South Dakota State University

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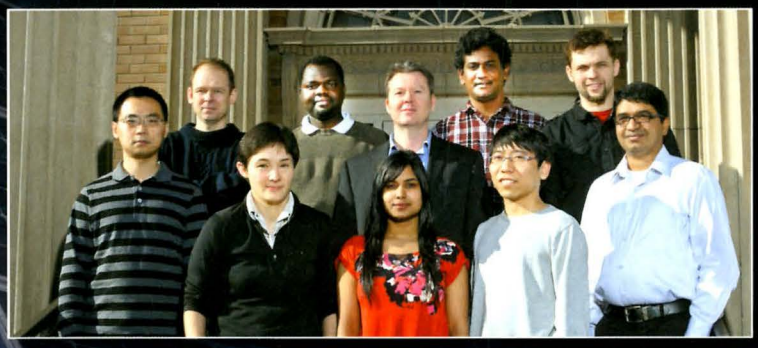
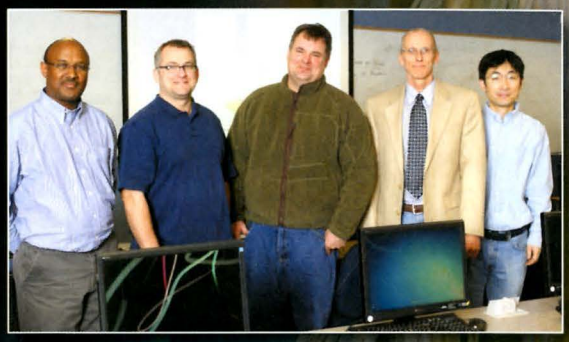
TEAM Science Research 2012





An important key to future success will be our ability to enhance **TEAM**-based science.

TEAM Science

At South Dakota State University, we know that research, discovery, and application are vital to the future of our state. Research has been at the core of our mission since 1887 when the South Dakota Agricultural Experiment Station was established. Since then our strengths have grown not only in agricultural sciences, but also in engineering, physical sciences, social sciences, health, and many more fields.

The commitment of our faculty, staff, and students has resulted in SDSU emerging as a regional research epicenter. Success leads to further success, and our national ranking among peer institutions, as well as our funding, has been increasing.

An important key to future success will be our ability to enhance team-based science. SDSU scientists have coalesced many robust teams that are working in areas such as wheat improvement, geographic information sciences, human and animal health, our transportation infrastructure, and renewable energy. We have built enhanced capabilities to support our teams, such as the Seed Technology Laboratory, METLAB, pyrolysis processing, the functional genomics core facility, and the Avera Health and Science Center.

Team-science usually entails collaborations beyond our own campus. At SDSU, we seek out effective relationships with scientists at other institutions in South Dakota, other states, and around the globe. We partner with scientists in industry and federal agencies. We seek to involve the very people that support us and whom we are here to serve, such as farmers, small business owners, and state leaders.

Research is a vital element to our economic success because it inspires people and their talents. Research creates jobs and opportunities that attract talented people. Research attracts investment and creation of wealth. Perhaps most importantly, research builds upon our knowledge base to support ever-higher education.

Kevin D. Kephart, Ph.D.
Vice President for Research

TEAMS

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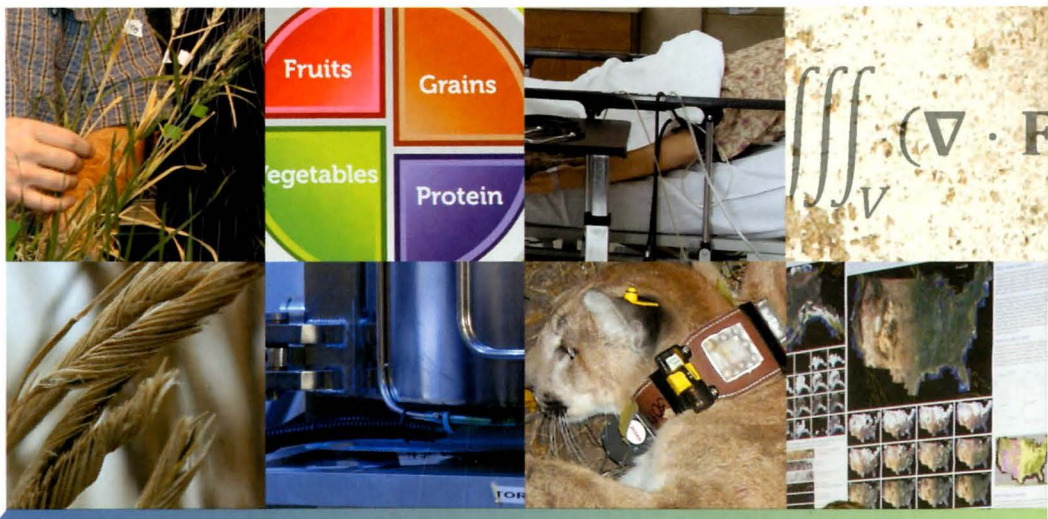


www.sdstate.edu/research/

Wheat

Wheat breeding program spurs economic development

State's wheat breeding program is at the heart of SDSU's engine for statewide economic development.

SDSU is one of only three institutions in the nation to have long-term breeding programs for both winter wheat and spring wheat.

Geographic conditions helped SDSU earn this distinction as South Dakota farmers generally plant winter wheat south of U.S. Highway 14 and spring wheat north of the highway.

While its location helped spur both breeding programs at SDSU, they have earned their success through a long history of collaboration, innovation, and professionalism.

That success is reflected in the new state-of-the-art Seed Technology Laboratory on the northwest corner of the Innovation Campus, a long string of breeding success stories, and a tradition of farmers and industry collaborators looking to SDSU first when they need help.

"There's not much we do as an island," says Associate Professor Karl Glover, head of the breeding program for spring wheat.

Both Glover and his winter wheat counterpart, Associate Professor Bill Berzonsky, credit the help they receive from molecular biologist Jose Gonzalez, other faculty colleagues, and a cadre of talented graduate students.

"We've been very fortunate from a student standpoint," Berzonsky says. "We've enjoyed the successful integration of research, training, and education of graduate students."

Industry partnerships are also a key factor. Bayer CropScience has signed a non-exclusive agreement for access to SDSU's spring wheat germplasm. SDSU and Bayer CropScience have also partnered with Ducks Unlimited to expand winter cereal acres in the Prairie Pothole Region to support modern agriculture and benefit waterfowl habitat.

Berzonsky notes the success of the Monsanto Graduate Fellowship in Plant Breeding that has given the program an international flavor with doctoral students from Brazil, Bangladesh, Mexico, Africa, and the United States.

"They're all working on wheat breeding and genetics," Berzonsky says. "It affords us the opportunity to do the research and at the same time train the graduate students. They get that hands-on type of experience."

That experience can be wide-ranging. In addition to working on new varieties of wheat seed, researchers also turn their attention to how the grain that grows from that seed is used.

Professor Padmanaban Krishnan, head of the food science program in the College of Education and Human Sciences, is collaborating on research to seek a better balance of grain protein and starch in tortillas.

"We're developing a protocol for continually evaluating our breeding lines for those kinds of traits and qualities," Berzonsky says.

Researching better wheat quality also means breeding plants that are resistant to diseases and insects. That task is made all the tougher by pests and diseases that may spring up quickly while the process for breeding one new line of seed may take from nine to eleven years.

TEAM

Associate Professors Karl Glover and Bill Berzonsky lead the wheat breeding programs at SDSU, one of the few institutions in the nation to have both spring wheat and winter wheat breeding programs.

"Breeding is such a long-term process," Berzonsky says. "You can't shift your breeding approach on a dime."

For Glover, the main disease concerns for spring wheat are Fusarium head blight and bacterial leaf streak.

Wheat stem sawfly is a concern in winter wheat, a pest that has SDSU researchers collaborating with their counterparts in North Dakota.

Berzonsky notes that there's national concern about head blight as well as the threat of stem rust making its way to the United States from Africa.

"Everybody in the United States is concerned about stem rust," Berzonsky says, adding that SDSU is part of a national initiative to fight the disease. As its part of the initiative, SDSU has shared germplasm with researchers for testing in Kenya.

Breeding wheat that's resistant to disease or insects means more than a greater yield for farmers. A scab resistant variety of wheat helps producers get a higher quality test weight, but it also helps millers and bakers.

"The fungus produces a toxin that millers and bakers absolutely lose money on in the production of flour," Berzonsky says.

New, better-yielding wheat varieties have a profound impact on the economy in South Dakota and the region. Glover notes two recent spring wheat releases that produced, on average, an increase of 0.72 bushels per acre. The increased income on roughly 1.5 million acres of spring wheat grown in South Dakota meant an additional $5.4 million for the state economy. Considering acres of these varieties grown in Minnesota and North Dakota, Glover estimates the overall economic impact at $10 million.

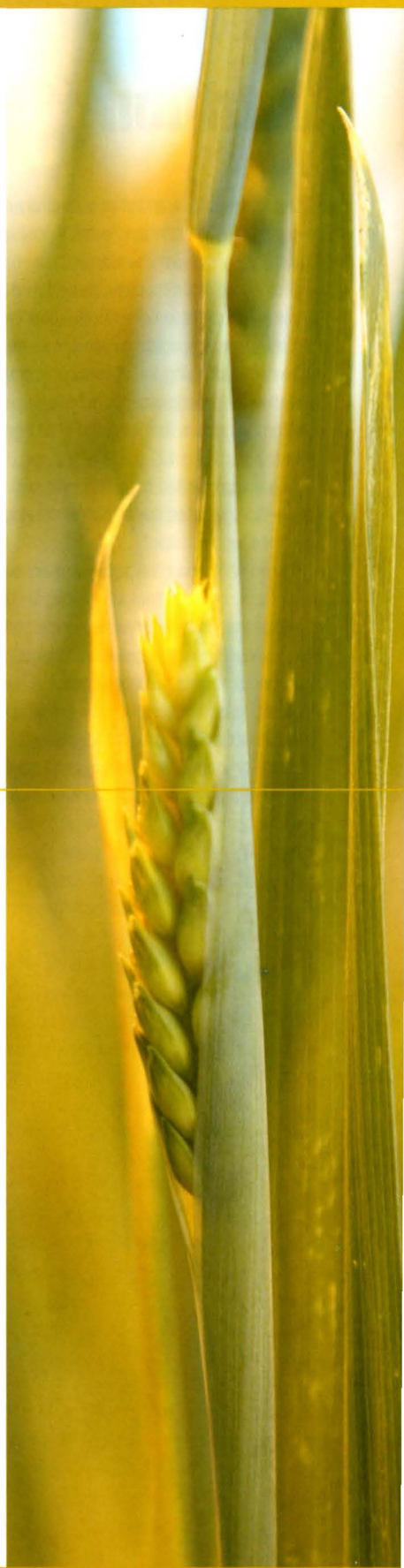
"It's generally the goal of plant breeding to make continuous improvements," Glover says.

Those improvements are also a revenue source for the University as it collects a royalty from the sale of wheat seed.

"A portion of those funds will come back to the University to help fund our research," Berzonsky says.

With so much to be gained from better wheat varieties, it's no wonder that the farming community plays close attention to what's going on at SDSU. Glover and Berzonsky welcome their collaboration.

"We've been very fortunate to have the support of the South Dakota Wheat Commission," Berzonsky says. "That's a reflection of the producers in the state. It's always gratifying to see the interest they have in our program."



Wheat breeders must think long-term

Ambrose Bierce called patience a mild form of discomfort disguised as a virtue. If that's true, wheat breeders must be really uncomfortable or extremely virtuous. Nothing happens fast in wheat breeding. SDSU's 2011 spring wheat release, "Advance," testing as SD4023, got its start in 2001.

"It took ten years for this one," says Professor Karl Glover, "and often it can take eleven to develop a new cultivar."

He explains that the experimental lines have to be tested in the program for four to five years to make sure their performance characteristics are both useful and consistent from year to year. Then it takes at least three years of field observation throughout the state to make sure the qualities are repeatable and predictable.

"You always want to be in a position to produce the next variety," says Associate Professor Bill Berzonsky. "I call it a pipeline. It's critical to keep that pipeline flowing."

Once breeder seed is developed, there's still a few miles left in the pipeline.

The culmination of seven or eight years of research may yield anywhere from a few pounds to ten bushels of breeder seed. That seed goes from the researcher to the South Dakota Foundation Seed Stocks Division on the SDSU campus.

A division of the South Dakota Crop Improvement Association, the mission of Foundation Seed is to significantly increase the amount of breeder seed. This is done through a labor-intensive process that includes closely monitoring fields and thoroughly cleaning all seed-handling machinery to ensure that the seed maintains its genetic purity.

"Seed expansion is what we do," says Jack Ingemansen, manager of Foundation Seed. "Varietal purity—that's the main reason we're here."

In two to three years, Foundation Seed may have 500 to 1,500 bushels of the breeder seed, depending on growing conditions. This seed is distributed to growers based on criteria set by the South Dakota Crop Improvement Association.

"We are the curators of those varieties when they're released," says Neal Foster, manager of the Crop Improvement Association, which has its offices in SDSU's Seed Technology Laboratory.

The seeds are planted in fields with verifiable crop histories so that the new variety isn't subject to carryover from a previous crop. The fields are physically inspected for noxious weeds and to make sure there's enough separation between fields.

After eight years of breeding and another two or three years of work in the field, a new line of wheat seed is finally ready for release.

"It's a long, meticulous process," Foster says. "I don't think the general public realizes the work that goes into it."

TEAM A wide-ranging team of scientists and stakeholders take part in wheat breeding at SDSU. Associate Professor Karl Glover leads the spring wheat breeding while Associate Professor Bill Berzonsky leads the winter wheat breeding. Other key personnel at SDSU are molecular biologist Jose Gonzalez and Professor Padmanaban Krishnan who heads the food science program, Foundation Seed Manager Jack Ingemansen, and South Dakota Crop Improvement Association Manager Neal Foster.

Nutrition

KidQuest research program seeks to curb childhood obesity

KidQuest, a nutrition and physical activity education program got its start when Becky Jensen couldn't find the kind of curriculum she wanted.

Trained as a clinical dietician and working as an Extension educator in Lake County, Jensen was starting her master's degree studies when she became interested in studying the efficacy of nutritional education for preadolescents. What she needed was a nutrition curriculum that targeted fifth- and sixth-graders ages 10 to 12.

"They represented a great opportunity for intervention," Jensen says. "Habits developed at that age of life tend to stick."

Those habits aren't typically good ones. There's usually a decrease in fruit, vegetable, and dairy intake with increases in higher calorie and fat foods. All the while youngsters are targeted by advertising that promotes questionable eating habits.

What Jensen developed later became KidQuest, a six-lesson, hands-on program designed to teach fifth- and sixth-graders about making good decisions about nutrition and physical activity. KidQuest also includes a research component studying ways to curb childhood obesity. SDSU researchers involved in KidQuest come from departments as diverse as Nutrition, Exercise Science, Nursing, Physical Education, and Early Childhood Education.

Students are evaluated before the program, at six months when the program is finished, and again at twelve months. At those points students have their height, weight, body fat percentage, waist circumference, blood pressure, lipid levels, iron status, vitamin A, and blood glucose checked. Currently in use in eight schools, researchers are still in the process of collecting data gathered through the KidQuest program.

Jensen, who currently serves as an Extension associate and grant coordinator at SDSU, credits Assistant Professor Teresa Kemmer with guiding the research project to greater success on a grander scale. Originally focused on rural schools, a new partnership with the University of Nebraska-Lincoln will add to the project's scope.

"They will evaluate the program with Hispanics as well as urban African-Americans," Kemmer says. "This is a South Dakota-grown program and now we are collaborating beyond our borders."

Jensen, who has raised children in the target age group, understands that in order to engage those students, the program has to be "cool." KidQuest upped its cool quotient by implementing a teens-as-teachers model.

"They like to hear more from high schoolers rather than people their mother's age," Jensen says. "The teens actually go in and provide the lessons."

Each lesson begins with a PowerPoint presentation followed by a hands-on activity. One lesson is Sugar Shocker in which students determine the amount of sugar in various drinks. They measure the amount of sugar and determine the number in sugar cubes which allows them to visualize the amount of sugar in various drinks and points them toward healthier decisions.

KidQuest also reaches beyond the classroom into students' homes. Each lesson includes a newsletter that's sent home with students so they can complete a challenge with their parents.

Extension, schools, families, and community stakeholders have all invested in KidQuest.

"Economically, if we reduce childhood obesity, it can increase output and reduce health-care costs," Kemmer says. "Tweens have decision-making power. We want to teach them to make healthier choices."

KidQuest also provides a wealth of opportunities for SDSU students. "We're incorporating SDSU graduate students into the research process for their thesis and dissertation requirements," Kemmer says. "We also have undergraduates involved as trained research assistants collecting data."

As a research component of the Transdisciplinary Childhood Obesity Prevention Graduate Education Program, the efficacy of KidQuest is being evaluated using a variety of teaching and assessment methods. A collaborative effort between SDSU and the University of Nebraska-Lincoln, it is supported by a five-year, $4.1 million National Research Initiative Grant from the Food and Agriculture Division of Nutrition.

Additional funding support for KidQuest has come from the U.S. Department of Agriculture, the S.D. Agricultural Experiment Station, and SDSU's Obesity Research Group supported by Senator Tim Johnson via an award from the Centers for Disease Control and Prevention.

Extension associate Becky Jensen and Assistant Professor Teresa Kemmer show off some of the hands-on items that are used to teach preadolescents about nutrition and physical activity in the KidQuest program.

TEAM

TEAM The SDSU team behind the ever-expanding KidQuest research on nutrition and physical activity for preadolescents includes Assistant Professor Teresa Kemmer, Extension Associate Becky Jensen, Assistant Professor Jessica Meendering, Food and Families Program Director Suzanne Stluka, Professor Kendra Kattelmann, and Associate Professor Howard Wey.

Health Sciences

Research seeks better self-management for diabetics

While SDSU and the University of South Dakota are traditionally rivals in athletics, that didn't keep the schools from forming a partnership to improve the quality of health care.

In 2007, the USD Sanford School of Medicine and School of Health Science joined forces with the SDSU College of Nursing and College of Pharmacy to form the Health Sciences Alliance. Since its formation, the alliance has put an emphasis on multidisciplinary training and research.

Pharmacy Dean Dennis Hedge credits SDSU President David Chicoine and USD President James Abbott with laying the groundwork for the alliance.

"They created a framework for regular communication between the health science programs," Hedge says.

With an emphasis on interprofessional training, the alliance has sponsored annual Research Day gatherings on topics as varied as emergency preparedness and patient safety and quality care.

According to Hedge, the goal is to inspire students to become "good health-care teammates" in both scholarship and research.

That approach was carried out in the alliance's flagship research project, bringing multiple health-care disciplines together in a study of how to best help diabetics control their disease.

The Interprofessional Student Diabetes Project included nursing and pharmacy students from SDSU and medical, dental hygiene, and nutrition students from the University of South Dakota.

"It's a student-led, interprofessional approach for caring for patients with Type 2 diabetes," Hedge says.

In the study, thirty-eight diabetics met once a month for six months with forty-eight students in the health-care professions to learn more about how to manage their disease. With a goal of caring for underserved populations, sessions were held at a low-income clinic and at a church with a focus on elderly parishioners.

Professors monitored the sessions, but students were in charge of collecting medical information from patients at the first and last session, making presentations about diabetes in a group setting, and meeting individually with patients who had questions related to their field of study.

"All specialties were there at the same time," says Cristina Lammers, an associate professor of nursing. "They were really working together, learning about other areas."

Bringing health-care students to one location regularly was convenient for the patients and proved to be useful training for the students.

"There's extensive research that says we need interprofessional training for our students," says Rebecca Randall, an assistant professor of nursing. "We need health-care professionals that work together. When they don't communicate, it contributes to health-care costs."

Lammers notes that teamwork among medical professionals is particularly important for diabetics who are susceptible to a variety of complications.

"They actually need a group of professionals taking care of them," Lammers says.

Communication was a key element in the study as patients learned about self-managing their diabetes through a mnemonic-based tool that used the first seven letters of the alphabet.

As an example, the letter A stood for "Advice" about quitting smoking, managing diet, and increasing exercise. The letter B was for "Blood pressure" and the letter C stood for "Cholesterol." SDSU nursing students offered advice that linked the letter E to care of the "Eyes" and the letter F to care of the "Feet."

"It looks like the alphabet strategy appears to improve outcomes in self-management for patients with diabetes," Randall says. "If clients with diabetes have the tools to manage their diabetes, they'll be healthier and live longer."

With 7.6 percent of South Dakota's population affected by diabetes, successful self-management techniques could make a significant impact on health-care costs.

"By controlling diabetes, we'll add years of productive life," Lammers says.

While data from the project is still being studied, there's no question about its usefulness as a way to bring multiple health-care professions together for community outreach.

"It hits every aspect of our mission as well as USD's," Hedge says.

Gathered in the College of Nursing Sim Lab are three researchers who have worked to develop a program that helps diabetics self-manage their disease. They are, from the left, Assistant Professor Rebecca Randall, Assistant Professor Olayinka Shiyanbola, and Associate Professor Christina Lammers.

TEAM

TEAM A research project on self-management for diabetics included researchers from two colleges. On the team from the College of Nursing were Associate Professor Christina Lammers and Assistant Professor Rebecca Randall. On the team from the College of Pharmacy were Dean Dennis Hedge, Professor James Clem, and Assistant Professor Olayinka Shiyanbola.

Mathematics and statistics

No crystal ball needed to see future of predictive analytics

Assistant Professor Tom Brandenburger and his students in the SDSU Mathematics and Statistics Department are working to accurately predict the future. Brandenburger is developing the institution's capabilities in his field of study: predictive analytics. He explains that predictive analytics uses statistical techniques to analyze data to make predictions about future events or people's behavior.

"It's not a designed experiment," Brandenburger says about research in predictive analytics. "You get what you get and you don't throw a fit."

Certainly no one at SDSU predicted the surge in the field that was precipitated by a call from Chad Noble of CAPITAL Card Services in Sioux Falls to Kurt Cogswell, head of the Mathematics and Statistics Department. As Brandenburger retells it, Noble, working in CAPITAL Card Services' risk department, told Cogswell he was giving up on being able to hire the kind of statistics researchers he needed.

Noble's frustration and Cogswell's determination led to a partnership with CAPITAL Card Services and Meta Payments establishing $100,000 fellowships for students seeking a Ph.D. in computational sciences and statistics.

The fellowships were structured in such a way that students would intern for a company, researching a statistical problem that the company needed to have solved.

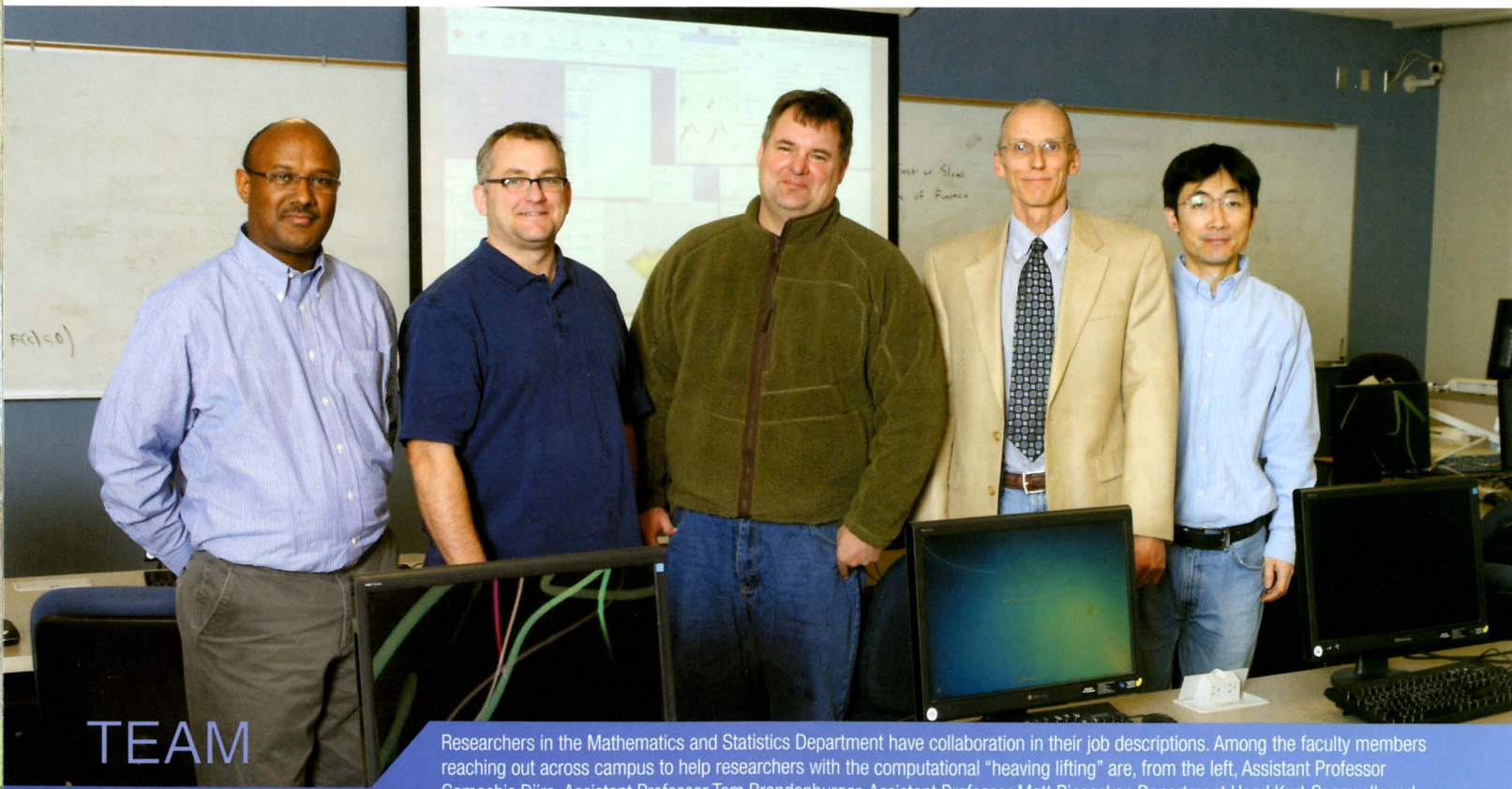
"They funded my Ph.D. studies," says Brandenburger, one of the first two fellowship students to graduate.

He went right to work for SDSU while the other student, Alfred Furth, went to work for CAPITAL Card Services. Brandenburger says Furth must have set some sort of record, going from intern to Vice President of Portfolio Analytics and Risk in just four years.

The model used for doctoral students—companies investing in the education of students who will serve as interns doing research—was adapted for master's degree students with investments in education at SDSU made by MetaBank, Wells Fargo EFS, CAPITAL Card Services, First Bank and Trust, and Dacotah Bank with other companies exploring the possibility of investing as well.

Brandenburger estimates that next fall he'll have seven master's degree students whose work will be fully funded by companies who need predictive analysis research.

"We try to do their research project in such a way that they get new knowledge and it works out well for them," Brandenburger says.



TEAM

Researchers in the Mathematics and Statistics Department have collaboration in their job descriptions. Among the faculty members reaching out across campus to help researchers with the computational "heaving lifting" are, from the left, Assistant Professor Gemechis Djira, Assistant Professor Tom Brandenburger, Assistant Professor Matt Biesecker, Department Head Kurt Cogswell, and Assistant Professor Xijin Ge.

Those research projects use predictive models that can ascertain customer risk, point out those who are likely to respond to marketing, predict churn or retention to see who is likely to close an account, and work with collections to see which customers are more likely to pay off their accounts.

According to Brandenburger, plans are in the works to expand the internship model to undergraduates. In the program, juniors would intern for a company and continue with that company through the completion of their master's degree. This would allow the young researchers more time to study the company's culture and get familiar with the challenges it faces.

Predictive analysis works with any large database of information. Brandenburger even aimed the analysis at his own department. Traditionally freshmen college students are tested for math placement. Brandenburger determined, through using data like high school class standing and ACT scores, that the same determination could be made by using a statistical analysis.

"What we found out is, we don't need the test," Brandenburger says.

When Brandenburger earned his Ph.D. at SDSU in 2009, he probably wouldn't have predicted his career path.

"I work almost exclusively with these private companies and the students I have working for them," Brandenburger says. "The probability market is hot. We have more demand than we have supply."

Collaboration built into mathematics, statistics workload

Research faculty members of the Mathematics and Statistics Department wear many hats.

They're professors.

They're researchers.

They're consultants and collaborators.

Research faculty in statistics, bioinformatics, computational science, and applied mathematics conduct their own research, but they also act as consultants/collaborators for researchers in other disciplines.

"You might say that they are part of the research infrastructure of the University," says Department Head Kurt Cogswell, "providing the advanced quantitative support the University research community needs in much the same way the campus IT group provides computing support."

To facilitate collaboration, research faculty members have campus consulting time built into their workloads.

"In some cases, we even schedule regular times when our faculty members will be on-site in other buildings ready to provide free, walk-in consulting to faculty and grad students who work in departments housed in those buildings," Cogswell says.

Some of those contacts have grown into full-blown partnerships. Currently mathematics and statistics researchers are collaborating with faculty from Plant Science, Nutrition, Economics, Electrical Engineering, and Education as well as off-campus partnerships with the University of South Dakota Physics Department and many regional financial institutions.

According to Cogswell, everyone involved in the collaboration benefits.

"Faculty researchers in other disciplines can focus on what they do best and leave the quantitative 'heavy lifting' to math/stat faculty," Cogswell says, "while our faculty and undergraduate and graduate students gain access to a rich source of regionally significant applied problems."

With collaborators across campus and throughout the region, mathematics and statistics faculty work on a diverse range of problems:

- Assistant Professor Tom Brandenburger advises graduate students who are working on research problems for regional financial institutions.
- Assistant Professor Gemechis Djira has advised graduate students in longitudinal data analysis and helped with statistical consulting in more than fifteen departments on campus.

"It is a highly interdisciplinary field," Djira says of statistics. "That is the main thing that connects us with all the departments."

- Assistant Professor Matt Biesecker is working with Associate Research Professor Venkateswara Bommisetty and Assistant Professor Mahdi Farrokh Baroughi of the Department of Electrical Engineering and Computer Science on simulating the movement of certain charged particles in the compressed environment of a photovoltaic device.

"How compressed the molecules are at a nanoscale level has an effect on power generation," Biesecker says. "The overall goal is to build a better, more efficient solar device."

- Assistant Professor Xijin Ge is working with a team of biology researchers to gain an understanding of unexplained forms of RNA, or ribonucleic acid. Ge's portion of the research uses a field of study called bioinformatics that he explains as where "biology meets informatics."

"Without teamwork," Ge says, "it's not possible for this kind of work."

Biofuels

Driving another biofuels boom

Bill Gibbons can look out his window and see where it all began. From his office he looks down on the small building where the ethanol industry was born in the United States. He should know.
He was there.

Since the late 1970s, Gibbons has seen the ethanol industry rise, sputter, and rise again. And now he's getting ready for the biofuels industry to go through another growth spurt.

"We'll see a surge just like we saw in the corn ethanol surge," Gibbons says.

The coming surge has turned the SDSU professor of industrial microbiology into a recruiter. He's visiting middle school students to get them interested in training for the kinds of engineering and scientific jobs that the coming biofuels boom will need.

"We'll see this jobs trajectory continue to grow," Gibbons says. "A recent study estimates that 3 million jobs will be created by 2020 to support the industry. For South Dakota students, it could mean the chance for a good-paying job that will keep them close to home."

As the assistant director of the Center for Bioprocessing Research and Development, one of the Governor's 2010 Centers of Excellence, Gibbons is again at the heart of a biofuels boom. Headquartered at the South Dakota School of Mines, the center's SDSU contingent includes a team of as many as twenty-five faculty from departments as diverse as Plant Science,

TEAM

A few of the members of the biofuels team at SDSU include, from the left, Associate Professor Heike Bucking, Assistant Professor Xingzhong Yan, Professor Gary Anderson, Assistant Professor ZhenGrong Gu, Professor Carter Johnson, Assistant Professor Lin Wei, Assistant Professor Susan Rupp, Professor Arvid Boe, Professor Bill Gibbons, and Professor Vance Owens.

Agricultural and Biosystems Engineering, Chemistry and Biochemistry, Biology and Microbiology, Mechanical Engineering, Natural Resource Management, Dairy Science, Animal Science, and Economics.

A cadre of doctoral students, master's degree students, and undergraduates supplement the work of the faculty members.

"We try to involve as many undergraduate students as we can," Gibbons says, "so they can experience the opportunities that lie ahead."

Their research centers on three areas of importance in biofuels. Ever aware of the food versus fuel debate, one area of research seeks a second generation of ethanol made from biomass or cellulosic material from grass, corn cobs and stover, trees, or waste.

According to Jim Doolittle, director of the North Central Sun Grant Regional Center, a key supporter of biofuels research, one aspect of the work at SDSU looks at crops like prairie cordgrass, cup plant, big blue stem, and clover as plants adapted to the north central region that will do as well or better than current annual crops.

In the Plant Science Department, Professor Arvid Boe, Associate Professor Jose Gonzalez, and Professor Vance Owens are spearheading work into the genetics, breeding, and agronomy of these plants while Associate Professor Heike Bucking of the Biology and Microbiology Department is exploring how soil fungi interact beneficially to help establish and maintain these perennial stands. Assistant Professor Susan Rupp and Professor Carter Johnson, in the Department of Natural Resource Management, are evaluating how production of these perennials can benefit wildlife and the ecosystem.

"They're researching species and systems that fit marginal land," Doolittle says. "They want the right crop on the right spot on the landscape that's good for the environment, good for the soil, and good for the producer."

Third generation biofuels will be strikingly similar or even identical to their petroleum counterparts. These fuels will be able to "drop in" to the transportation system to replace gasoline, diesel, or jet fuel in vehicles as well as be able to use the infrastructure of pipelines, distribution networks, and storage facilities used for petroleum products.

The third generation biofuel research concentrates on two processes. Thermochemical pyrolysis uses high temperatures and pressures to convert cellulosic biomass into hydrocarbon chains that resemble or are identical to gasoline, diesel, or jet fuel.

A diverse team, including researchers from Agricultural and Biosystems Engineering, Chemistry and Biochemistry, and Mechanical Engineering are evaluating various process options. Assistant Professor Lin Wei is leading efforts on catalytic pyrolysis, while Professor Alex Moutsoglou is working on fluidized bed pyrolysis. Assistant Professor Doug Raynie and Professor Kasi Muthukumarappan are performing process analysis and Assistant Professor ZhenGrong Gu and Professor Jim Julson are evaluating uses for biochar, a coproduct of the fuel production system.

"In essence," Gibbons says, "they are producing from biomass what we now get from petroleum."

Another area of research focuses on photosynthetic cyanobacteria which formerly were called blue-green algae. Associate Professor Ruanbao Zhou of the Biology and Microbiology Department is re-engineering cyanobacteria to convert sunlight, carbon dioxide, and water directly into hydrocarbon biofuels that would be excreted directly into the culture fluid. Professors Gary Anderson, Muthukumarappan, and Gu are developing photobioreactor systems that include phase separation units for the recovery of the drop-in fuels. Assistant Professor Xingzhong Yan of the Electrical Engineering Department is integrating a wavelength shifting technology that will increase photosynthetic efficiency.

Researchers have dubbed this system the "cyano factory" and envision that they could be installed next to existing ethanol plants to capture and convert the carbon dioxide that the plants produce.

The idea of cyano factories using the carbon dioxide emissions from ethanol plants is particularly gratifying for Gibbons who has watched the corn ethanol process grow more efficient over the years. Their progress reminds him of the old saying from the Morrell's hog packing plant: "We use everything but the squeal."

"Ethanol is here to stay," Gibbons says, "and the plants have evolved to use less energy and less water. It's likely that the next generation of biofuels will follow the same path and the progress our researchers are making is quite exciting."

TEAM Researchers from a variety of departments take part in the biofuels/biomass research at SDSU. They include Professor Bill Gibbons, Professor Arvid Boe, Associate Professor Jose Gonzalez, Professor Vance Owens, Associate Professor Heike Bucking, Assistant Professor Susan Rupp, Professor Carter Johnson, Assistant Professor Lin Wei, Professor Alex Moutsoglou, Assistant Professor Doug Raynie, Professor Kasi Muthukumarappan, Assistant Professor ZhenGrong Gu, Professor Jim Julson, Associate Professor Ruanbao Zhou, Professor Gary Anderson, and Assistant Professor Xingzhong Yan.

Photovoltaics

Team's quest: Cost-effective solar-powered technology

At the front of a classroom or working in the laboratory, Professor David Galipeau might not look it, but he's in a race. So is the team he leads in a quest to affordably harness solar energy.

Galipeau and his colleagues race against time to beat the projection that calls for a slow drop in the cost of producing solar cells while fossil fuels experience a slow rise in price.

"If we can get the technology developed sooner," Galipeau says, "we'll reduce our dependence on fossil fuels and our carbon footprint."

Galipeau coordinates the Center for Advanced Photovoltaics at SDSU. The center's goal is to provide cost-effective solutions for the nation's energy needs through the development of new photovoltaic devices.

To do that, a wide-ranging team has been formed

TEAM

More than fifty researchers take part in the study of photovoltaics at SDSU. Shown above is a representative group of faculty and graduate students in the new cleanroom of the Electrical Engineering and Computer Science Building. From the left are Professor David Galipeau, Assistant Professor Mahdi Farrokh Baroughi, Mahbube Siddiki, Assistant Professor Qiquan Qiao, Associate Professor Qi Hua Fan, Buddi Lamsal, Ishtiaq Maqsood, Associate Professor Venkat Bommisetty, Umesh Gautam, Rubana Priti, Braden Bills, and Jun Wang.

that brings together engineering and chemistry faculty determined to find low-cost methods for providing solar energy.

As the center's coordinator, Galipeau oversees a roster of research projects that is as diverse as it is encouraging. A sampling of their research includes:

- Professor Venkat Bommisetty is mapping the surface of photovoltaic materials in nanoscale resolution.
- Assistant Professor Mahdi Farrokh Baroughi is working on low-cost silicon technologies and hybrid model dye-sensitized solar cells.
- Associate Professor Qi Hua is researching low-cost high-throughput silicon.
- Assistant Professor Qiquan Qiao is working on polymer-based solar cells.

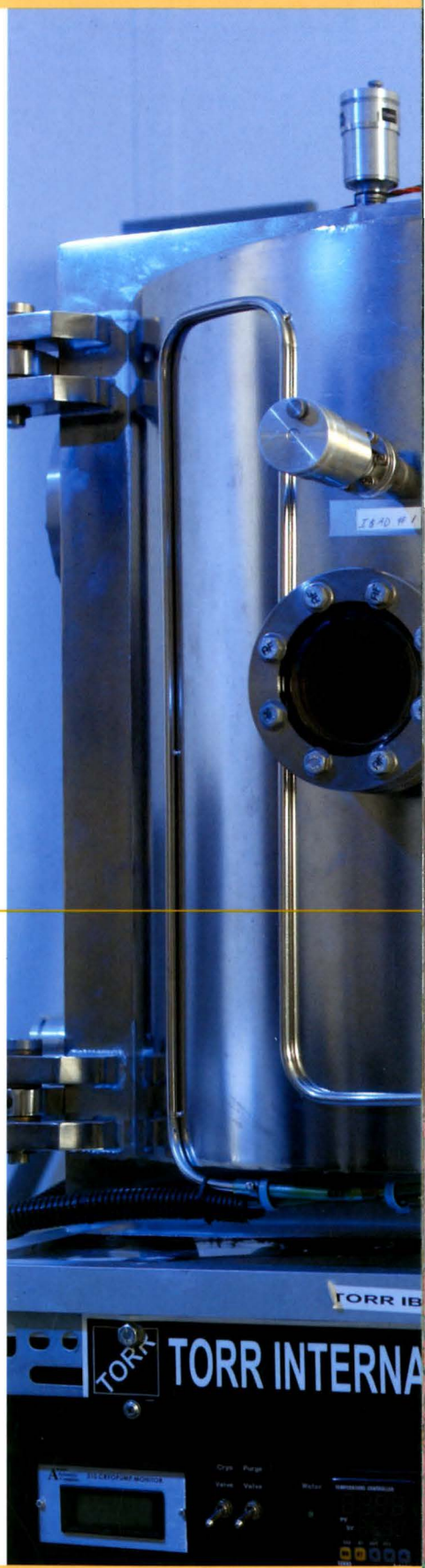
Four other faculty members—Assistant Professors Hongsan He and Xingzhong Yan of Engineering and Assistant Professors Brian Logue and Cheng Zhang of the Chemistry and Biochemistry Department—are researching ways to bring efficiency and staying power to solar cells made with less expensive organic materials.

Six postdoctoral students, nineteen doctoral students, seven research assistants, fourteen master's degree students, and five undergraduates supplement the work of faculty members.

Galipeau is also the director of the Alternative Power Technologies Laboratory, where the center's research can be applied in renewable energy alternatives like a smart grid technology that will one day reduce logistical issues for the military, allowing troops in remote locations to use solar power and avoid the risks inherent in being resupplied with fuel.

While the research is funded by the military, the smart grid technology could be used by anyone who needs power generation in a remote location.

According to Galipeau, both of the entities he leads have a similar objective: "The goal is to make photovoltaic devices more cost-effective so they can replace fossil fuels."



Renewable energy leads SDSU to solar research

Six years ago, the stars aligned just right to allow SDSU to become a leader in photovoltaic research—the study of solar cells.

"Concern over alternative energy was building," recalls Associate Dean for Research Dennis Helder, who at the time served as head of the Department of Electrical Engineering and Computer Sciences. "It was a major interest nationwide if not worldwide."

Choosing an alternative energy to study boiled down to a choice between wind energy and solar energy. Wind energy was already an established commodity in the Midwest.

"We thought solar could be more transformative," Helder says. "It was a conscious decision on our part."

It was also a decision that suited the department's strengths.

"We had the resources available," Helder says, noting that those resources included faculty expertise, laboratory space, and a cleanroom for microelectronics research.

Not only was the department suited for the work, but its geographic location in South Dakota meant that researchers would benefit from sunny conditions year-round and temperature extremes that would provide a useful test environment.

That initial interest in photovoltaics has grown into two entities that provide a multidisciplinary study of solar cells—the Center for Advanced Photovoltaics, which works to develop and commercialize new photovoltaic devices, and the Alternative Power Technologies Laboratory, which works on the application of photovoltaic power grids for use by the military and society.

Helder reckons that at any time during the year there are between thirty and forty full- and part-time researchers working on photovoltaics at SDSU.

TEAM

During his study of South Dakota's mountain lion population, SDSU Distinguished Professor Jonathan Jenks has led a long roster of graduate students, many of whom have gone on to leadership roles in state wildlife agencies. Above is doctoral student Josh Smith. In the lower right corner are two subadult males who were given GPS collars in the northern Black Hills. At right is Jenks and doctoral student Brian Jansen.

Mountian Lions

State agencies turn to Jenks when the topic is mountain lions

When SDSU Distinguished Professor Jonathan Jenks has a guest in his office, he gives the visitor his full attention. And that's not as easy as it sounds.

His cell phone rings.

The ping from his computer signals a fresh e-mail.

That whirring noise from his pocket is a new text message.

Wildlife professors might commune with nature in the field, but in his office Jenks is in constant electronic communication. As South Dakota's foremost authority on mountain lions, those messages could be coming from anywhere in the nation.

"Mountain lions don't realize that they cross state borders and international borders," Jenks says.

The lions' nature to be boundary-challenged means that Jenks could spend part of his day communicating with wildlife agencies in Oklahoma, Missouri, Montana, Wyoming, Saskatchewan, or even Connecticut.

Jenks and an ever-changing roster of graduate students have been studying mountain lions in the Black Hills since 1998.

"We started studying the population when it was low," Jenks says.

He recalls the uncertainty that he and Game, Fish, and Parks personnel felt when they first discussed putting electronic tracking collars on mountain lions. "We knew there were mountain lions in the Black Hills, but we weren't real sure if there was a sufficient population to have much luck putting out collars," Jenks says.

Then a graduate student collared twelve lions.

"That surprised us," recalls Jenks. To date, more than 300 tracking collars have been put on mountain lions in the Black Hills over the past thirteen years of mountain lion research.

Those first collars were the start of years of study in which Jenks and his students have worked to determine population size, track movements, study the effects of harvest, and monitor prey selection.

On this day it's prey selection that has kept Jenks in near constant communication. The Game, Fish, and Parks Commission, the civilian board that oversees the agency and sets hunting and fishing limits, is meeting in Rapid City where one of the topics is the mountain lion hunting season.

For two days Jenks has been on conference calls with Game, Fish, and Parks biologists as they deliberate on a harvest limit of lions that is supported by science yet will placate hunters who have seen a drop in the number of deer and elk in the Black Hills.

"Some people place full blame on mountain lions," says Jenks who knows that his population estimate of around 200 lions will be a key factor as Game, Fish, and Parks tries to balance the need to maintain a sustainable mountain lion population in the Black Hills with the need to bolster two big game populations that are highly sought by hunters from across the state.

Game, Fish, and Parks recommended a quota of sixty lions. The commission, perhaps responding to the elk and deer hunters who packed the meeting, set the quota at seventy lions.

Asked for his opinion of the quota, Jenks is polite but firm: "I conduct research here to help answer GFP's biological questions. GFP and the commission use the research and social information to make management decisions."

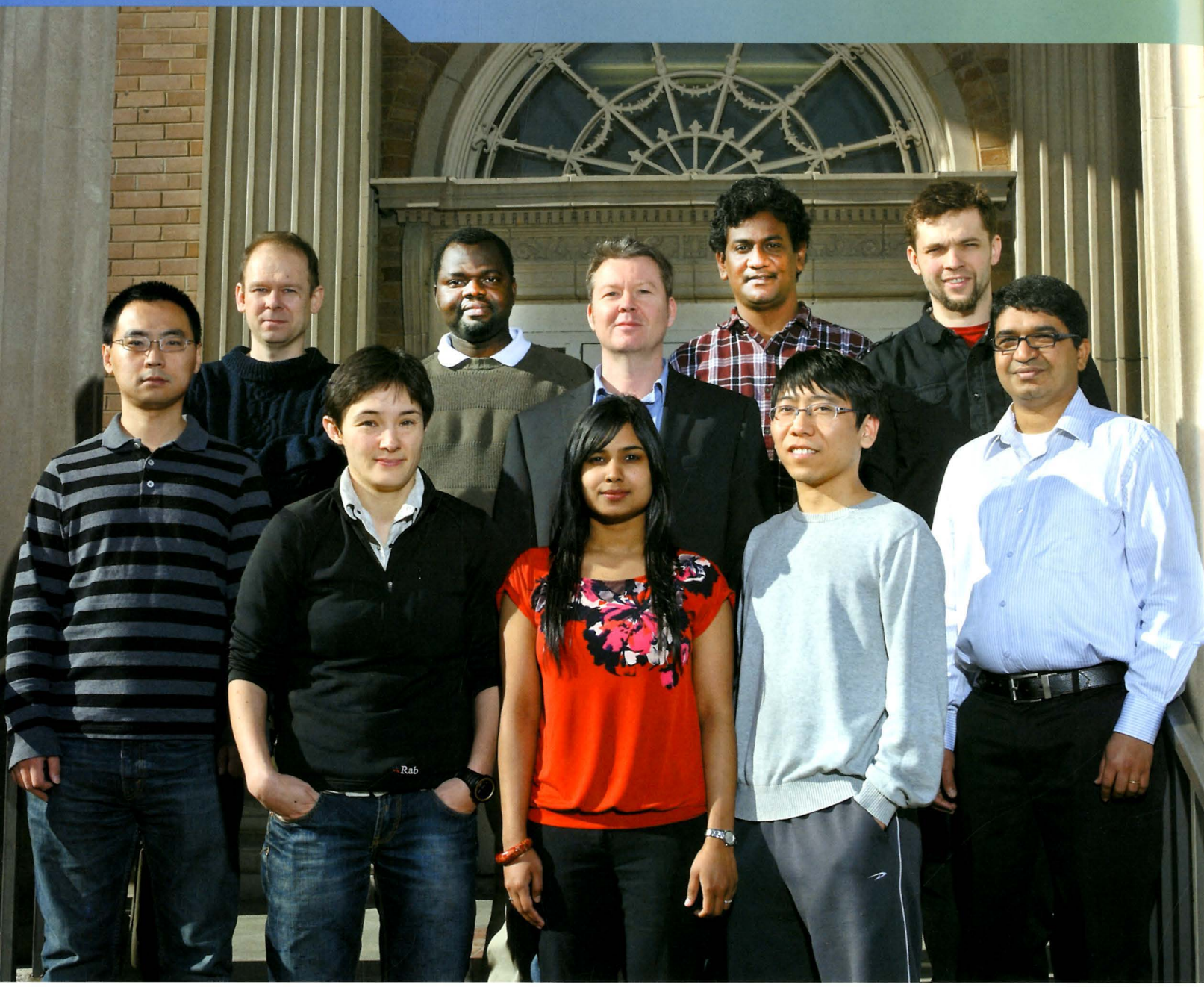
While he won't venture an opinion on their policy, that's about the only information that Jenks denies Game, Fish, and Parks.

"It's a very close relationship," Jenks says. "They have supported the research."

Now he's forming the same relationship with wildlife biologists in North Dakota, where a small population of mountain lions lives in its Badlands region.

The constant call for Jenks' services means plenty of work for his past and current crop of graduate students—four doctoral students and two seeking master's degrees. He notes that his close relationship with Game, Fish, and Parks is reflected in the work of his students.

"My students interact with Game, Fish, and Parks biologists on a daily basis, it's like they work for Game, Fish, and Parks and SDSU," Jenks says. "You almost don't even realize that there's any difference."



WELD

Project puts Landsat information just a click away

The next time you're struggling to fold up a road map so it fits neatly back in the glove compartment, think of the challenge faced by researchers at the Geographic Information Science Center of Excellence.

They have developed a system for storing and disseminating the information contained in ten years worth of Landsat images of the conterminous United States and Alaska. The information is readily available at no cost to anyone with an Internet connection.

Funded by a $3.3 million NASA grant, Web-enabled Landsat Data (WELD) is a collaborative effort of the United States Geological Survey Center for Earth Resources Observation and Science—commonly known in South Dakota as EROS—and SDSU's Geographic Information Science Center of Excellence.

"You can get a large amount of satellite data and analyze it quickly," explains Professor David Roy, principal investigator on the project. "The real power of it is when you use the data to examine surface changes through time."

Landsat information is available through WELD on an annual, seasonal, monthly, or weekly basis. Users can target areas as small as thirty meters for analysis. Directions about how to access the information about the area are sent to the user in an e-mail.

"They can use the data very quickly and with

TEAM

Members of the WELD team include, in the front row from the left, Emma White, Indrani Kommareddy, and Yuchu Qin. In the middle row from the left are Lin Yan, Principal Investigator David Roy, and Anil Kommareddy. In the back row from the left are Alexey Egorov, Sefa Adekpui, Sanath Kumar, and Valeriy Kovalskyy.

minimal additional processing," Roy says.

Available to the public since October 2010, the site has had more than 470 users from twenty countries. More than half the users are academics with a significant number of users represented by the general public and the federal government.

According to Roy, the data available through WELD is of interest to scientists studying land-surface change, managers interested in strategic fire management, government agencies charged with land management, policy-makers concerned about regional land assessment, agricultural producers, and the media.

Data that come from earth-orbiting satellites may remind some folks of Google Earth. Roy is a fan of the high-resolution images available from Google Earth, but cautions that it doesn't provide near the data available from WELD.

"It's static," Roy says of the images from Google Earth. "You don't see images through time and they can be from any time of the year. WELD allows you to zoom in and basically get a picture of the landscape, but through time."

Roy counts himself among the users of WELD. He uses the WELD system in a senior-level remote sensing class in which students order WELD data and track eleven locations along a line of longitude to examine when spring comes to that area as a means of studying Hopkins Law of Bioclimatics.

Roy also uses the WELD data in his own research on a NASA-funded project to determine field sizes.

"I think field sizes in the United States have gotten a lot larger," Roy says. "This data is very applicable to agriculture."

The next step for Roy and his colleagues will be developing a way to offer Landsat data on a larger scale.

"We're now working to expand this to go global," Roy says. "This takes teamwork to a national level."

A world's worth of data isn't easily processed. Roy is making arrangement for the use of a supercomputer at NASA's Ames Research Center at Moffett Field in California's Silicon Valley.

Sharp-eyed visitors to the WELD Web site at http://weld.cr.usgs.gov will notice SDSU's logo on the home page along with logos for the U.S. Geological Survey—the home of EROS—and NASA. According to Roy, EROS invests $200,000 a year to staff and maintain the Web site.

"All of this project is a partnership with EROS," Roy says.

Federal funds lead to invention at SDSU

Federal funding is a driving force in research. Taxpayers are getting plenty of "bang for the buck" at SDSU where those federal funds invested in research result in a high percentage of inventions.

Those were the findings in an article about highly performing research universities written by innovative tech transfer consultant Melba Kurman on the Innovation Excellence Web site. (www.innovationexcellence.com)

Kurman listed SDSU among twenty research universities comparing new inventions with federal funding. She noted that inventions are "a significant indicator of a university's commitment to, and skill in commercializing research."

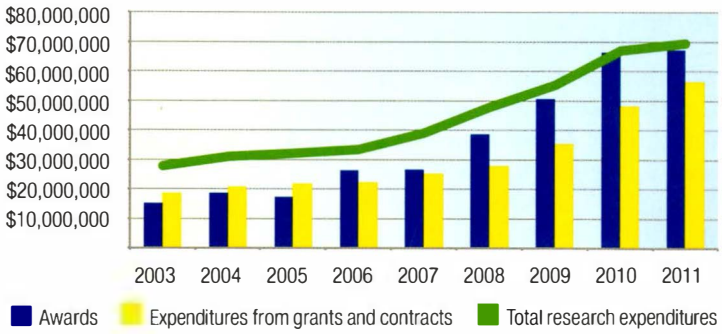
Starting just its fourth year of operation, the Technology Transfer Office at SDSU submitted sixty-three intellectual property disclosures in fiscal year 2011, up from forty-six in fiscal year 2010.

Kurman noted a trend of smaller schools optimizing federal funding for new inventions.

"If you count invention bang for the buck, these small schools are actually turning their research into reported inventions at a brisk rate, e.g. University of Akron, Michigan Tech, and South Dakota State."

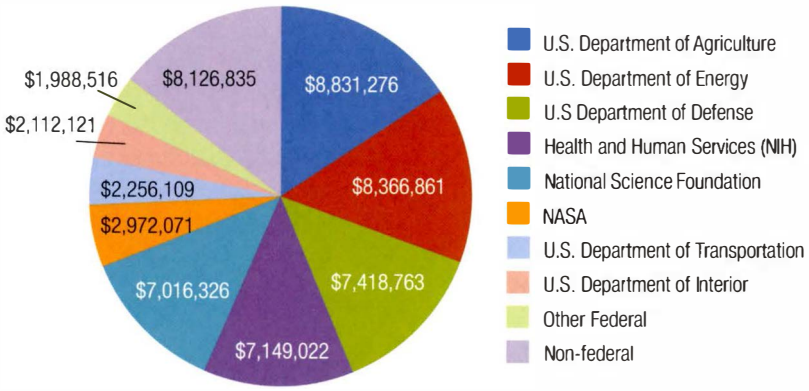
Total SDSU research expenditures, awards from grants and contracts, and expenditures from grants and contracts for fiscal years 2003 to 2011.

Awards from grants and contracts and expenditures are often used as indicators of research growth and competitiveness. Funds awarded in 2011 through grants and contracts have increased nearly fourfold since 2003. Expenditures resulting from these awards have increased by 205% since 2003. These measures indicate that SDSU has one of the fastest-growing research programs in the nation.



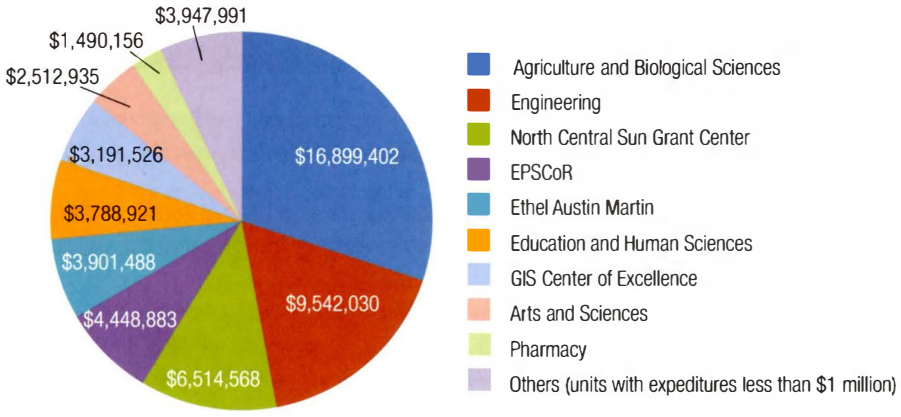
Fiscal year 2011 expenditures from grants and contracts, ranked by funding source.

The primary funding sources for SDSU grants and contracts are competitive federal programs.



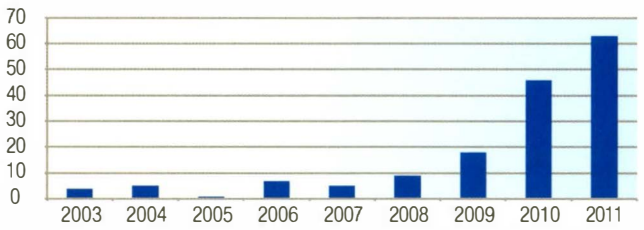
Fiscal year 2011 expenditures from grants and contracts ranked by SDSU colleges and units.

Four of SDSU's academic colleges each have expenditures that exceeded $2 million during 2011. SDSU also benefits from four multidisciplinary research centers, all of which have expenditures that exceeded $3 million in 2011.



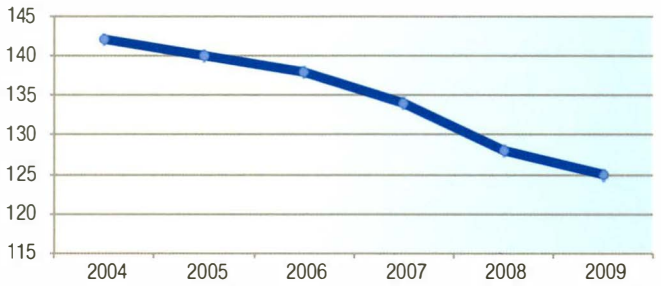
Disclosures from SDSU faculty and staff for inventions and other intellectual property during fiscal years 2003 to 2011.

Increased successes in research have resulted in new discoveries and innovations that have potential value in the marketplace. SDSU has taken steps to be a responsible steward of intellectual property derived from research and scholarship. Disclosures often result in new patent applications, newly established businesses, and copyrighted materials.



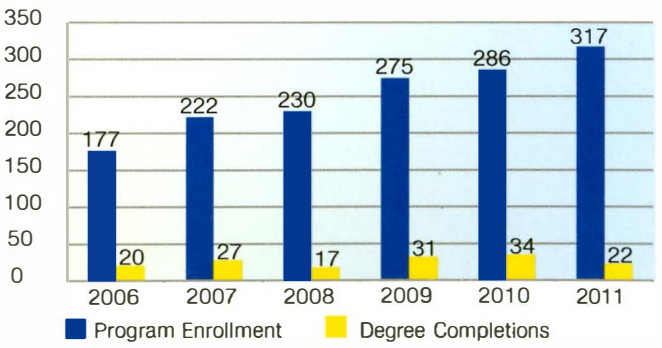
Ranking Among Public Institutions

SDSU's ranking among public institutions based on total research expenditures as determined annually by the National Science Foundation. Since 2004, SDSU's ranking has improved by seventeen places.



Annual enrollment and degree completions for Ph.D. programs at SDSU for academic years 2006 to 2011.

Graduate education and research create synergies and benefit the institution and regional economic development. Prior to 2006, SDSU had seven Ph.D. programs. Today, there are 12 programs. Enrollment in SDSU Ph.D. programs exceeded 300 for the first time in 2011. Students are attracted by SDSU's growing research capabilities.



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