

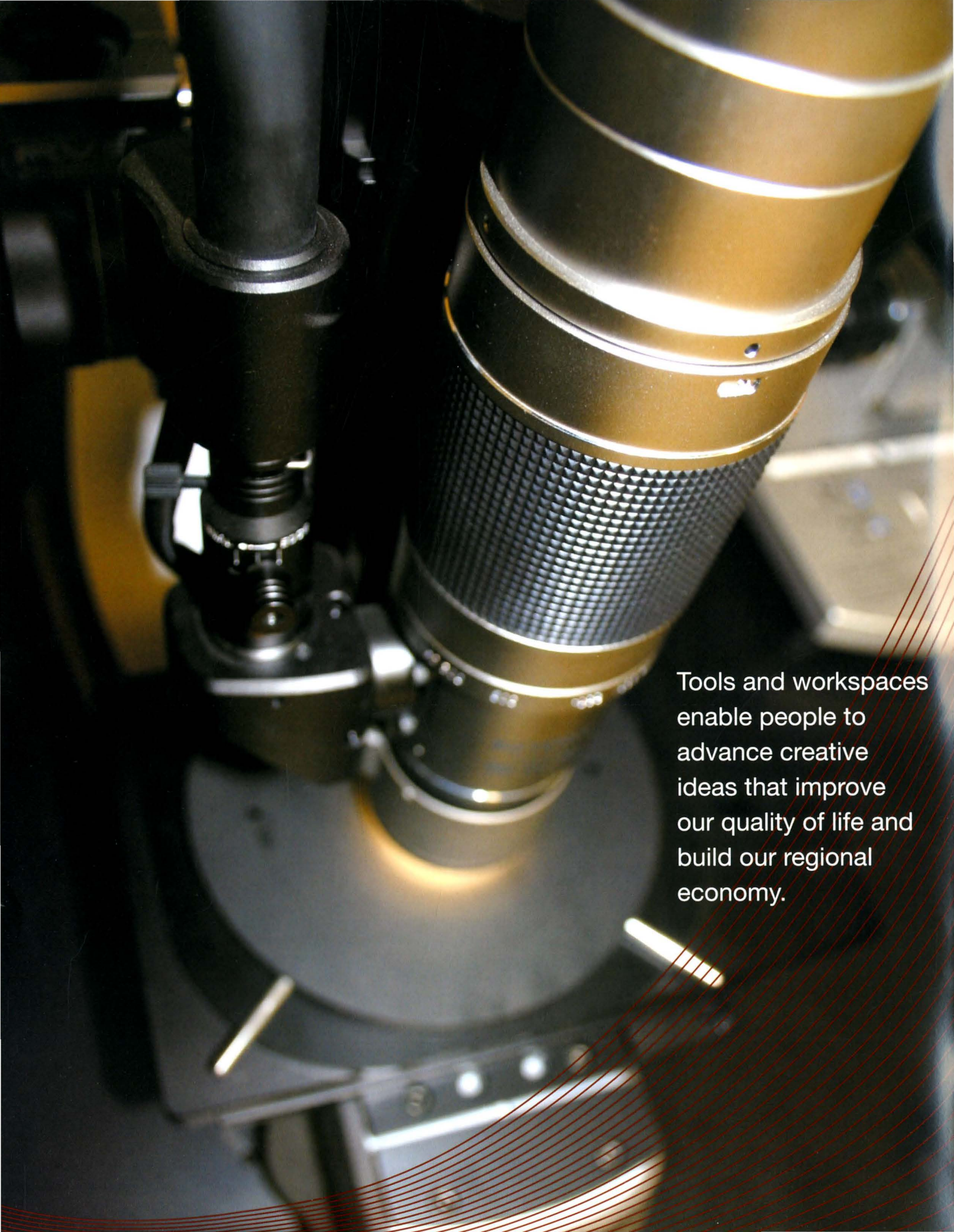


BUILDING SPACES TO GROW

New Ideas

South Dakota State University
Research 2011

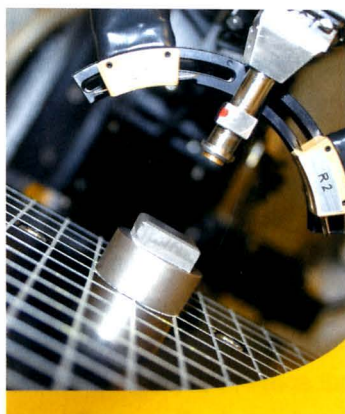




Tools and workspaces
enable people to
advance creative
ideas that improve
our quality of life and
build our regional
economy.



BUILDING SPACES TO GROW New Ideas Research 2010



The most important goal of South Dakota State University's land-grant mission is to provide students the best possible educational experiences and training. Their experience at SDSU will prepare them to respond to the opportunities they will face in their lives. Many of our students are bound to have careers in science and they will without doubt make this world a better place. Our mission at SDSU is to grow scientists, artists, technicians, and responsible citizens, yet we can't grow a scientist by putting a student in a laboratory anymore than we can grow a building by planting a brick. We can build a scientist in the very same way we build buildings, however, — by laying a good foundation, using quality materials, then relying on highly skilled people to see that the job is done right.

Here at SDSU, we're building the future in more ways than one — with steel and concrete, and also with human capital. The point we want to emphasize in our 2011 SDSU research report is that bricks and mortar matter. Part of the way we make scientists and empower them to make new discoveries is by having state-of-the-art facilities for teaching, learning, and research in the big issues that face us today and the foreseeable future. Tools and workspaces enable people to develop new ideas that make life better and help build our regional economy.

It takes people of vision to understand that. We are fortunate to have that kind of vision here in the Upper Midwest, where our rural communities, our state and federal lawmakers, and SDSU students themselves have helped fund the facilities where truly amazing scholarship is taking place. Inside these laboratories and classrooms, zealous young scientists, engineers, and seasoned researchers are grappling with issues in such fields as agriculture, renewable energy, and health sciences.

We're not only constructing buildings at SDSU. We're enabling greatness.

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



Feeding the world

The new \$6.5 million Seed Technology Laboratory adds state-of-the-art facilities to help scientists such as spring wheat breeder Karl Glover (above) and winter wheat breeder Bill Berzonsky provide the best possible wheat varieties for area farmers. Small grains plant pathologist Jeff Stein will use the greenhouse space and a biocontainment facility in such tasks as making plant inoculations to evaluate resistance to diseases.

Plant geneticist Jose Gonzalez will use the new facility's labs to discover genes involved in traits such as high yield or resistance to diseases and insects. That work focuses not only on cereal grains, but also on crops such as soybeans and even biomass crops such as prairie cordgrass that can be processed into biofuels.

The facility also enables researchers to carry out some of the work in connection with SDSU's 2010 Research Initiative Center of Excellence for Drought Tolerance Biotechnology.

The bottom line? Greater profits for farmers who plant SDSU crop varieties. One major new initiative involves developing winter wheat germplasm specifically for the





Building agricultural systems to feed the world

Prairie Pothole Region because of its habitat benefits for nesting waterfowl.

Wheat breeders will now be only a few steps away from the cereal chemistry laboratory and food scientist Padmanaban Krishnan (above). His laboratory helps plant breeders determine which wheat lines have desirable end-use qualities for milling or baking.

Krishnan's research also looks at new uses for SDSU wheat varieties and dried distillers grains in products such as Asian flatbread. The payoff for the commodity groups that help fund the facility will be a wider market for South Dakota farm products such as wheat, corn, soybeans, and oilseeds. Major donors were the South Dakota Corn Utilization Council, South Dakota Wheat Commission, South Dakota Oilseeds Council, South Dakota Soybean Research and Promotion Council, South Dakota Crop Improvement Association, and the Foundation Seed Stock Division.

For plant geneticist Jose Gonzalez, the science he pursues in SDSU's Seed Technology

Laboratory is a little bit like trying to unravel a road map within a plant such as prairie cordgrass or wheat. By mapping which sequences of genetic material are responsible for certain traits, he can provide knowledge that scientists and plant breeders can use to more easily package those desired traits in plants through plant breeding. One of his current research interests is finding out which genetic sequences are responsible for the expression of cellulose, hemicellulose, and lignin in prairie cordgrass — all components that can be processed to make cellulosic biofuels. Gonzalez uses the same techniques to improve wheat.





A light on new possibilities

In the glistening new laboratory space of the Avera Health and Science Center, the new home to SDSU's College of Pharmacy and the Department of Chemistry and Biochemistry, Distinguished Professor Chandradhar Dwivedi (above) carries on some of the same research he's pursued for years — using flaxseed in the diet to reduce the size and incidence of colon tumors. He and his colleagues are exploring new pharmaceuticals for treating skin cancer. Researcher Shafiqur Rahman (above right, with graduate student Ravi Sajja) explores drugs to treat alcohol and nicotine addiction.

The College of Pharmacy also houses the Translational Cancer Research Center, funded as a 2010 Research Initiative Center by the state of South Dakota. The College of Pharmacy has won research grants from the National Institutes of Health and Department of Defense. SDSU pharmaceutical scientists are patenting new technology for drug delivery. This work has led to formation of PNST LLC, a Brookings based startup company.

Such work could have taken place in any properly equipped laboratory, but having a new building with 97,000 square feet of new space for laboratories, classrooms, and offices dedicated to their work will make it all the easier for scientists to carry out research in the health sciences. A lead private investment of \$15 million from Avera Health covered





Building a healthier population through new technologies

a significant portion of project costs for the \$52 million facility, while the South Dakota Board of Regents approved \$24 million from the Higher Education Facilities Fund.

The price tag for the project includes a renovation that has completely transformed the 48,600-square-foot Shepard Hall, next door. That is where some researchers in SDSU's Department of Chemistry and Biochemistry continue their work in areas such as investigating chemical compounds in traditional Native American herbal remedies or building a better understanding of how carbon is stored in the soil, or what the air trapped in ice cores from Antarctica and Greenland can reveal about changes in the atmosphere and climate over past centuries. An important part of SDSU chemists' work explores the use of light to study and control chemical and biochemical processes through SDSU's 2010 Research Initiative Center for Biological Control and Analysis by Applied Photonics, or BCAAP. Other work by chemists and biochemists in the department is focused on developing new materials that can be used to create low-cost solar cells and finding chemical markers in real time that indicate whether soldiers in a battlefield situation have been exposed to chemical warfare agents so prompt treatment can begin.



SDSU assistant professor Adam Hoppe (above) in SDSU's Department of Chemistry and Biochemistry has won a National Science Foundation career award of \$785,000 to help him continue his work building a high-tech microscope to offer unprecedented resolution for observing the biochemical machinery at work in living cells. In this technique, molecules such as proteins are tagged with a molecule that emits light. Once inside a cell, the microscope can follow its transformation by the biochemical reactions that cells use to digest molecules for food and energy. Hoppe is enlarging the instrument he's already designed and built to enhance its ability to resolve interactions of individual molecules in living cells.



Designing new tools

SDSU expertise is at work every time Google Earth® is used. Since 1988, engineers, physicists and SDSU students under the leadership of professor Dennis Helder (above left) have worked with U.S. Geological Survey EROS (Earth Resources Observation and Science) and with the National Aeronautics and Space Administration on the important work of calibrating satellite images.

Thanks to alumni and friends who paid for all of the building and structural costs, that work is now taking place in the \$7.5 million east wing of the new Electrical Engineering and Computer Science Building. Work began in fall 2010 on a \$4.5 million west wing paid for almost entirely by SDSU alumnus Jerry Lohr.

Helder, the associate dean for research in SDSU's College of Engineering, said the new facility also holds offices, classrooms, and laboratories to carry out an important project exploring alternative power technologies to help the U.S. military become less dependent on fossil fuels. Meanwhile, SDSU is continuing its effort to develop improved photovoltaic devices that convert light directly into electricity. SDSU scientists are working to make existing silicon-based photovoltaics more efficient, they're developing



Harvesting energy and understanding the world

new inexpensive carbon-based materials, and they're at work on hybrid solar cells that combine different technologies.

Meanwhile, assistant professor Venkateswara Bommisetty (above) is building a first-of-its-kind microscope that can help scientists fine-tune such photovoltaic devices. The light-activated probe can simultaneously measure factors that might be limiting efficiency in a wide variety of solar cells. One version of the microscope will be available to SDSU scientists in SDSU's new state-of-the-art Class 1000 cleanroom — designed to allow no more than 1,000 particles per cubic foot of air — in the basement of the new facility.

The cleanroom will also house a new plasma enhanced chemical vapor deposition system, which is very useful for synthesizing electronic materials for a variety of applications. More than a dozen research projects — some cooperative projects involving colleagues at the University of South Dakota and South Dakota School of Mines and Technology — will use the equipment.

Assistant professor Qiquan Qiao (right) in SDSU's Center for Advanced Photovoltaics

has been awarded a grant of \$400,000 — \$80,000 over each of the next five years — to build new high-performance organic solar cells with increased efficiency. The prestigious National Science Foundation CAREER award will help Qiao pursue his work with organic photovoltaics, or solar cells, assembled from carbon-based polymers instead of traditional solar cells that rely on inorganic materials such as silicon. Qiao wants to develop new long-lifetime excited state polymers. That means that the electrons excited by sunlight would remain in that state longer. That gives the photovoltaic device made from such materials a longer window of time to harvest the excited electrons.

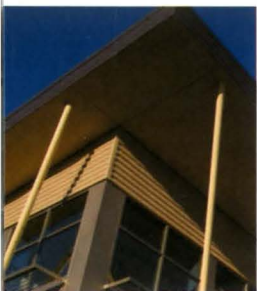




Wellness science

A few paces away from SDSU's new student-funded Wellness Center, SDSU researchers focus on wellness from the viewpoint of the scientist, not the student or athlete. It's an important and ongoing line of research at SDSU. Work in recent years by Matt Vukovich, (opposite page, center) the head of SDSU's Department of Health and Nutritional Sciences, has examined how a higher-than-normal protein diet helped build healthy bones among college-aged men and women who were involved in strength and conditioning training. SDSU undertook the study with funding from the U.S. Department of Defense, specifically to look at factors in bone health for college-aged men and women, since young people in that age group make up the bulk of new recruits to the armed services. Vukovich has also been looking at the effects of dietary protein on energy metabolism.

Yet another study is exploring beef as a vehicle to supply needed iron for female athletes. Iron is important for athletes because it is part of hemoglobin, and hemoglobin is the molecule that carries oxygen in the blood. The SDSU study showed iron deficiency





Building healthy bones through nutritional science

was more common in high-impact sports such as running, volleyball, and soccer. Vukovich said that's partly due to a phenomenon called foot-strike hemolysis: every time the foot hits the ground, red blood cells rupture, leaving the hemoglobin in those cells incapable of carrying oxygen. But it may also be due partly to inadequate intakes of dietary iron, of which the best source is red meat or beef.

SDSU's Health and Nutritional Sciences researcher Moul Dey is also looking at food extracts with possible health benefits; Elizabeth Droke is examining bioactive food components in soybeans that may help offset some of the medical problems of chronic inflammation and obesity; Padmanaban Krishnan is looking at ways to use distillers grains from corn-based ethanol plants as a food ingredient in human diets.



A prestigious Pathway to Independence award for promising young scientists is helping an SDSU scientist examine a food extract with far-reaching health implications. That National Institutes of Health grant of nearly \$900,000 over five years was awarded to Moul Dey (above) for work she began as a researcher at Rutgers University and is continuing at SDSU. After screening nearly 3,000 plant extracts for potential anti-inflammatory activity, Dey pursued further work on a plant-derived compound called Phenethyl isothiocyanate, or PEITC, with potential anti-inflammatory activities. Dey's latest work in mice shows that the extract alleviates signs of ulcerative colitis, an inflammatory bowel condition. Dey moves on now to examine the potential use of the plant extract against colon cancer.

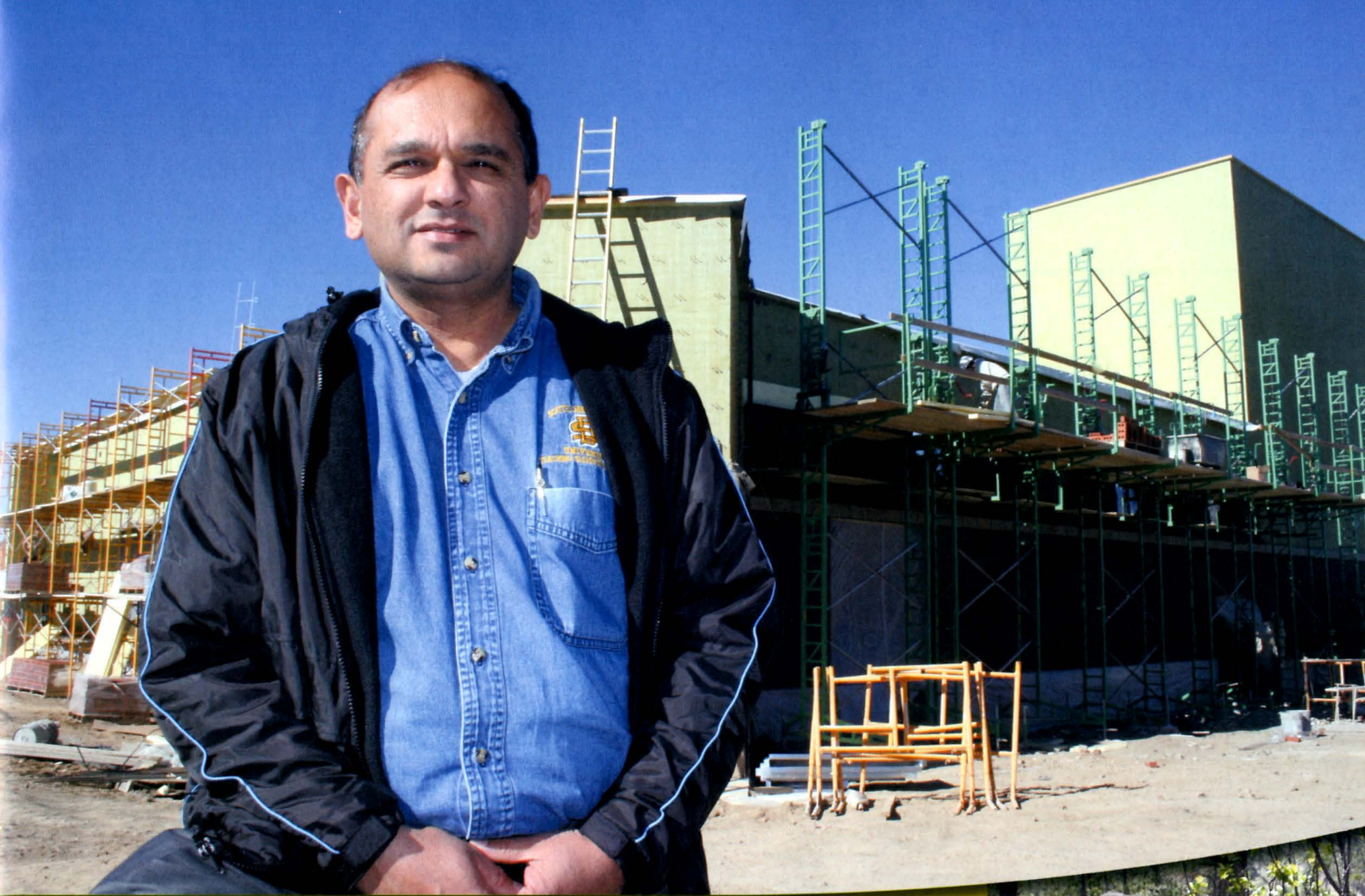


Renovating a science resource

For research entomologist Paul Johnson, (above) renovations in Ag Hall mean more accessible space for SDSU's Severin-McDaniel Insect Research Collection. That will enable students, faculty, and visiting researchers to make better use of a valuable science resource. The renovation project similarly provides new quarters for the soils and geology collections, in the Plant Science Department. These collections represent years of field work by SDSU scientists and student researchers. Ag Hall's third floor has been renovated to house individual research labs and the Soil and Plant Tissue Testing Laboratory. Scientists will perform routine tests for farmers and study issues such as carbon sequestration and use of biochar in soils. The Ag Hall remodeling and a sweeping renovation in the Dairy-Microbiology Building next door together will cost about \$10.8 million, funded by state funds and student dollars.

Elsewhere in the College of Agriculture and Biological Sciences, a Functional Genomics Core Facility will enable researchers to study the way an organism's genes interact. And veterinary science researchers have won a major contract to evaluate U.S. veterinary diagnostic laboratories' efforts to keep disease-causing microbes and toxins safely inside the labs. Part of the project includes funds for making physical





Building better spaces for day-to-day science in agriculture

improvements at SDSU's Animal Disease Research and Diagnostic Laboratory that could serve as a model for similar laboratories elsewhere.

Private industry is funding most of the costs for a dairy processing plant, (above) addition and remodeling project that adds 10,000 square feet for teaching and research. Although South Dakota's Higher Education Facilities Fund pays for about \$1 million of the \$9.5 million project, the rest comes from industry — dairy producers, processors, dairy industry suppliers, alumni, and friends. SDSU is a reliable source of well-trained graduates who understand the industry from the dairy farm to the finished products.

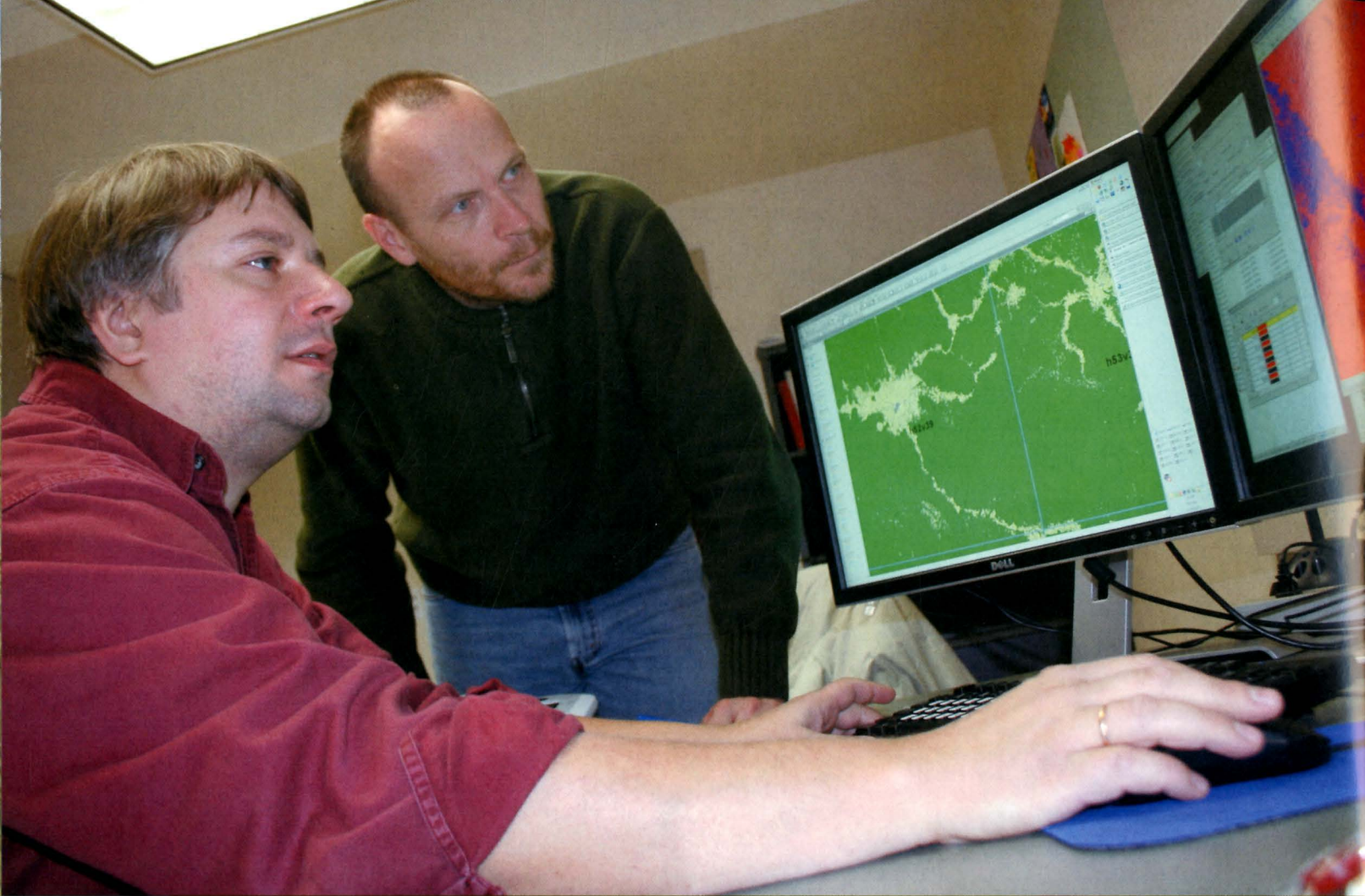
The upgrade to the 50-year-old plant gives scientists up-to-date equipment so that research can be handed easily from the lab to the marketplace.

The benefits from bricks and mortar? Graduates who are virtually assured of jobs in industry and improved facilities for cutting-edge research designing new cheeses or exploring questions such as the potential of some milk products to lower the risk of developing colon tumors.



The making of a young scientist at SDSU is also helping South Dakota learn far more about some of its native insects. SDSU

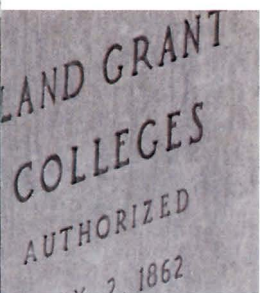
graduate student David Drons (above) is carrying out the fieldwork for the first major inventory of the native bees in the Black Hills, working with SDSU research entomologist Paul Johnson. Biologists know that at least 100 species of bees are found in the region. But there's a possibility that perhaps 80 or more additional species could be found there. A grant of nearly \$50,000 from the South Dakota Department of Game, Fish and Parks is funding part of the cost of the three-year study. It's a project of the Severin-McDaniel Insect Research Collection at SDSU through its Dakota Biodiversity Program. Drons is working toward his master's degree at SDSU.



Connect world possibilities

SDSU research takes place beyond the Brookings campus. University chemists are drilling ice cores in Antarctica, researchers for the Geographic Information Science Center of Excellence are tracking forest loss in places such as the Congo and the Amazon Basin, entomologists are gathering insects new to science in Central America.

Those are among the places SDSU scientists are engaged around the globe on the important issues confronting human health, agriculture, energy, transportation, and the environment. In South Dakota, SDSU scientists use research farms and range experiment stations around the state to carry out crop, range, and livestock research. They also work with cooperating producers to study value-added, selenium-rich wheat, use “vegetated treatment systems” to convert feedlot nutrients to grass, and monitor the way carbon is stored in the soil. Through the Mountain Plains Consortium, engineers investigate road, bridge and construction technologies that can help engineers who work in similar conditions, especially in the member states of South Dakota, North Dakota, Colorado, Wyoming, Utah, and Montana.





Charting new frontiers across the globe, from agriculture to zoology

Meanwhile, SDSU helps nations around the world understand their resources and environment. Professor Matt Hansen (opposite page, right) and postdoctoral researcher Peter Potapov (opposite page, left) of the Geographic Information Science Center of Excellence use satellite imagery to track forest disturbance worldwide. The GIS Center's Mark Cochrane studies forest disturbance and biodiversity in the Amazon Basin. And he's currently beginning a study for NASA that will look at how climate change may affect fire events in North America, South America, and Australia.

SDSU faculty not only study the way things are now, they help to chart the future. Professors W. Carter Johnson, Arvid Boe, and Thomas Schumacher helped found EcoSun Prairie Farms near Colman, a South Dakota nonprofit corporation, to demonstrate the potential economic and ecological benefits of establishing grass-based farms on converted cropland. Ultimately, studies at the EcoSun site (above) will include analyses by SDSU economists on how profitable such alternatives might be when compared to conventional farming.

Julie DeJong's (right) work toward her Ph.D. in SDSU's Department of Wildlife and Fisheries not only

involves quite a bit of travel, but something like time travel as well. By visiting important natural history museums on either coast and in several points in between, DeJong is able to measure duck eggs collected by other researchers up to 150 years ago. Her goal is to determine whether the dimensions of wild duck eggs measured in current studies differ from the dimensions of those eggs of long ago. Thanks to the diligence of scientists of another age, duck eggs could be one way to assess whether trends such as climate change may be limiting the nutrients available to waterfowl in some areas, perhaps resulting in smaller eggs for some species. It is work that could help people better understand the natural world.





Transfer research

SDSU isn't just building state-of-the-art facilities. It is also building a process to transfer University research to the marketplace so that discoveries in fields such as health sciences, engineering, or agriculture can make life better for people. Denichiro Otsuga, (opposite page, far right) hired as the University's first technology transfer director in 2008, compares setting up a technology transfer process to building a road that's meant to carry ideas to the marketplace.

For example, much of associate professor Omathanu Perumal's (above, right) pharmacy research at SDSU has focused on new drug delivery methods. One project explored a coproduct of ethanol production, a biodegradable corn protein called zein that is already approved by the U.S. Food and Drug Administration as safe for humans. Perumal successfully encapsulated medications in tiny nanoparticles about 500 times smaller than the diameter of a human hair. Such particles pass by tightly packed, healthy tissues, but they are small enough to penetrate fast-growing, loosely organized cancerous tissues, where the drugs are released — something scientists call passive targeting.





Discoveries leading to better lives

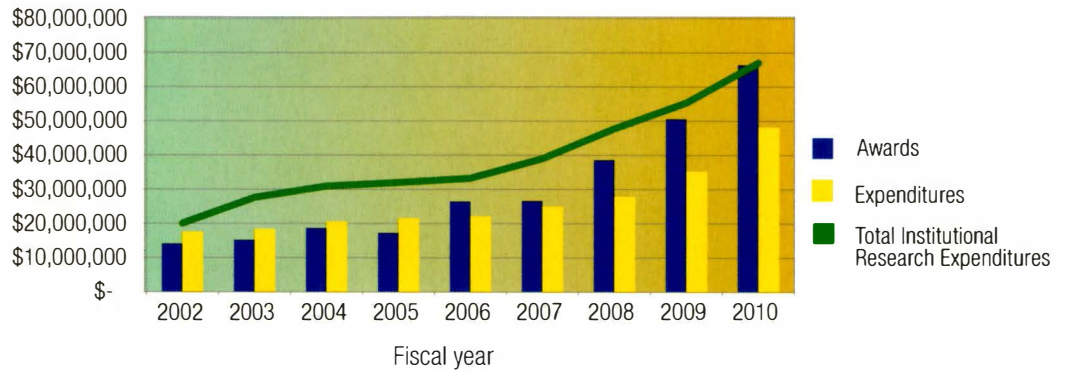
Otsuga's office is pursuing patents on the technology on behalf of Perumal and SDSU. With the help of South Dakota Innovation Partners LLC, a seed stage venture capital firm, Perumal and his colleagues have also formed a start-up company in Brookings.

Otsuga said at SDSU, the technology transfer process starts with the vision implicit in the land-grant model — that education and research are to be used to help improve the quality of life for the people. The technology transfer office simply makes the process more organized and efficient. Investors and entrepreneurs play a key role by providing funding for additional technology development. The pay-off will be in new jobs developing new products in South Dakota. More jobs and increasing company sales, in turn, will mean more dollars flowing through the local and regional economy. That generates more tax revenues to pay for government services such as higher education and research.

Dr. Denichiro Otsuga, director of SDSU's Technology Transfer Office, works behind the scenes to help get good ideas out of the laboratory and into the marketplace. The number of invention disclosures or discoveries reported at SDSU has gone from nine in 2008, the year before Otsuga's arrival, to 18 in 2009 and 46 in 2010, Otsuga's second year on the job. That level of activity is well above the national average of about 25 invention disclosures or discoveries for the other institutions with the same level of research activity as SDSU.

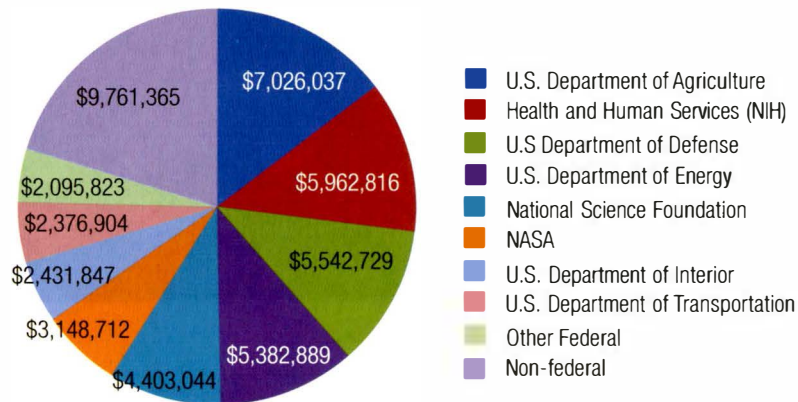


Total SDSU research expenditures, awards from grants and contracts, and expenditures from grants and contracts for fiscal years 2002 to 2010.



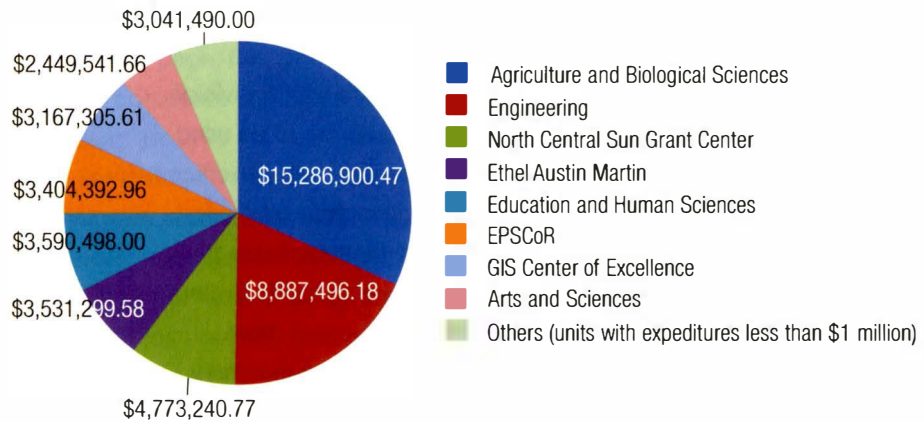
Awards from grants and contracts and expenditures are often used as indicators of research growth and competitiveness. Funds awarded in 2010 through grants and contracts have increased nearly fourfold (e.g. 368%) since 2002. Expenditures resulting from these awards have increased by 173% since 2002. These measures indicate that SDSU has one of the fastest growing research programs in the nation.

Fiscal year 2010 expenditures from grants and contracts, ranked by funding source.



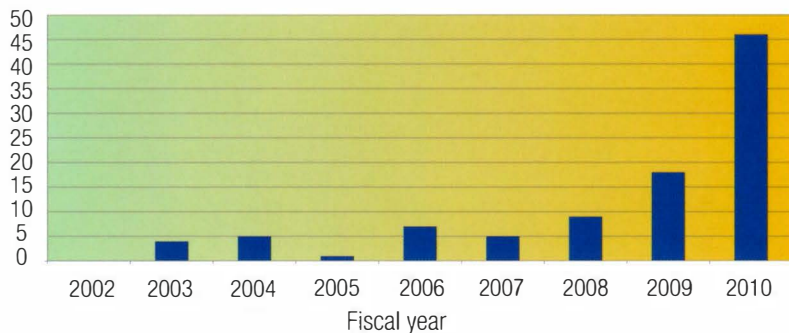
The primary funding sources for SDSU grants and contracts are competitive federal programs.

Fiscal year 2010 expenditures from grants and contracts ranked by SDSU colleges and units.



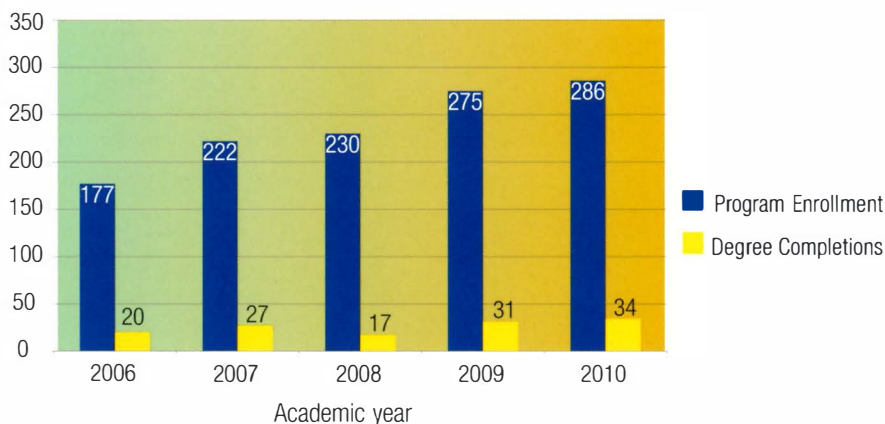
Four of SDSU's academic colleges each have expenditures that exceeded \$2 million during 2010. SDSU also benefits from four multidisciplinary research centers, all of which have expenditures that exceeded \$3 million in 2010.

Disclosures from SDSU faculty and staff for inventions and other intellectual property during fiscal years 2002 to 2010.



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.

Annual enrollment and degree completions for Ph.D. programs at SDSU for academic years 2006 to 2010.



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 has increased 62% since 2006. Students are attracted by SDSU's growing research capabilities.

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