroleum-based economy with renewable energy, chemicals, and biomaterials.

Other academic members of the cooperative research center include Kansas State University, North Carolina State University, the University of Hawaii, and the University of New York at Stony Brook. Each of these universities pledged, as part of the membership agreement, to bring five industry or governmental partners on-board, yielding a strong industry commitment of more than 30 members. Industry dues from the I/UCRC fund more than $2 million of research activities each year.

The universities benefit from the opportunities to partner with other leading institutions to conduct industrially relevant research and receive seed funding and recognition as an NSF research center. University researchers benefit from collaborative efforts with their counterparts at the other institutions and exposure to real-world industry research needs. Industrial partners are able to leverage their research and development funds while gaining access to multi-university centers renowned for their innovative research capabilities. This partnership also proves to be an excellent recruiting tool, building the future for partnering companies and providing job opportunities for graduates of the universities.

CBERD examines ways to find, improve, and commercialize bio/renewable energy routes and systems. The bioprocessing industry is undergoing a transition, moving from food-based sources such as corn and soybeans to non-food based sources such as forest and agricultural waste and energy crops. CBERD’s research reflects this transition. As fuel is produced from these new sources, a variety of byproducts are available, and developing these byproducts into useful products is an important research area for the CBERD.

The center has seven research foci: feedstock agronomy and supply, feedstock breeding and genomics, bioprocessing microbes and enzymes, biomass processing, new platform technologies, modeling and process lifecycle analysis, and end-use and product development. The CBERD draws upon its member universities to provide expertise in this “cradle to grave” approach to develop commercially viable technologies. At the School of Mines, CBERD research includes developing advanced separation technologies to remove valuable products and inhibitors, bioprospecting in DUSEL and other extreme environments for lignocellulose degrading thermophilic organisms, and developing biocomposites from the lignin co-product.

Between the five consortium universities, a wide range of facilities and laboratory equipment covering every aspect of bioanalysis, bioprocessing, and bioenergy is available.

Duane Abata, Ph.D., Executive Director, CBERD

Duane Abata, Ph.D., earned his doctorate in mechanical engineering from the University of Wisconsin-Madison. Abata, a past president of the American Society for Engineering Education, is a mechanical engineer with more than 20 years of experience in research, education, and academic administration as well as management experience at the National Science Foundation and the Department of Energy Interdisciplinary Center for Advanced Propulsion.

He joined the School of Mines in 2006 as the dean of engineering and now serves as the executive director of CBERD. In addition to this research center, Abata is active with international engineering education and participates in an eight-university consortium in the European Union that provides international engineering design opportunities for students in engineering and science.
Located on the South Dakota School of Mines and Technology campus, the Center for Bioprocessing Research and Development (CBRD) was established in 2006 through the Governor’s 2010 Initiative for Economic Development to bring together the bioprocessing research and development resources of more than 110 faculty, research scientists, students, and staff at South Dakota State University (SDSU) and the School of Mines. Research activities are jointly conducted and co-located on both campuses.

CBRD’s focus is on research that leads to new technologies for processing plant-derived lignocellulose materials into biofuels and value-added biochemicals and biomaterials. The goal of the Center is to reduce national dependence on imported fossil fuels and petroleum-based chemicals by developing new technologies and bioproducts that mitigate the environmental impact of greenhouse gas emissions and combat climate change. The CBRD mission is to provide expertise, research facilities, education, training and assist farmers, entrepreneurs, and biofuels industries in South Dakota in technology transfer.

The engineering and science collaborators of the CBRD represent the fields of agriculture and biosystems engineering, biochemistry, chemical and biochemical engineering, industrial microbiology, mechanical engineering, and plant science. Principle areas of research at the CBRD are feedstock development and logistics; feedstock pretreatment; enzymatic hydrolysis; biochemical conversion of feedstock to transportation fuels and chemicals; thermochemical conversion of feedstock to next generation biofuels; product recovery and downstream processing.

Current projects at the School of Mines include using a thermochemical process to create a “green gasoline” from biomass, and transformation of animal fat, waste and algae oil into biodiesel for the U.S. Air Force. Other important projects focus on bioethanol and biohydrogen production from waste biomass as well as utilization of co-products such as lignin and bio-char in high-value biodegradable plastics and nanomaterials.

Researchers at the CBRD have also identified two niche areas of research specialization. The first is the development of technologies for utilization of by-products and co-products from the chemical and biofuels industries. The second area of specialization is microbial and enzymatic applications of extremophiles isolated at the Deep Underground Science and Engineering Laboratory (DUSEL) in Lead, South Dakota. Researchers are currently bioprospecting for heat-tolerating bacteria in order to apply them to processing biomass.

Because of the unique geographical location of the center, local industry by-products, such as agriwaste and logging waste, play a significant part in providing the feedstock for bio-derived chemicals and fuel research. This research has the potential for far-reaching impact on the economy of the Black Hills, the state of South Dakota, and the Midwest as a whole. Other areas of impact include the national agribusiness and energy industries.

CBRD is actively involved in and supports Ph.D. and M.S. graduate programs at both universities. The center’s research output in fiscal year 2010 included two patents, seven invention disclosures, 21 peer-reviewed publications, and 60 national and international presentations. In addition, 26 industry collaborations were initiated and 83 graduate and undergraduate students were trained.
CENTER FOR BIOPROCESSING RESEARCH AND DEVELOPMENT
Transforming Plant Material Into Power
The Center for Friction Stir Processing was recently awarded the fifth annual Alexander Schwarzkopf Prize for Technological Innovation from the I/UCRC Association, a voluntary, independent organization of past and present members of the NSF’s I/UCRC program, involving more than 50 centers, 100 universities, and 750 faculty researchers directing nearly 1,000 students each year. The award recognizes the CFSP for its work in the fabrication of the Littoral Combat Ship USS Freedom, commissioned in September 2006. More than 12 miles of friction stir welding was used to construct the all-aluminum, 377-foot-long ship.
The Center for Friction Stir Processing (CFSP) is a National Science Foundation (NSF) Industry/University Cooperative Research Center (I/UCRC), formed and headquartered at the South Dakota School of Mines and Technology from 2004 to 2010. The School of Mines now operates as one of the five sites within the center. The CFSP is one of the world’s leading centers for research and development in emerging friction stir welding processing technologies.

The center’s research on friction stir welding, stir spot welding, and friction stir structural designs and applications has resulted in significant improvements to weld strength and durability by, among other things, replacing fusion welds and rivets. Center facilities include a wide range of friction stir processing, testing, and support equipment.

The CFSP is comprised of five university partners—the School of Mines, Brigham Young University, Missouri University of Science and Technology, Wichita State University, and the University of South Carolina—and 27 industry and government partners. The center carries out research and trains students for positions of responsibility within these organizations.

The CFSP has an extensive government base of support for research and development programs, with current research collaborations with the Army Research Laboratory, the Air Force Research Laboratory, the National Aeronautics and Space Administration, Langley Research Center, Department of Energy, Pacific Northwest National Laboratory, and Oak Ridge National Laboratory. Industrial partnerships exist with aerospace, automotive, defense, energy, and primary materials production sectors. These partnerships include direct funding, materials and equipment contributions, and engineering consultation and support.

The overall objective of the center is to develop and deliver relevant scientific knowledge that will help its industrial members with future challenges. Center programs are designed to complement the members’ in-house research and development in the area of friction stir processing by bringing together theoretical, experimental, and application experts from industry and academia. Current research objectives include friction stir welding of materials with high melting temperatures, microstructural modifications by friction stir processing, automotive applications of friction stir joining, tool design and evaluation, and more.

Michael K. West, Ph.D.
Site Director, CFSP

Michael West, Ph.D. received his bachelor’s degree from Arizona State University, his master’s from Texas A & M University, and his doctoral degree from the University of Tennessee. West joined the School of Mines as an assistant professor of materials and metallurgical engineering in 2006.

His research includes work in physical metallurgy, materials joining, and advanced materials processing methods including friction stir joining and cold spray in many alloy systems. He is actively engaged in research projects sponsored by the National Science Foundation, Department of Energy, Department of Defense, and private industry. He serves as the site director for the National Science Foundation Industry/University Cooperative Research Center (I/UCRC) - Center for Friction Stir Processing (CFSP). West is also the site director for a National Science Foundation Research Experiences for Undergraduates (REU) “Back to the Future” site at the School of Mines, focused on metallurgical engineering research.
The Composites and Polymer Engineering Laboratory (CAPE) at the South Dakota School of Mines and Technology is a multidisciplinary research and education center specializing in polymers and polymer matrix composites. CAPE, created in 2004, takes a fully-integrated approach to research and development, encompassing materials science, computer simulations, composite and component design, process engineering and manufacturing technologies, prototyping, and testing. To conduct original research and development, the 10,000-square-foot facility houses an array of polymer and composite processing and prototyping equipment, ranging from bench-scale units to pilot manufacturing capabilities. These capabilities provide students, faculty, and external collaborators an extensive set of tools to create the prototypes for the next generation of advanced composite structures.

Collaboration is key to research functionality at CAPE. Working with industrial, government, and academic partners to explore and develop the next innovations in polymers and polymer composites, CAPE moves from research in materials science and processing technology through to prototype demonstration and testing.

CAPE plays a critical role in supporting polymer and composite research and innovation. Current work in developing composite structures for extreme conditions involves the creation of lightweight composite structures that will help deflect impact and thermal energy from blast waves and projectiles. Research in composite materials with electronic sensing capabilities seeks to develop polymer materials and composites with embedded-sensing, diagnostic, and communications capabilities for use in applications such as the next-generation of advanced combat helmets. Additional research focuses on the advanced processing of thermoplastic and thermoset composites, biocomposites, and more.

In addition to research and development, CAPE plays a key role in producing the next generation of polymer and composite engineers and scientists. CAPE supports graduate students working in areas of interest to the laboratory and offers instruction and practical training in composites processing and characterization to undergraduates. In collaboration with the Center for Advanced Manufacturing and Production (CAMP), CAPE has played a critical role in the successes of many of the student national competition projects. CAPE provides expertise and facilities that have created the first monocoque body for the human powered vehicle team, the unified inverted wing under-carriage for the formula SAE team, structures for several SAE aero design team planes, and the sub-vehicle for the Unmanned Aerial Vehicle team.

David Salem, Ph.D.
Director, CAPE

David Salem, Ph.D., received his doctorate in polymer and fiber physics from the University of Manchester and is a chartered physicist. He held several senior research positions at TRI/Princeton in New Jersey and Rhone-Poulenc in France, before serving as director of research at TRI/Princeton from 1995–2002. Salem then entered the arena of venture-backed technology development, leading the research and development activities of two start-up companies pioneering advanced nanofiber, nanopowder, and nanocomposite technologies. In 2010, Salem became director of CAPE. He also serves as a professor in the materials and metallurgical engineering and chemical and biological engineering departments at the School of Mines.

Salem has led numerous research groups and has served on various professional advisory boards and committees, including the Governing Council of the Fiber Society. He is recognized for his published contributions to the field of structure formation and crystallization in oriented polymers and is the recipient of the Award for Distinguished Achievement in Fiber Science (1996). Salem is the editor of and a contributing author for the book, *Structure Formation in Polymeric Fibers*. 
COMPOSITES AND POLYMER ENGINEERING LABORATORY

Developing the Materials of Tomorrow
COMPUTATIONAL MECHANICS LABORATORY
Modeling the Solutions to Today’s Engineering Problems
The Computational Mechanics Laboratory (CML) was established in 2006 to provide the basic infrastructure (facilities, hardware, and software) required to promote, support, and perform academic and research activities in the field of computational mechanics at the South Dakota School of Mines and Technology.

Computational mechanics is concerned with the numerical simulation of advanced engineering problems. It brings together highly sophisticated methods of structural and applied mechanics, computer science, and applied mathematics, and encompasses numerical methods for application to various mechanical engineering problems. It is now a well-established and growing discipline, increasingly applied by engineers and scientists to optimize existing products and manufacturing processes and to promote the development of new technologies.

The CML provides nearly 7,000 square feet for a variety of high-end computing activities. The lab has state-of-the-art computer hardware and software, providing School of Mines students access to modeling capabilities commonly used in industry. The CML also hosts a small experimental mechanics area where tests can be conducted to validate numerical simulations related to small-scale impact problems.

The CML has the resources required to analyze complex engineering problems with the help of numerical methods, to perform computer simulations of the performance of a product under expected service conditions, and to predict the results of a manufacturing process under a given set of operating parameters. Expertise offered by the laboratory includes computational solid and fluid mechanics, solid mechanics, fluid mechanics, heat transfer, thermodynamics, biomechanics, composite materials, and more.

Current and recent research projects include developing novel extremity body armor, testing blast waves on advanced combat helmets, simulating the effects of improvised explosive devices in different soils, simulating complex manufacturing processes such as laser powder deposition and friction stir welding, and more. The application of computational mechanics to these projects is vital. Numerical simulations allow a researcher to investigate physical phenomena prior to the expensive and time-consuming process of building and testing physical product prototypes. Collaboration is a key aspect to the operation of CML. The laboratory regularly partners with other campus research centers and laboratories, businesses such as Respec and RPM, and governmental entities such as the Army Research Laboratory.

To incorporate teaching and research, the CML houses two specialized computer laboratories, one classroom, office space, one visualization room, a small ballistics laboratory, a small meeting room, and a computer server room. A new Ph.D. program in mechanical engineering is heavily integrated with the CML.

Karim Muci-Kuchler, Ph.D.
Co-Director, CML
Karim Muci-Kuchler, Ph.D., holds B.S. and M.S. degrees from the Instituto Tecnologico y de Estudios Superiores de Monterrey (ITESM) and a Ph.D. from Iowa State University. He joined the School of Mines in 2002, where he currently serves as professor of mechanical engineering and co-director of the Computational Mechanical Laboratory. His research interests include computational mechanics, solid mechanics, biomechanics, and product development. He is currently engaged in research projects related to blast and impact loading. He has been an invited lecturer at international conferences and symposiums, has more than 40 publications, is the co-author of the book “Adaptive Meshing with Boundary Elements,” and has done consulting for companies in Mexico and the United States.

Michael Langerman, Ph.D.
Co-Director, CML
Michael Langerman, Ph.D., holds B.S. and M.S. degrees from the South Dakota School of Mines and Technology and a Ph.D. from the University of Idaho. His career spans more than 30 years, encompassing the development of thermal protection for missile systems at the Navy Missile Center to modeling nuclear systems at the Idaho National Engineering Laboratory. He has made significant contributions to the area of thermal science, specifically in the application of numerical methods in which he has more than 50 peer-reviewed publications. Langerman joined the School of Mines in 1992, where he currently serves as department head and professor of mechanical engineering, in addition to co-director of the Computational Mechanics Laboratory.
opened in 1876, the former Homestake Gold Mine in Lead, South Dakota, produced more than $42 billion in gold in present-day dollars and employed thousands of people over the course of its 125-year lifespan. Its closure in 2003 signaled the end of an era. But with the National Science Foundation’s selection of the mine as the future site of the Deep Underground Science and Engineering Laboratory (DUSEL), a new door opened.

The longstanding connections between the South Dakota School of Mines and Technology and Homestake began in 1885 when the university was established to meet the growing research needs of the mining industry. These connections continued when, nearly a decade ago, the School of Mines helped champion the conversion of the mine into a national laboratory.

In 2010, the School of Mines established the DUSEL Project Office in order to manage this important role. The center has two separate and important functions: engineering design and research.

The major contracts providing information for the design surface and underground infrastructure, the geotechnical characterization, and the underground laboratory design are all being managed through the university. Twenty people are employed by the center and most are focused on the technical design for the project. These employees make up the core of the group that will be responsible for the laboratory’s construction.

The group’s efforts are currently focused on preparing the preliminary design report addressing the engineering design for the facility at 30 percent completion. This report will go to the National Science board in Spring 2011, where they will make the decision to move the DUSEL project forward as a Major Research Equipment Facility Construction (MREFC) project. The MREFC designation supports the acquisition and construction of major research facilities and equipment that extend the boundaries of science, engineering, and technology.

The center also encompasses research associated with the DUSEL. The laboratory is situated at the deepest mine in North America, providing a unique environment to conduct a wide array of research. At least 20 School of Mines faculty members and researchers are conducting projects at the DUSEL, representing nearly every academic department. A wide variety of projects are being carried out – dark matter detection, isolation of bacterial thermophiles, blast monitoring, coupled processes, geodatabases and geologic mapping, robotics, wave propagation, and more.

While the engineering design and research functions may seem disparate, they are in fact complementary. Many of the research projects support the design effort, and the engineering design takes into consideration the various needs presented by current and future research.

There are other underground research laboratories around the world. What sets the DUSEL apart is its dedication to a wide, multidisciplinary range of research. These projects, on the forefront of scientific exploration, will lead us closer to understanding the universe and our place within it. The School of Mines is proud to be a leading partner in bringing DUSEL from an extraordinary vision to a phenomenal reality.
William Roggenthen, Ph.D.
Director, DUSEL Project Office

William Roggenthen, Ph.D., holds a B.S. from the South Dakota School of Mines and Technology, an M.S. from the University of Colorado, and a Ph.D. from Princeton University. He joined the School of Mines in 1997 and currently serves as a research scientist IV and director of the DUSEL Project Office. His research has involved studies in engineering and environmental geophysics, hazardous waste disposal, and nuclear policy issues. Roggenthen also serves as co-principal investigator for the Deep Underground Science and Engineering Laboratory (DUSEL). In addition to this position’s responsibilities, he has ongoing experiments at the laboratory involving installation of seismic accelerometers and nanoradian tiltmeters measuring ground movement.

DUSEL PROJECT OFFICE
Understanding the World Around us from 4,850 Feet
he longest-running core research facility at the South Dakota School of Mines and Technology, the Engineering and Mining Experiment Station (EMES) has provided analytical services to the public and private sectors since 1903. Founded by the South Dakota Legislature more than a century ago, what was then named the Mining Experiment Station performed assays and experiments on the treatment of ores and other mineral products.

Today, the EMES acts as a centralized facility for multi-user instrumentation supporting research, training, and the acquisition of new equipment. It works to acquire, manage, and maintain analytical instrumentation to support faculty research, graduate and undergraduate research, academic programs, other academic and governmental organizations, and the private sector. The center also trains students on the proper use of the equipment.

Analytical methods in use include a wide variety of classical and advanced instrumental techniques for the characterization and testing of minerals, ores, raw materials, and manufactured products. The EMES operates, maintains, and oversees training in electron microscopy (scanning and transmission electron microscopes), X-ray diffraction, atomic absorption spectroscopy, inductively-coupled plasma mass spectrometry, visible and near infrared spectroscopy, and carbon/sulfur and hydrogen/nitrogen/oxygen analyses.

The EMES also works closely with other departments on campus, which house additional instruments, including a gas chromatograph-atomic emission detector, an atmospheric-pressure-ionization mass spectrometer, an X-ray fluorescence spectrometer, a laser particle size analyzer, Raman and FT-IR spectrometers, and scanning tunneling and atomic force microscopes.

The EMES supports a wide range of clients that wish to utilize equipment and elicit support. From 2004-10, the center supported 20 programs and 50 faculty members at the School of Mines; nine state universities and government entities; 39 state industries; 28 national and international industries; and two federal government entities.

Edward Duke, Ph.D., holds a B.S. degree from Beloit College and M.A. and Ph.D. degrees from Dartmouth. He joined the School of Mines in 1984, where he currently serves as professor of geology and directs the Engineering and Mining Experiment Station and the South Dakota Space Grant and NASA EPSCoR programs. Duke teaches courses in mineralogy, crystallography, and electron microscopy. His research interests include the Precambrian geology and tectonics of South Dakota and applications of remote sensing in geology. NASA, NSF, DOE, and other organizations have funded his research.
ENGINEERING AND MINING EXPERIMENT STATION
Supporting Public and Private Research Endeavors
The Institute of Atmospheric Sciences (IAS) at the South Dakota School of Mines and Technology has a rich history of research going back to the early 1960s, when the emphasis was on weather modification and hail damage research. Areas of scientific emphasis have broadened today to include aspects of atmospheric studies varying from air quality to convection in the atmosphere and ecosystem structure and the effects of climate on our earth’s ecosystems.

The IAS strives to improve understanding of the Earth’s natural ecosystems using observations made on a variety of platforms. These observations focus on specific phenomena such as lightning and severe storms and are linked to complex numerical models used to predict short- and long-term system behavior. Current research areas include observational and numerical modeling studies of thunderstorms and hailstorms; numerical modeling of clouds and storms, including storm electrification, lightning, and lightning-influenced atmospheric chemistry; applications of weather radar data to remote inference of cloud microphysical characteristics and rainfall measurements; numerical weather prediction and forecast assessment; fire weather prediction and modeling; land-surface/atmosphere exchange processes; biogeochemical cycling; studies of the planetary boundary layer; effects of aerosols on cloud physics; regional climate modeling; and meteorological information and visualization technologies.

The IAS works to transform new knowledge developed as a result of basic research into practical applications. For example, information related to the carbon cycle has been incorporated into a system that can be used to predict how specific agricultural management practices are likely to affect carbon storage in soil. IAS scientists and students take field measurements during active fires using portable, solar-powered mesonet stations specifically deployed in the area of the fire. The data are integrated with larger-scale observations in order to help deploy fire-fighting resources for maximum safety and effectiveness. The IAS has analytical and research facilities, including those that analyze key constituents of terrestrial and aquatic ecosystems and focus on measurements of atmospheric constituents that have the potential to affect the radiation and the oxidant balance of the earth system. The IAS operated a T-28 specially designed aircraft to penetrate and investigate severe storms for more than 30 years. Plans are underway to procure its successor, the A-10 Warthog. IAS scientists and students collaborate with many partnering institutions such as the National Weather Service, the National Center for Atmospheric Research and the EROS Data Center, and with several tribal colleges, including Sinte Gleska and Oglala Lakota Colleges.

Paul Smith, Ph.D.
Interim Director, IAS

Paul Smith, Ph.D., earned his doctorate in electrical engineering from the Carnegie Institute of Technology. Smith joined the IAS in 1966 as a research engineer and held positions as chief engineer, engineering group head, and senior scientist. He held the position of IAS director from 1981-1996 and currently serves as interim director.

Smith has received the Award for Meritorious Civilian Service from the U.S. Air Force Air Weather Service and the Editor’s Award from the Journal of Applied Meteorology. He has also served as a Fulbright lecturer in Finland and the chief scientist for the Headquarters Air Weather Service in the U.S. Air Force. Having published more than 70 articles or books and presented more than 100 papers, Smith has a substantial record of research in cloud physics, weather modification, radar meteorology, physical meteorology, and microwave engineering.
The South Dakota School of Mines and Technology is the site of the Repair, Refurbish, and Return to Service Applied Research Center (R3S), a South Dakota Governor’s 2010 Research Center focusing on developing and qualifying innovative repair processes that extend the life of military equipment.

The center utilizes technologies developed at the Arbegast Materials Processing and Joining (AMP) Laboratory at the School of Mines. Traditional joining processes weaken materials or even change their properties in undesirable ways. Friction stir (welding without melting), cold spray (accelerating particles to supersonic speed), and laser additive manufacturing (particles injected in laser beams for free-form fabrication) offer engineers and industry professionals next-generation methods for retaining or improving the strengths of materials, extending their lives, and offering cost-savings and reducing waste. Inspiration for the R3S came from a 2007 Aging Aircraft Repair Facility study conducted by the School of Mines in cooperation with Ellsworth Air Force Base, several major aerospace and defense companies, Department of Defense (DOD) Logistics Centers, and Rapid City companies HF Webster Engineering and Professional Services and RPM & Associates. The study showed that utilizing these technologies to repair and refurbish B1 bombers and other aircraft would result in $35 million per year in cost savings for the U.S. Air Force.

Using these technologies on other military equipment would expand the cost savings across the DOD into the hundreds of millions of dollars, a compelling cost/benefit analysis that identified needs now being addressed by the R3S Center.

The School of Mines collaborates with South Dakota State University, Western Dakota Technical Institute, and other educational partners; industrial partners such as H.F. Webster Inc. and RPM & Associates in Rapid City; and corporations such as Boeing, GE Aviation, General Atomics, Pratt & Whitney, Lockheed Martin, Rolls Royce, and Friction Stir Link to use the processes developed and certified by the center to repair military and civilian equipment.

The R3S provides an opportunity for students and faculty to work with industrial partners in a multi-disciplinary setting, creating a truly collaborative environment and giving students hands-on applied research opportunities, first in developing technologies and then working on the real hardware. The R3S is not only a benefit to the School of Mines and its students, but to Rapid City. As the center identifies new technologies, it will need supporting industrial partners to transition to production, creating an opportunity for high-tech spinoff companies in Rapid City.

Christian Widener, Ph.D.
Director, R3S

Christian Widener, Ph.D., received his bachelor’s, master’s, and doctoral degrees from Wichita State University. He served as a research scientist in the Advanced Joining Lab - National Institute for Aviation Research (NIAR) at Wichita State University. In 2010, Widener became director of R3S at the School of Mines. He also serves as an associate professor in the materials and metallurgical engineering and mechanical engineering departments at the School of Mines, as well as the director of the Arbegast Materials Processing and Joining Laboratory.

Widener is a member of several professional organizations, including the American Society of Mechanical Engineers, the Minerals, Metals, and Materials Society, and others. He has published a number of peer-reviewed papers and given many presentations at national and international conferences and seminars.
REPAIR, REFURBISH, AND RETURN TO SERVICE APPLIED RESEARCH CENTER

Bringing New Life to Vital Military Equipment
PALEONTOLOGY RESEARCH LABORATORY

Preserving the Past, Uncovering the Future
The newest of the 13 research centers at the South Dakota School of Mines and Technology is the Museum of Geology’s Paleontology Research Laboratory. Officially opened in September 2010, the center serves as the repository for one of the world’s finest fossil collections.

While the center itself is new, the research done within its walls is not—paleontology at the School of Mines has been an integral part of the university for more than 100 years. Current estimates are that the center houses more than 500,000 invertebrate and vertebrate fossils, mineral and rock samples, and fossil plants, making it one of the largest collections in the United States and some of the best scientifically documented specimens in the world.

The 33,000-square-foot Paleontology Research Laboratory provides a safe, environmentally-controlled location for the Museum of Geology’s fossil, geological, and archival collections, protecting a rich heritage. The facility houses geochemistry, preparation, and fabrication laboratories for the preparation, preservation, and conservation research involving the collections. In addition to traditional paleontology research, these resources allow faculty members and students to work in biostratigraphy, taphonomy, forensic paleontology, isotope testing, and much more. Hallway viewing windows of the laboratories allow visitors to watch and progress through the steps needed to take a fossil from the ground to a museum exhibit.

In addition to the collections it houses, the Paleontology Research Laboratory facility is unique in itself. Because of the program’s significant study of past environments and sustainability issues, creating a sustainable building became an important design objective and has resulted in the facility earning a Leadership in Energy and Environmental Design (LEED) Gold rating from the U.S. Green Business Council. The facility is the first state-owned building in South Dakota to receive this prestigious distinction.

The new facility serves as an important academic resource to the School of Mines paleontology master’s program, the only one of its kind in the United States. This program has long attracted students because of its reputation for excellence and its location near the natural laboratories of the Black Hills and Badlands. The new lab will only increase that draw with the opportunity for students to experience every aspect of the collection, curation, and research process.

Working with federal agencies, tribal governments, and private landowners makes collaboration an important part of the center’s activities. Recent examples include partnering with representatives from Oglala Lakota College (OLC) and the Oglala Sioux Tribe in inventorying and packing fossils from the South Unit of Badlands National Park. In addition, several students and a faculty member from OLC are participating alongside School of Mines students in a paleontology resource management course. The class will prepare a formal report for park and tribal stakeholders about the impact to fossil resources resulting from future implementation of the National Park Service’s General Management Plan for the Badlands South Unit.

Sally Shelton, M.A.
Interim Director, PRL

Sally Y. Shelton, M.A., received her bachelor’s degree in wildlife biology with a museum science option at Texas A&M University and her master’s degree in museum science with a thesis in vertebrate paleontology from Texas Tech University. She later completed a post-graduate diploma in geological conservation from the Sedgwick Museum’s Geological Conservation Unit at Cambridge University in the United Kingdom. Shelton joined the School of Mines staff and faculty in 2008 after working in collections management leadership positions at Texas Memorial Museum, the San Diego Natural History Museum, and the National Museum of Natural History (Smithsonian Institution). She has taught a number of museum professional short courses in the United States and Europe, and currently teaches museum curation, museum exhibits, and paleontological resource management at the School of Mines. She also teaches museum curation courses for the National Park Service. She is a past president of the Society for the Preservation of Natural History Collections, manages archives for the Society of Vertebrate Paleontology, is the creator and list owner for PERMIT-L (which provides information on scientific collecting), and is the author of a number of papers on museum conservation issues.
The South Dakota Space Grant Consortium (SDSGC) was established in 1991 under the National Aeronautics and Space Administration’s (NASA) National Space Grant College and Fellowship Program. The program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states, plus the District of Columbia and Puerto Rico.

The South Dakota School of Mines and Technology serves as the home institution for the SDSGC. The statewide network includes 20 affiliate organizations from public, private, and tribal universities; industry; museums; informal science centers; and federal government.

The vision of the SDSGC is to expand opportunities for all South Dakotans through education, research, and public service in the fields of aerospace and earth, and space sciences. As the link between NASA and the citizens of South Dakota, SDSGC’s mission is to instill the spirit of exploration and discovery in students and educators—and in the general public—with a special focus on the fields of science, technology, engineering, and mathematics that are essential for the development of the U.S. workforce.

The consortium administers a fellowship and scholarship stipend program (approximately $150,000 in student awards every year) with the goal of offering educational and research opportunities to students from diverse backgrounds who are pursuing degrees in science, technology, engineering, and mathematics-related (STEM) fields that align with NASA’s mission and those of the consortium’s membership. It also provides summer fellowships through NASA Centers, industry, and the USGS Earth Resources Observation and Science Center to help enhance interactions among member institutions and strengthen research capabilities related to aerospace, earth science, and remote sensing. Current student research sponsored at the School of Mines includes underwater autonomous vehicles, friction-stir damping techniques applied to landing gear, and a number of undergraduate senior design projects.

The consortium has assisted in the development of a Geographic Information Systems laboratory on campus. Other consortium programs include support for undergraduate and graduate research projects and faculty member travel to NASA Centers or additional destinations that may aid in developing enhanced research capabilities. SDSGC also maintains a K-12 informal education function to help foster wider use of earth science and aerospace-related materials in precollege educational programs throughout the state, and to improve education in the areas of STEM. Outreach activities include sponsorship of South Dakota Space Days, teacher workshops, visiting scientist programs in schools, and Aviation Careers Exploration Academy.

Tom Durkin
Deputy Director, SDSGC

Tom Durkin holds a B.S. degree in earth science from Adelphi University and an M.S. degree in geology from the School of Mines. He served as a hydrologist with the South Dakota Department of Environment and Natural Resources from 1987-99. In 1999 he joined the School of Mines.

Durkin is a certified professional geologist and a professional geologist licensed in the State of Wyoming. He is a member of the American Institute of Professional Geologists (AIPG) and is currently president-elect of AIPG’s South Dakota Section. He has published more than 30 papers and given numerous technical presentations at national and international conferences and seminars. Durkin currently provides numerous educational programs about NASA missions and astronomy to college and precollege students, educators, and the general public.
The South Dakota NASA Experimental Program to Stimulate Competitive Research (NASA EPSCoR) is a separately funded component of the South Dakota Space Grant Consortium that focuses solely on research. The goals of the South Dakota NASA EPSCoR program are to expand research capacity in science and engineering fields critical to NASA’s future workforce and to promote science and technology-based economic development. This program provides about $675,000 in annual NASA funding to South Dakota. Recent research has focused primarily on land cover dynamics and nanoscaled carbon fibers for aeronautics and space applications. Additional seed grants are made available to South Dakota researchers for projects that are aligned with NASA mission directorates and state research priorities such as 2010 Research Centers, new Ph.D. programs, the EROS, and the Deep Underground Science and Engineering Laboratory.
Lightning Research in the Spotlight

TOM WARNER was recently featured on the website Wired. In the “This Day in Tech” section, Warner discusses his research in lightning using optical and electromagnetic sensors and high-speed video cameras. To view the article and video of his research, visit <http://www.wired.com/thisdayintech/2010/02/gallery-lightning>. Warner served as a pilot for the Institute of Atmospheric Sciences’ T-28 armored research plane and received his master’s degree in atmospheric sciences from the School of Mines in 2003. He is currently pursuing his Ph.D. in atmospheric and environmental sciences with a specialization in lightning research.

Team Blob Takes Fourth Place in Microsoft’s Imagine Cup Technology Competition

During Microsoft’s eighth annual Imagine Cup, students across the country came together in Washington, D.C., to celebrate their creativity and passion for solving the world’s toughest problems using technology. More than 22,000 students registered for this year’s U.S. competition; only 80 were selected by a panel of judges to compete in the U.S. finals. The School of Mines team of ROBYN KRAGE (computer science ’10), LORI REBENITSCHE (physics ’10), and JAELLE SCHEUERMANN (computer science ’10) were among those lucky few. Working with faculty mentor Dr. ANTOINETTE LOGAR, interim dean of graduate education and professor of mathematics and computer science, the team competed in the Software Design invitational, taking fourth place.

The team, which calls itself “Team Blob,” from the image processing term for the shape that a finger makes when it touches a screen, created a project to address gender equality by developing a design tool—the Blob Multitouch Designer—to help teachers create interactive presentations. Imagine Cup judges weren’t the only ones that recognized the value of Team Blob. In an address to the Accelerator Summit, Microsoft CEO Steve Ballmer discussed the team’s work and the impact of their project on education.

Samurai Sword Project on the Cutting Edge

“Secrets of the Samurai Sword,” produced by NOVA, did more than provide historical background to viewers—it inspired ongoing research and design projects at the School of Mines.

The NOVA episode illustrated the ancient techniques and technologies that were used to craft samurai swords. A large clay furnace, called a tataras, diffuses carbon into iron to create a block of steel, which is then sorted to separate low carbon steel from high carbon steel. The high carbon steel is hammered into a sleeve and the low carbon steel is drawn into a bar. The low carbon bar is placed into the high carbon sleeve and the two segments are forge-welded together and hammered to make a blade with a low carbon core and a high carbon edge. The sword is then heated and quenched. This unique quenching process is what gives the samurai sword its distinct curve. Finally, the blade is sharpened and polished.

School of Mines students focused on using a Black Hills iron ore, collected from a mineral precipitate (formed from the water retrieved from the abandoned Homestake Mine), and modern technology to fashion a samurai sword. More than 30 students have worked on the project, which has been supported by the National Science Foundation and numerous industrial partners.
Building Better Dental Implants

Funded by the U.S. Army’s Armament Research, Development, and Engineering Center (ARDEC), School of Mines student KIRSTEN WILLIAM (M.S. biomedical engineering) is working to create better dental implants. Most metals currently used for dental prosthetics have high modulus elasticity, meaning that the implant takes more stress than the bone. Without this stress, the bone does not receive the signal to build more bone in the area, leading to further bone loss and eventual loosening and failure of the prosthetic dental implant, an effect called stress shielding.

To prevent this failure, the prosthesis’s modulus elasticity must be closer to that of the bone, allowing for better fixation. William is working with a substrate that she believes will achieve this effect. Her research focuses on Ti-15Mo, a substrate that is suitable for dental implants and prosthetics. The substrate is coated with a three-dimensional porous powder coating using the laser deposition process. After culturing the samples with osteoblast cells, she tests them for histological markers that would prove that cells will grow and survive on the proposed prosthetic material. William hopes her research will show that the substrate and the porous coating will support better osteointegration of dental implants and prosthetic devices.

Diving for New Knowledge

The School of Mines’ Robotics and Intelligent Autonomous Systems (RIAS) program has lent its support to a team of undergraduate and graduate students researching the applications of autonomous underwater vehicles (AUV).

The team is currently working to assemble and test an AUV with a design pressure rating of 1,500 psi, capable of dives to more than 1,000 meters beneath sea level, achieved by using crushable design techniques like protecting electrical components with mineral oil compartments. Allowing speeds of 1 m/s and five degrees of freedom, the AUV is designed to incorporate a water sampling system; visual, ultra-violet, and inferred imaging systems; temperature and pressure sampling; and the potential for a mineral or biological collection system. The vehicle will have an operating time of three hours and will be viable between 20 and 200 degrees Fahrenheit.

The current AUV is intended for scientific exploration and underwater work under extreme conditions—perfect for its initial mission to map the flooded regions of the Deep Underground Science and Engineering Laboratory (DUSEL) in Lead, South Dakota.
RESEARCH KEY PLAYER IN ECONOMIC GROWTH
A recent report from the South Dakota Board of Regents revealed that the South Dakota School of Mines and Technology generates a long-term economic impact of $148.3 million per year through job support, day-to-day operations, consumption of goods and services, and student and visitor spending.

In fiscal year 2009, the School of Mines received $14.2 million in state appropriations—approximately 27 percent of the university’s total budget. The university leveraged this state support through entrepreneurial activities such as increasing research activity through securing grants and contracts, growing enrollment, and collaborating with stakeholders to generate an incredible return on investment for the State of South Dakota.

This focus on research activity has resulted in some of the most dramatic growth for the School of Mines in recent years. The university has realized a 484 percent increase—from $6 million in fiscal year 2000 to $35 million in fiscal year 2010.

In South Dakota and nationwide, scientists and engineers provide a substantial boost to the economy through innovations generated through research activity. School of Mines faculty, staff, students, and alumni drive the development of technology-based companies that employ thousands of South Dakotans. Examples of businesses established by School of Mines researchers and alumni include RESPEC, RPM & Associates, and Daktronics. The university is also the site of the Black Hills Business Development Center, home to several companies with ties to the School of Mines, including Zyvex, C-Lock Technology, Inc., and Innovative Systems. In addition, long-term university partner Caterpillar Inc. has recently opened an engineering design center at the facility.

The School of Mines is also a leading partner in the Deep Underground Science and Engineering Laboratory (DUSEL). The DUSEL is more than just a beacon to scientists and engineers from all over the world; it is a draw to employees interested in building the infrastructure of the proposed laboratory. As the DUSEL grows in size and scope, a highly-skilled staff is required to continue its momentum—a staff that must live, work, and spend money, supporting the economic growth of the region.

The economic impact from the School of Mines involvement has been substantial, with the university receiving $27 million to date for the DUSEL project. The university currently has 20 employees associated with the DUSEL in addition to faculty members carrying out research associated with the facility. Through expenditures such as housing, food, entertainment, transportation and more, these employees—and others associated with the project through the Sanford Underground Laboratory and the South Dakota Science and Technology Authority—inject money into the local economy and create a compound effect, supporting additional local jobs.

“The School of Mines takes very seriously our responsibility in supporting the economic growth of the region and the state,” President Robert A. Wharton, Ph.D., said. “As we educate and prepare the future leaders in science and engineering, we also work to ensure opportunities that retain their knowledge and earning power in the area. The creation of high-tech companies and projects like the DUSEL are prime examples of this effort.”
Steven W. Squyres, Ph.D., has been named the 2010 recipient of the South Dakota School of Mines and Technology’s prestigious Mines Medal. Squyres is the Goldwin Smith Professor of Astronomy at Cornell University and the principal investigator for the science payload on NASA’s Mars Exploration Rover Project.

Squyres successfully conceived, organized, and led the exploration of the planet Mars with two small rovers, Spirit and Opportunity. He is also a co-investigator on the Mars Express mission and on the Mars Reconnaissance Orbiter’s High Resolution Imaging Science Experiment.

Squyres’ research focuses on the large, solid bodies of the solar system: the terrestrial planets and the satellites of the Jovian planets. His areas of particular interest include the tectonics of Venus, the history of water on Mars, and the geophysics of the icy satellites of the outer planets. He utilizes data analysis and theory together to examine the processes that have shaped the surfaces and interiors of these bodies.

Squyres has participated in a number of planetary spaceflight missions. From 1978 to 1981, he was an associate of the Voyager imaging science team, participating in analysis of imaging data from the encounters with Jupiter and Saturn. He was a radar investigator on the Magellan mission to Venus, a member of the Mars Observer gamma-ray spectrometer flight investigation team, and a co-investigator on the Russian Mars ‘96 mission.

He has served as the chair of the NASA Space Science Advisory Committee and as a member of the NASA Advisory Council. In addition, Squyres is a member of the imaging team for the Cassini mission to Saturn.

While much of Squyres’ NASA work has centered on Mars, his ground-based research focuses on geophysical modeling of all of the planets, as well as some large moons, in an effort to understand the geological forces at work on these distant worlds. He has also conducted field work in Antarctica, working with the perennially ice-covered lakes.

Among his honors, Squyres has received the Harold C. Urey Prize, the Space Science Award of the American Institute of Aeronautics and Astronautics, the 2004 Carl Sagan Award of the American Astronomical Society, the 2005 Wired Rave Award, the 2006 Roy Chapman Andrews Society Distinguished Explorer Award, and the 2007 Benjamin Franklin Medal in Earth and Environmental Science.

The Mines Medal program was established by the School of Mines to bring recognition and acknowledgement to a leader in engineering or science. The Mines Medal was designed by the university and includes an ounce of Black Hills gold. The award also includes a privately-funded honorarium. For more information, visit <http://mines-medal.sdsmt.edu>.

In addition to honoring a leader in science or engineering, the Mines Medal allows the university to assist the best and brightest students through the Mines Medal Graduate Student Fellowship.

Erin Handberg is the 2010 fellowship recipient. A native of Dell Rapids, South Dakota, she graduated from the School of Mines in December 2006 with bachelor’s degrees in computer science and applied and computational mathematics. While working as a research assistant at the John T. Vucurevich Cancer Care Institute, she developed an interest in physics and decided to attend graduate school. She joined the doctoral program in nanoscience and nanoengineering at the School of Mines in the summer of 2007 and started the master’s program in physics at its inception in 2009.

Handberg is working with her adviser, Andre Petukhov, Ph.D., and fellow graduate student, Luke Pendo, to develop a theoretical model for a quantum computer using lithium-doped silicon. Her Ph.D. research, “Quantum computing with spin qubits in lithium-doped silicon,” investigates two problems: the displacement of the lithium donor in the silicon lattice and its possible impact on the longevity of the spin qubit, and the effect of a static electric field on the lithium donor to develop a mechanism for controlling the qubit with an electric field. After receiving her doctorate, Handberg plans to seek a physics faculty position and to extend her research into other areas of quantum computation.
President ROBERT A. WHARTON, Ph.D. (photo) has been named to the Association of Public and Land-grant Universities (APLU) Energy Advisory Committee, formed to maximize and advance the contributions of public research universities to the energy-independence effort, based on the belief that these institutions have valuable insight to offer in developing solutions to energy challenges facing the United States and the world.

WHARTON has also joined the Council on Competitiveness, a group of CEOs, university presidents, and labor leaders working to set an action agenda to drive U.S. competitiveness, productivity, and leadership. He participated in the council’s National Energy Summit & International Dialogue conference, which brought together U.S. cabinet officials, international ministers, and global business, labor, university, and non-governmental organization leaders to address and find solutions for the challenges of energy security, innovation, and sustainability.

Dr. JAN PUSZYNSKI (photo), professor, chemical and biological engineering, has been named a Fellow of the American Institute of Chemical Engineers (AIChE). The grade of Fellow identifies tenured AIChE members who have made significant contributions to the chemical engineering profession.

The School of Mines hosted one of the nation’s three NASA SOLAR (Space Observation Learning and Research) Institutes, welcoming 38 high school juniors from across the country. The students, selected by NASA after a competitive application process, participated in the two-week pre-college experience incorporating space-related topics in the science, technology, engineering, and mathematics (STEM) disciplines.

The School of Mines hosted the fifth annual Rocky Mountain Unconventional Gas Conference, welcoming nearly 75 participants to campus. The conference focused on industry topics such as coalbed methane, shale gas reservoirs, and unconventional shallow gases.

The Black Hills Natural Science Field Station has added a new field opportunity for students, the Geomorphology Field Camp. The camp, held in the Himalayas, provides students with essential skills in the field of geomorphology including hill-slope processes, geomorphological mapping, glacial geology, and fluvial processes.

Dr. SCOTT J. AMOS (photo) has joined the School of Mines as the director of the university’s new construction management M.S. program. Amos brings nearly 25 years of construction-related experience in academia and public service, including the development of highly-successful construction management programs at three other institutions.

Dr. JENNIFER KARLIN (photo), associate professor, industrial engineering, joined 48 of the nation’s brightest young engineering researchers and educators selected to take part in the National Academy of Engineering's (NAE) first Frontiers of Engineering Education (FOEE) symposium. The program focused on effective ways to ensure that students learn the engineering fundamentals, the expanding knowledge base of new technology, and the skills necessary to be an effective engineer or engineering researcher.

Fall 2009 saw an 8-percent increase in graduate enrollment, helping to fuel the research engine of the university, the Black Hills region, and the state of South Dakota.

The Renewable Energy Research Facility has opened on the School of Mines campus, providing modern technology for researching wind and solar energy opportunities. The facility, which includes two wind turbines and three photovoltaic panels, was funded by a $90,000 donation from Black Hills Power.

Dr. ANDREW DETWILER (photo), professor, Institute of Atmospheric Sciences, has received a citation from the American Geophysical Union (AGU) for excellence in refereeing. Citations recognize individuals for consistently providing constructive and thoughtful reviews of scientific articles.

The School of Mines received $6.9 million in funding from the Fiscal 2010 Defense Appropriations bill. Projects include the use of advanced materials processing technologies to repair Navy equipment, the development of strong and lightweight future combat vehicles, and the exploration of bioconversion technologies for the U.S. Air Force. The School of Mines has received more than $80 million in Congressional funding since 2001.

Dr. UMESH KORDE (photo), associate professor, mechanical engineering, has been named the first Pearson Professor of Sustainable Energy Systems. The Pearson Professor will focus on all areas of energy sustainability.
The South Dakota Board of Regents has approved the implementation of a Ph.D. program in mechanical engineering. The program will emphasize three areas of research and study: thermal/fluid systems, engineering mechanics and controls, and design and manufacturing.

The Center for Friction Stir Processing (CFSP) has been awarded the fifth annual Alexander Schwarzkopf Prize for Technological Innovation from the I/UCRC Association, a voluntary, independent organization of past and present members of the National Science Foundation’s Industry/University Cooperative Research Center (I/UCRC) program. The award recognizes the CFSP for its work in the fabrication of the Littoral Combat Ship USS Freedom, commissioned in September 2006.

Dr. PERRY H. RAHN, professor emeritus, geology and geological engineering, has been named the 2010 J.P. Gries Geologist of the Year for his exceptional work in the field of geology by the South Dakota Section of the American Institute of Professional Geologists.

Dr. DAVID DIXON, professor, chemical and biological engineering, was awarded a Fulbright Award grant in the lecturer/research category at the Technische Universität Darmstadt (TUD), Germany, where he taught a chemical engineering thermodynamics course.

Concrete researchers, contractors, cement plant workers, consulting firms, builders, government agencies and others gathered at the School of Mines for the 46th annual Concrete Conference, “High Performance Concrete.”

A new master’s program in robotics and intelligent autonomous systems opened for enrollment in Fall 2009. The program focuses on robotics, artificial intelligence, control communications, sensors, signal processing, and more.

Dr. LEW CHRISTOPHER (photo), professor and director, Center for Bioprocessing Research and Development, attended the BIO Pacific Rim Summit on Industrial Biotechnology and Bioenergy in Honolulu, Hawaii, where he delivered two presentations relating to bioprocessing as it relates to the production of sustainable energy and renewable biomaterials.

MICHAEL JANES, a 2010 mathematics and computer science graduate, was awarded first place in the School of Mines’ Undergraduate Research Symposium for his project, “Mathematical Model for Friction Stir Welding.”

Dr. M.R. HANSEN (photo), professor, civil and environmental engineering; DR. J. FOSTER SAWYER, assistant professor, geology and geological engineering; and alumnus CHARLES JASON TINANT, presented papers at the first Mining and the Environment Conference, co-sponsored by the South Dakota School of Mines and Technology and Mongolia’s Erdenet Institute of Technology.

Dr. KEITH WHITES (photo), professor and Steven P. Miller Chair, electrical and computer engineering, presented two joint papers at Metamaterials 2009: Third International Congress on Advanced Electromagnetic Materials in Microwaves and Optics, held in London earlier this year. Whites also co-chaired one session at the same conference entitled “Periodical Structures.”

WHITES and ANTHONY AMERT, research scientist III, electrical and computer engineering, co-authored the paper “Miniaturization of the Biconical Antenna for Ultrawideband Applications,” for the journal IEEE Transactions on Antennas and Propagation.

Dr. ARDEN DAVIS (photo), professor, geology and geological engineering, presented a paper and conducted an ABET training session for geological engineering and mining engineering program evaluators at the Society of Mining, Metallurgy, and Exploration’s annual meeting.

Dr. ARDEN DAVIS (photo), professor, geology and geological engineering, attended the ABET Board of Directors Meeting in San Antonio, Texas, on October 31, 2009. Davis was appointed to the Board of Directors in 2007, representing SME-AIME.

AMANDA GRILL, chemical engineering M.S. student, SAM PAPENDICK, chemical and biological engineering Ph.D. student, and TIM SHENK, chemical and biological engineering Ph.D. student, were selected to participate in the East Asia and Pacific Summer Institute. The program, funded by the National Science Foundation, funds eight- to 10-week research experiences at laboratories in Australia, China, Japan, Korea, New Zealand, Singapore, or Taiwan.
Dr. SCOTT P. AHRENKIEL (photo), assistant professor, nanoscience and nanoengineering; Dr. HIAPING HONG, research scientist IV, materials and metallurgical engineering; Dr. RAJESH SANI, assistant professor, chemical and biological engineering; Dr. MICHAEL TERRY, assistant professor, geology and geological engineering, and associate curator, mineralogy; and Dr. RAJESH SHENDE, assistant professor, chemical and biological engineering, received $699,000 from the National Science Foundation for the project, “MRI: Acquisition of a Modern Transmission Electron Microscope for Research and Training in South Dakota.”

Dr. AHRENKIEL also received $15,000 in additional funding from the United States Department of Energy EPSCoR, for the project, “Lattice-Mismatched III-V Epilayers for High-Efficiency Photovoltaics.”

JASON ASH (photo), instructor, mechanical engineering; Dr. MICHAEL BATECHLDER, chair and professor, electrical and computer engineering, and co-director, Center of Excellence for Advanced Manufacturing and Production; and Dr. JEFFREY MCGOUGH, associate professor, mathematics and computer science, received $5,000 from the National Aeronautics and Space Administration for the project, “Lunar Regolith Excavator Competition.”

Wayne Krause, professor, mechanical engineering; Dr. JEFFREY MCGOUGH, associate professor, mathematics and computer science; and Dr. JOHN WEISS, professor, mathematics and computer science, received $350,000 in additional funding from the United States Department of Defense—Army Research Laboratory for the project, “Advanced Materials and Processes for Future Combat Systems.”

Dr. DAVID BOYLES (photo), professor, chemistry, received $60,000 in additional funding from the United States Department of Defense—Office of Naval Research for the project, “Novel High-Temperature Polycarbonates for Pulse Power Capacitor Applications.”

Dr. WILLIAM CAPEHART (photo), associate professor, atmospheric sciences and Institute of Atmospheric Sciences; and Dr. MARK HJELMFELT, chair, atmospheric sciences, and professor, Institute of Atmospheric Sciences, received $481,286, from the United States Department of Defense—Armament Research, Development, and Engineering Center (ARDEC) for the project, “Advanced Atmospheric Sciences Technology and Applications to Support NAMK project.”

Dr. LEW CHRISTOPHER (photo), director and associate professor, Center for Bioprocessing Research and Development, received $500,000 in additional funding from the South Dakota Board of Regents for the project, “Center for Bioprocessing Research and Development.”

Dr. CHRISTOPHER also received $43,850 from the United States Department of Agriculture—Cooperative State Research, Education, and Extension Service for the project, “Multi Vessel Fermentation System for Screening, Optimization and Scale-Up of Biofuels Research.”

Dr. CHRISTOPHER and Dr. RAJESH SANI, assistant professor, chemical and biological engineering, received $37,510 from the University of South Dakota (subaward from the U.S. Department of Energy - Energy Efficiency and Renewable Energy) for the project, “Transforming and Densifying Biomass in Regional Biomass Processing Center (RBPC).”

Dr. WILLIAM CROSS, associate professor, materials and metallurgical engineering, received $1,603 in additional funding from the National Aeronautics and Space Administration for the project, “Development, Characterization, and Evaluation of Lunar Regolith and Simulants.”

Dr. ARDEN DAVIS (photo), Mickelson Professor, geology and geological engineering; Dr. DAVID DIXON, professor, Center for Bioenergy Research and Development and chemical and biological engineering; and Dr. M.R. HANSEN, professor, civil and environmental engineering, received $12,131 from South Dakota State University (subaward from the U.S. Geological Survey) for the project, “Acidic Leaching Tests to Determine Arsenic Mobility from Concrete-Encapsulated Limestone Waste.”

Dr. DAVIS; Dr. SOOKIE BANG, professor, chemical and biological engineering; and Dr. DAVID DIXON, professor, Center for Bioenergy Research and Development and chemical and biological engineering, received $13,983 from South Dakota State University—Water Resource Institute (subaward from U.S. Geological Survey) for the project, “Investigation of Arsenic Removal from Water by Microbiologically Induced Calcite Precipitation.”

Dr. ANDREW DETWILER (photo), professor, atmospheric sciences and Institute of Atmospheric Sciences, received $56,279 in additional funding from the National Science Foundation for the project, “Intergovernmental Personnel Act Assignment,” allowing him to take a temporary position with the NSF as associate program director in the division of atmospheric sciences.
Dr. DAVID DIXON, professor, Center for Bioenergy Research and Development and chemical and biological engineering; and Dr. DUANE ABATA, executive director, Center for Bioenergy Research and Development, and professor, mechanical engineering, received $99,000 in additional funding from the National Science Foundation for the project, “I/JUCRC Center for Bioenergy Research and Development.”

Dr. EDWARD DUKE (photo), manager of analytical services, engineering and mining experiment station, and professor, geology and geological engineering, received $795,742 in additional funding from the National Aeronautics and Space Administration (NASA) for the project, “South Dakota Space Grant Consortium.”

Dr. DUKE; Dr. STEVE SMITH, associate professor and program director, nanoscience and nanotechnology; Dr. WAYNE KRAUSE, professor, mechanical engineering; and Dr. JAN PUSZYNSKI, professor, chemical and biological engineering, received $750,000 from NASA for the project, “CAN/Experimental Program to Stimulate Competitive Research (EPSCoR)—2009.”

Dr. DUKE; Dr. HAIPING HONG, research scientist IV, materials and metallurgical engineering, received $61,110 in additional funding from the United States Department of Defense—Army Research Laboratory for the project, “Advanced Materials and Processes for Future Combat Systems.”

Dr. DUANE HRNCRIR, provost and vice president, academic affairs, received $32,000 from the University of Alaska Anchorage (subaward from the National Science Foundation) for the project, “Partnerships for Innovation (PFI).”

Dr. DAMON FICK (photo), assistant professor, civil and environmental engineering, received $1,000 from Dr. Thomas H. Cook for the project, “Residential Construction Alternatives.”

TIMOTHY HENDERSON, vice president, business and administration, received $1,535,250 from the Bureau of Administration (subaward from the U.S. Department of Energy) for the project, “Governor’s Office of Economic Development American Recovery and Reinvestment Act State Energy Plan Grant Agreement.”

Dr. HAIPING HONG (photo), research scientist IV, materials and metallurgical engineering, received $61,110 in additional funding from the United States Department of Defense—Army Research Laboratory for the project, “Advanced Materials and Processes for Future Combat Systems.”

Dr. JOSEPH FAZIO, associate professor, civil and environmental engineering, received $42,784 from South Dakota State University (subaward from the U.S. Dept. of Transportation — Federal Highway Administration — South Dakota Dept. of Transportation) for the project, “South Dakota Local Transportation Assistance Program (SDLTAP) 2010.”

Dr. BHARAT JASTHI (photo), research scientist II, Advanced Materials Processing and Joining Laboratory, received $200,000 from Transition45 Technologies (subaward from NASA) for the project, “Friction Stir Processing of Cast Superalloys.”

Dr. JON KELLAR; Dr. DANA MEDLIN, associate professor, materials and metallurgical engineering; Dr. JENNIFER KARLIN, associate professor and coordinator of faculty development, industrial engineering; and Dr. STUART KELLOGG, department head and Pietz Professor, industrial engineering, received $595,700 from the National Science Foundation for the project, “Culture and Attitude—Innovative Partnerships for Success.”

Dr. KELLAR and Dr. KEITH WHITES, professor and Steven P. Miller chair, electrical and computer engineering, received $65,236 in additional funding from South Dakota State University (subaward from the National Science Foundation) for the project, “The 2010 Initiative: Science-Based Leadership for South Dakota.”

With the rapid depletion of petroleum reserves, the need for renewable fuels has become increasingly vital. Funded by a $477,561 award from the United States Department of Agriculture, School of Mines researchers are addressing this need by developing improved technologies for the conversion of agricultural and forestry lignocellulosic biomass, such as corn stover, wood, and grasses, into high-value ethanol. Researchers have discovered a means of absorbing harmful compounds in solution, which are toxic to the yeast cells that make ethanol. Because of this discovery, they can now attempt to concentrate sugars prior to fermentation. This method produces ethanol more efficiently because it reduces distillation energy costs and generates a higher ethanol concentration. In addition, researchers have created a faster, more efficient conversion process by reusing yeast cells in fermentation technologies. Traditional processes create a build-up of solids in solution, allowing yeast cells to be used only once and requiring larger equipment to complete the fermentation. However, since this new procedure removes all solids from solution, yeast cells can be recycled, eliminating the need for larger processing equipment. Applying this research to current biorefinery methods will yield a substantial cost savings, leading to production of ethanol that is economically competitive with petroleum-based processes. Moreover, Dr. TODD MENKHAUS, principal investigator of the project, hopes this research, along with several other related projects taking place on campus, will help establish a national reputation for the School of Mines as a leader in the research and development of biorenewable products.
For many years, lead was a common component in soldering materials for electronic equipment. Under the Reduction of Hazardous Substances standard, manufacturers made the move toward lead-free solder. However, while environmentally friendly, this shift has been responsible for billions of dollars in damage to electronic systems like communications satellites and power plants. The culprit? Tiny splinters, called tin whiskers, which result from lead-free manufacturing.

The Department of Defense is working through the Advanced Electronic Rosebud Integration project to develop joint research collaboration with Radiance Technologies, Inc., Rosebud Electronics Integration Corporation, and the School of Mines to research, develop, design, test, prototype, and demonstrate new techniques and processes technologies that enable the use of non-hazardous materials substrates while avoiding the issues posed by current materials.

Funded with $235,854 from Radiance Technologies, researchers at the School of Mines, led by principal investigator Dr. DANA MEDLIN, are spearheading the research and development efforts with the metallurgical and materials engineering analysis and corrective action issues.

The first phase of this project involves a baseline comparison between leaded-solders and lead-free solders. The results from this evaluation will be used to develop continuing research projects involved with lead-free solder prototype development, resolution of prototype development problems (like whiskers), coating comparisons, operational/manufacturing procedure development, manufacturing validations, development of quality assurance and testing methodologies, and failure analysis of solders.

The mechanisms that control the phase transformations and whisker development in the lead-free solders are not understood, so the research team hopes to develop a fundamental understanding of these mechanisms in an effort to control and/or eliminate these problems.
While the United States has seen virtually no increase in the number of students entering engineering fields in the past 20 years, the number of engineering graduates from China and Japan has risen rapidly—an increase of 161 percent and 42 percent, respectively. This trend raises the concern that the U.S. will begin to lose its competitive economic edge. Moreover, while other professional fields in the United States have seen increases in female participation, women continue to be underrepresented in engineering disciplines.

“Tо get the innovation we need in science and engineering, we need a bigger, more diverse pool to draw from,” said Dr. JON KELLAR, principal investigator in the $595,700 project “Culture and Attitude—Innovative Partnerships for Success” funded by the National Science Foundation. The project will seek to address these disparities by emphasizing gender equity while increasing the overall number of B.S. graduates in metallurgical and industrial engineering.

According to Kellar, in order to recruit a diverse pool it is vital to change the delivery of program content due to different approaches to learning. “We don’t want to give up the rigor of education. We want instead to accommodate and modify and improve,” he said. The research team plans to achieve the project’s objectives through targeted recruitment strategies, a designated scholarship fund, student support services, and a change in the delivery of classroom content.

Dr. JAMES MARTIN (photo), professor, geology and geological engineering, and executive curator, Museum of Geology, received $24,999 from the United States Department of Army—United States Army Corp of Engineers for the project, “Paleontological Work on Lake Francis Case/Fort Randall Project.”

Dr. DANA MEDLIN, associate professor, materials and metallurgical engineering; Dr. STANLEY HOWARD, professor, materials and metallurgical engineering; Dr. HAIPING HONG, research scientist IV, materials and metallurgical engineering; and Dr. ANDRE PETUKHOV, department head and professor, physics, received $157,650 in additional funding from the University of South Dakota (subaward from the South Dakota Board of Regents) for the project, “2010 Center for Ultra-low Background Experiments.”

Dr. MEDLIN and Dr. JON KELLAR, department head and professor, materials and metallurgical engineering, received $235,854 in additional funding from Radiance Technologies (subaward from the U.S. Department of Defense) for the project, “Advanced Electronic Rosebud Integration (AERI) Research and Development Program.”

Dr. MEDLIN also received $6,000 from the United States Department of Interior—National Parks Service—Great Plains Cooperative Ecosystems Studies Unit for the project, “Metallurgical Analysis of USS Arizona Battleship Steel,” and $31,323 from the South Dakota School of Mines and Technology Foundation (subaward from Smith and Nephew, Inc. Endoscopy Division) for the project, “Photonic Curing of Hydroxyapatite onto Soft Tissues for Enhanced Tissue to Bone Healing.”

Dr. TODD MENKHAUS (photo), assistant professor, chemical and biological engineering; Dr. PATRICK GILCREASE, associate professor, chemical and biological engineering; and Dr. LEW CHRISTOPHER, director and associate professor, Center for Bioprocessing Research and Development, received $477,561 from the United States Department of Agriculture—Cooperative State Research, Education, and Extension Service for the project, “Efficient Fermentation of Lignocellulosic Biomass Slurries by Concentrating Sugars and Recycle/Re-Use of Fermentation Organisms.”

Dr. MENKHAUS also received $19,288.77 from the Argonne National Laboratory (subaward from the U.S. Department of Energy) for the project, “I/UCRC Flocculation.”

Dr. ANDRE PETUKHOV, department head and professor, physics; and Dr. MICHAEL FOYGEL, professor, physics, received $121,464 from the National Aeronautics and Space Administration for the project, “Investigation of Dynamics of the Solid Rocket Motor Fuel Deflagration and Detonation.”

Dr. JAN PUSZYNSKI (photo), professor, chemical and biological engineering; Dr. RAJESH SHENDE, assistant professor, chemical and biological engineering; and Dr. JACEK SWIATKIEWICZ, instructor and research scientist II, chemical and biological engineering, received, $220,850 from the United States Department of Defense—Armament Research, Development and Engineering Center for the project, “Tunable Multifunctional Energetic Materials.”

Dr. PUSZYNSKI; Dr. HAO FONG, associate professor, chemistry; and Dr. SCOTT P. AHRENKIEL, assistant professor, nanoscience and nanoengineering, received $143,609 in additional funding from the University of South Dakota (subaward from the United States Department of the Interior—National Parks Service—Great Plains Cooperative Ecosystems Studies Unit) for the project, “The Role of Sugar Chain Architecture in Fermentation of Sugarcane Lignocellulosic Biomass Slurries by Submerged Fermentation.”
Department of Energy) for the project, “Establishment of the SD Catalysis Group at USD and SDSM&T—Addressing Basic Research Needs for Solar Energy Utilization.”

Drs. PUSZYNSKI, AHRENKIEL, FONG, and SHENDE received $403,722 from the University of South Dakota for the project, “USD Catalysis Group for Alternative Energy.”

Dr. LANCE ROBERTS (photo), assistant professor, civil and environmental engineering, received $7,500 from the FORTA Corporation for the project, “Evaluation of Fiber Reinforced Asphalt Concrete Pavement.” Dr. ROBERTS also received $3,500 in additional funding from the FORTA Corporation for the project, “Laboratory Evaluation of Fiber Reinforced Asphalt Concrete Pavement—Continuation Proposal.”

Dr. WILLIAM ROGGENTHEN, project director, Deep Underground Science and Engineering Laboratory (DUSEL) and research scientist IV, DUSEL, received $15,621,297 from the University of California, Berkeley for the project, “Development of the Preliminary Design (subaward from the National Science Foundation) Underground Science and Engineering Laboratory (DUSEL) Site Selection and Technical Design Development.”

Dr. RAJESH SANI (photo), assistant professor, chemical and biological engineering; Dr. LEW CHRISTOPHER, director and associate professor, Center for Bioprocessing Research and Development; and Dr. DAVID DIXON, professor, Center for Bioenergy Research and Development and chemical and biological engineering, received $9,449.46 in additional funding from KL Energy Corporation (subaward from the U.S. Forest Service – South Dakota Department of Agriculture) for the project, “Development of a Thermostable Enzyme Cocktail for Rapid Release of Fermentable Sugars from Lignocellulosic Materials.”

Dr. SANI also received $156,333 in additional funding from Montana State University (subaward from the U.S. Department of Energy) for the project, “Biogeochemical Mechanisms of Nanocrystalline Uraninite Oxidation by Fe(III)-(hydr)oxides”; $82,463 from the South Dakota Board of Regents for the project, “Development of an Overexpressing Thermostable Cellulase Strain Using a Bacterium Isolated From the Homestake Gold Mine, Lead, South Dakota”; and $16,771 from South Dakota State University—Water Resource Institute for the project, “Protein-Based Mechanisms of Uranium Detoxification in Subsurface Bacteria.”

Dr. JAMES SEARS, director, Additive Manufacturing Laboratory, received $100,010 from the United States Department of Defense—Armanent Research, Development and Engineering Center (ARDEC) for the project, “Direct Printing Additive Manufacturing.” Dr. SEARS also received $99,111 from ARDEC for the project, “Laser Additive Manufacturing (LAM) For Powder Consolidation, Surface Modification and Low Volume Production.”

SALLY SHELTON (photo), collections manager, Museum of Geology, and instructor, geology and geological engineering, received $38,000 from the United States Department of Interior—Bureau of Reclamation—Cooperative Ecosystems Studies Unit for the project, “Management of Natural History Collections from Reclamation Lands.” SHELTON also received $14,700 from the National Park Service—Badlands National Park for the project, “Curatorial Backlog of Museum Specimens, Badlands National Park.”

Dr. STEVEN SMITH, associate professor and program director, nanoscience and nanoengineering, received $9,999 in additional funding from the United States Department of Energy—National Renewable Energy Laboratory for the project, “Development of Super-Resolution Optical Microscopy Techniques for Resolution Optical Microscopy Techniques for

Funded by an additional $157,650 subcontract from the Center for Rare Physics Processes with Ultra-Low Background Experiments at Sanford Lab/DUSEL, a team of School of Mines researchers will investigate materials used to create extremely precise detectors that can identify the source and nature of radiation from space or earth-based radioactivity.

Currently the team, led by co-principal investigators Dr. HAIPING HONG and Dr. STANLEY HOWARD, is developing a process for the production of ultra-high-purity germanium crystals, which will be used to create the detectors. They chose germanium because of its effective performance as a semiconductor, which releases a detectable energy pulse when a source of radiation strikes it. These pulses can then be measured to determine levels and source of the radiation. Constructing these materials on the earth’s surface, however, leaves them vulnerable to background radiation, which limits the components’ purity that greatly diminishes the detector’s operating characteristics. In response to this constraint, the crystals will eventually be produced and used at the 4,850 underground level of the DUSEL facility. The team will also focus on the electroforming of ultra-high-purity copper needed to assemble the detectors.

The demand for these detectors is growing in a range of fields, from nuclear medicine to homeland security and dark matter measurements. To meet this need, the researchers hope to transfer this technology to industry partners in South Dakota, fostering economic development and creating business opportunities within the state.
Visualization of Plant Cellular and Cellulose Enzyme Activity.”

Dr. JAMES STONE (photo), associate professor, civil and environmental engineering, received $33,033 in additional funding from the United States Department of Interior—National Park Service for the project, “Assessment of Atmospheric Mercury Deposition at Select Northern Great Plains National Parks.”

Dr. STONE also received $22,603 in additional funding from the South Dakota Department of Environmental and Natural Resources (subaward from the U.S. Environmental Protection Agency) for the project, “Statewide Mercury TMDL Assessment Project;” and $20,000 from South Dakota State University for the project, “Swine Facility Life Cycle Assessment Model Development.”

Dr. PALLAOOR SUNDARESHWAR (photo), associate professor, atmospheric sciences and the Institute of Atmospheric Sciences, received $114,075 in additional funding from the National Science Foundation for the project, “Collaborative Research: Exploration of the Mechanistic Basis and Biogeochemical Implications of Differential Nutrient Limitation Among Trophic Levels.”

SUNDARESHWAR also received $70,000 from the United States Department of Agriculture—Great Plains Cooperative Ecosystem Studies Unit for the project, “Phosphorous Speciation as an Indicator of Land Use and Conservation Practices on Wetland Condition.”

Dr. ANDREA SUROVEK (photo), associate professor, civil and environmental engineering, received $44,465 from the Steel Joist Institute for the project, “Development of an Improved Design Method for Joist Girder Moment Frames.”

Dr. CHARLES TOLLE (photo), associate professor, electrical and computer engineering, and Dr. JEFFREY MCGOUGH, associate professor, mathematics and computer science, received $90,000 from Idaho National Laboratory (subaward from U.S. Department of Energy) for the project, “SDSM&T SYS-ID Research.”

Dr. NURI UZUNLAR, director, Black Hills Natural Sciences Field Station, and associate professor, geology and geological engineering, received $22,323 from the National Science Foundation for the project, “Collaborative Research: Coupled Thermal-Hydrological-Mechanical-Chemical-Biological Experimental Facility at DUSEL Homestake.”

Dr. MICHAEL WEST (photo), assistant professor, materials and metallurgical engineering; Dr. ANTONETTE LOGAR, interim dean, graduate education, and professor, mathematics and computer science; received $33,268 in additional funding from the National Science Foundation for the project, “Friction Stir Processing Industry/University Cooperative Research Center.”

WEST also received $484,999 from the National Science Foundation for the project, “Collaborative Renewal Proposal: NSF Center for Friction Stir Processing I/UCRC,” and $35,000 in additional funding from the Friction Stir Processing University/Cooperative Research Center Memberships for the project, “Design, Analysis, and Performance of ‘Built-Up’ Aluminum Friction Stir Welded (FSW) and Friction Stir Spot Welded (FSSW) Structures.”

Dr. KEITH WHITES, professor and Steven P. Miller, chair, electrical and computer engineering, and ANTHONY AMERT, research scientist III, electrical and computer engineering, received $70,000 from BerrieHill Research Corporation (subaward from the U.S. Air Force) for the project, “An Integrated Computational/Measurement Technique for Accurate Electromagnetic Technique for Accurate Electromagnetic Characterization of Materials.”

Dr. WHITES, AMERT, and Dr. DIMITRIOS ANAGNOSTOU, assistant professor, electrical and computer engineering, received $12,000 in additional funding from the National Science Foundation for the project, “Multi-Scale Artificial Dielectric Materials and Their Applications.”

Dr. CHRISTIAN WIDENER, director, Arbegast Materials Processing and Joining Laboratory and Repair, Refurbish, and Return to Service Center, received $259,323 in additional funding from the South Dakota Board of Regents for the project, “Repair, Refurbish, and Return to Service—Applied Research Center (R3S-ARC).”

Dr. ROBB WINTER, department head and professor, chemical and biological engineering, and Center for Bioenergy Research and Development, received $50,000 from the Biocomposite I/UCRC Membership for the project, “Center for Bioenergy Research and Development/University Cooperative Research Center Memberships.”

Dr. ZHENGTAO ZHU, assistant professor, chemistry; Dr. HAO FONG, associate professor, chemistry; Dr. RAJESH SHENDE, assistant professor, chemical and biological engineering; and Dr. STEVE SMITH, associate professor and program director, nanoscience and nanoengineering, received $163,438 from the National Science Foundation for the project, “MRI-R2: Acquisition of a Thin-Film Deposition Glovebox System for Organic Electronics and Energy-related Nanoscience Research and Education.”

ZHU also received $40,000 from the Research Corporation for the project, “Probing the Interactions Between Conjugated Polymer and ZnO Nanostructure Through Nanostructure Surface Engineering.”

Dr. ZILIANG ZONG (photo), assistant professor, mathematics and computer science, and Dr. MANUEL PENALOZA, professor, mathematics and computer science, received $200,000 from the National Science Foundation for the project, “CSR: Small: Collaborative Research: FastStor: Data-Mining-Based Multilayer Prefetching for Hybrid Storage Systems.”
South Dakota School of Mines and Technology has been a national leader in preparing world-class engineers and scientists since 1885. Our graduates design, construct, and operate the most modern technology to meet complex challenges such as climate change, bioenergy, mineral extraction and processing, advanced materials, environmental quality, and national defense. Our alumni are held in the highest regard by their fellow leaders in industry, consulting, government, health, research, and education.

The School of Mines continuously adapts to meet the needs of engineering and science. Rugged individuals and pioneers in engineering and science founded the School of Mines’ intellectual environment 125 years ago. Our faculty, staff, students, and alumni carry on that tradition today.

The School of Mines is a state-supported university that provides graduate and undergraduate degrees in science and engineering. The School of Mines is an AQIP institution, accredited by the Higher Learning Commission and committed to continuous quality improvement. Undergraduate engineering programs are accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone: (410) 347-7700.

Mission, Vision, and Goal
The South Dakota School of Mines and Technology serves the people of South Dakota as their technological university. Its mission is to provide a well-rounded education that prepares students for leadership roles in engineering and science; to advance the state of knowledge and application of this knowledge through research and scholarship; and to benefit the state, regions, and nation through collaborative efforts in education and economic development.

The School of Mines is dedicated to being a leader in 21st century education that reflects a belief in the role of engineers and scientists as crucial to the advancement of society. Our vision is to be recognized as a premier technological university in the United States.

Most immediately, our goal is to be recognized as the university-of-choice for engineering and science within South Dakota and among our peer group of specialized engineering and science universities.

Strategic Focus Areas
1. Optimizing Enrollment
2. Securing Resources
3. Growing Graduate Education and the Research Enterprise
4. Continuously Improving Quality

2010-11 Enrollment:
2,354 students from 40 states and 27 countries

Costs and Fees:
A School of Mines education has never offered a better return on investment. 2010-11 annual undergraduate costs for tuition, fees, books, room, board, and supplies (including a TabletPC) total approximately $14,700 per year for South Dakota residents and $16,200 for non-residents.

Placement:
Starting salary offers to School of Mines graduates average approximately $56,000. Ninety-six percent of graduates find jobs in their career fields or continue on to graduate or professional programs within one year of graduation.

Research:
Researchers conduct high-tech research that benefits the state, region, and nation through advances in technology and economic development. In Fiscal Year 2010, researchers received more than $35 million in funding for 91 projects. Funding agencies included the Department of Defense, NASA, National Science Foundation, Department of Energy, State of South Dakota, and many more.

Faculty:
The School of Mines employs 142 full-time faculty members, more than 88 percent of whom hold doctorate or other appropriate terminal degrees. The student-to-faculty ratio is 13:1.

Honors and Awards:
One of America’s 100 Best College Buys® for 13 consecutive years
2008 and 2009 Carnegie South Dakota Professors of the Year
G.I. Jobs Military Friendly School
Bachelor of Science Degrees
Chemical Engineering
Chemistry
Civil Engineering
Computer Engineering
Computer Science
Electrical Engineering
Environmental Engineering
Geological Engineering
Geology
Industrial Engineering and Engineering Management
Interdisciplinary Sciences
- Atmospheric Sciences
- Pre-Professional Health Sciences
- Science, Technology, and Society
Mathematics (Applied and Computational)
Mechanical Engineering
Metallurgical Engineering
Mining Engineering
Physics

Master of Science Degrees
Atmospheric Sciences
Biomedical Engineering
Chemical Engineering
Civil Engineering
Construction Management
Electrical Engineering
Engineering Management
Geology and Geological Engineering
Materials Engineering and Science
Mechanical Engineering
Paleontology
Physics
Robotics and Intelligent Autonomous Systems

Doctor of Philosophy Degrees
Atmospheric and Environmental Sciences
Biomedical Engineering
Chemical and Biological Engineering
Geology and Geological Engineering
Materials Engineering and Science
Mechanical Engineering
Nanoscience and Nanoengineering
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