VOLUME 1 | EDITION 1| APRIL 2012 | BIZWEST MEDIA

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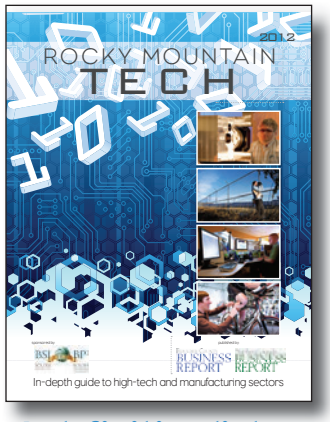


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# [ IN THIS ISSUE ]






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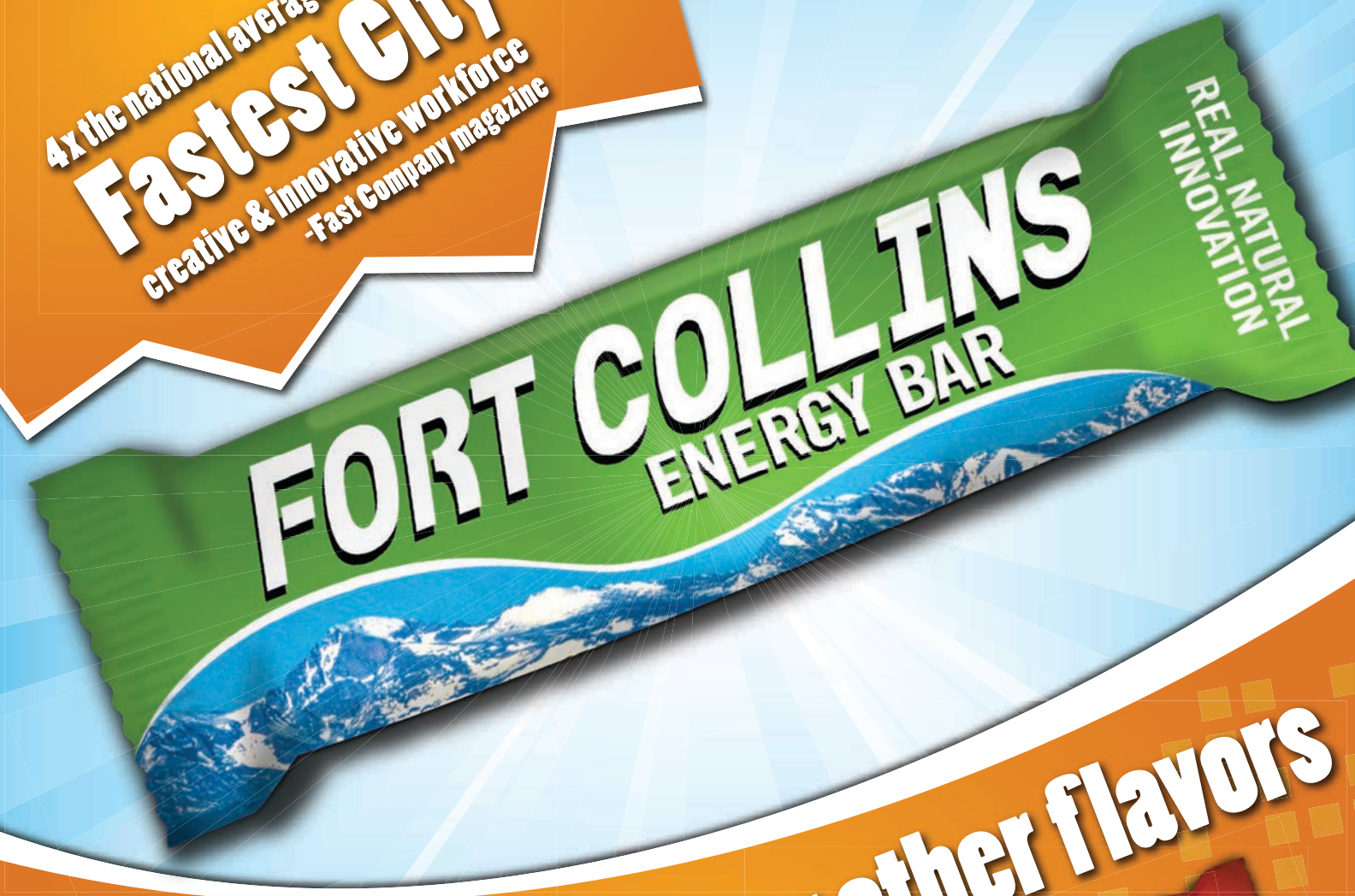
creative & innovative workforce
-Fast Company magazine




## Innovation Facts

Population size: 145,000

| Delicious blend of: | %Daily Value |
|---|---|
| **Entrepreneurial Culture** | 100% |
| **Educated Workforce** | 100% |
| **High Quality of Life** | 100% |

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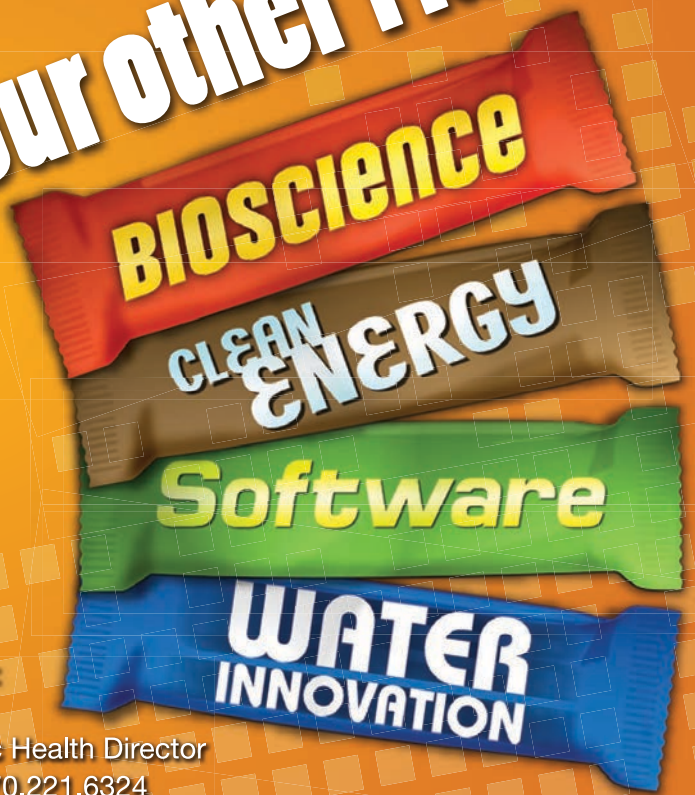


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For more information:
**City of Fort Collins**
Josh Birks, Economic Health Director
*jbirks@fcgov.com* 970.221.6324

# [ IN THIS ISSUE ]





# Colorado's true economic engine

CHRISTOPHER WOOD

JEFF NUTTALL

Few would think of a laboratory when contemplating what fosters economic growth in Colorado. Construction, tourism, manufacturing, retail, energy, real estate, government and other sectors more easily come to mind.

While those industries do constitute important parts of Colorado's economic mosaic, they don't reflect another important fact: Research drives the Colorado economy. From Colorado State University in Fort Collins to the University of Colorado in Boulder, from CU's Anschutz Medical Campus to the Colorado School of Mines, researchers are making discoveries, creating new products and advancing science.

Along the way, researchers at these universities and their colleagues at federal laboratories in Boulder, Jefferson and Larimer counties help pump billions of dollars into the Colorado economy and spur jobs in the private sector, whether at local high-tech companies or in other industries.

Here are some staggering numbers:

- CSU alone expends more than $330 million in research dollars annually.
- CU-Boulder secured $359.1 million in sponsored research.
- CU's Anschutz Medical Campus brought in $400.1 million.

Bioscience, clean technologies, environmental engineering, aerospace and atmospheric sciences are just examples of the major industry sectors that benefit from Colorado's research universities and federal laboratories.

Local universities and laboratories contribute to the state's economy through direct employment and purchases, but also by providing a foundation for key industries: research generates jobs and investment, with spinoff companies, contract research, and patent work. Many high-tech companies locate along the Front Range specifically because of the presence of our universities and laboratories.

Identifying the scope of the academic research community's impact on the Colorado economy is a monumental task, and one that we've embraced with this new annual publication, Research Colorado. Our company, BizWest Media LLC, publishes several regional business publications, including the Boulder County Business Report and the Northern Colorado Business Report, as well as numerous magazines and industry directories.

As we surveyed the economies of the Boulder Valley, Northern Colorado and the entire state, we have been amazed at the innovation and economic development that can be traced to our research universities and federal laboratories.

With that in mind, we are pleased to present this newest addition to our publishing library, produced in cooperation with Colorado State University, the University of Colorado Boulder and the University of Colorado Anschutz Medical Campus. These three institutions are largely responsible for much of what we take for granted in Colorado: quality high-tech jobs and a culture of innovation and entrepreneurship.

Research Colorado features articles highlighting the economic impact of the universities and federal laboratories, key areas of scientific excellence and profiles of new initiatives and researchers.

In addition, each of our sponsoring universities is featured in eight-page sections highlighting key areas of strength at their particular institutions.

This publication is being distributed through the sponsoring universities, economic-development agencies along the Front Range, through direct mail and as inserts in our two Colorado business publications.

In addition, visit www.researchcolorado.org for all of the content, with new features added throughout the year.

We're grateful for the help and support of officials at CSU, CU-Boulder and the CU Anschutz Medical Campus. We also welcome your ideas for our next edition.

---

*Christopher Wood is publisher of the Boulder County Business Report. Jeff Nuttall is publisher of the Northern Colorado Business Report. Both are managers of BizWest Media LLC. They can be reached at cwood@bcbr.com and jnuttall@ncbr.com, respectively.*

[ ON THE COVER ] **PhD student David Kupka works with a Ti:Saphire Oscillator at Colorado State University's Engineering Research Center.** COLORADO STATE UNIVERSITY

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**Paula Aven Gladych** is a veteran journalist with 21 years of newspaper, broadcast and Internet news experience. As a freelancer, she covers energy, judicial and retirement news. Prior to that, she served as corporate Web editor for Lehman Communications Corporation's newspapers in Loveland and Longmont and covered the education beat for the *Longmont Times-Call*. She spent 11 years covering energy issues for *Financial Times Energy* and *The Denver Business Journal*.

**Lisa Marshall** has been writing about health and medical science for nearly two decades. Her work has appeared in an array of regional and national publications, including *Natural Health*, *Runner's World*, *Delicious Living*, the *Denver Post*, *Colorado Biz*, and *CU Medicine Today*. When she's not writing, she raises chickens and trains for marathons. She lives in Estes Park, Colorado with her husband and two daughters. Connect at www.lisaannmarshall.com.

**Debra Melani** has worked in the journalism field in her native Colorado for more than 20 years. After graduating from the University of Colorado Boulder School of Journalism, she found her niche at the *Boulder Daily Camera* as a health and fitness editor. She ended her non-freelance career as a health writer for the *Rocky Mountain News* in Denver and has done a wide range of freelance work for a number of newspapers and magazines since. She now lives in Lyons with her husband and two sons.

**Paula Moore** is a Denver freelance writer, and veteran business journalist. She was a staff reporter at the *Denver Business Journal* for 17 years, covering mostly real estate but also finance, retail, sports business and Native American business. Moore was also a staff reporter at a DBJ sister paper, the *San Antonio Business Journal* in Texas. She started her journalism career as a copy editor at Southwest Airlines' inflight magazine.

**Tracee Sioux**, is a freelance writer, author of Love Distortion: Belle Battered Codependent and Other Love Stories, publisher of The Girl Revolution and owner of TGR Body, an organic skincare line. Tracee and her company were featured in *New York Times Magazine* in March 2012.

# 2012 Business Report Events

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Midtown Arts Center

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**Net Zero Cities 2012**

June 28, 2012
Hilton Hotel – Fort Collins
All day event

In partnership with the City of Fort Collins, OneTribe Creative and CSU Ventures, a subsidiary corporation of CSURF, NCBR is producing NetZero Cities 2012. The focus of NZC 2012 is the promise of and the path to sustainability for people, communities and corporations. Sponsored by: Kennedy and Coe; Better Business Bureau; Poudre Valley REA; Palmer Flowers; DaVinci Sign Systems; KUNC Community Radio, and Social Media Pilots.

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A breakfast celebration honoring the contributions of exceptional women in Northern Colorado. Nominations are open. Call 970-232-3132. Sponsored by: Poudre Valley Health System; The Women's Clinic of Northern Colorado; Eye Center of Northern Colorado; Mantooth Marketing Company; Better Business Bureau; Palmer Flowers; EKS&H; Monfort College of Business; Columbine Health Systems; First National Wealth Management; Allura Skin and Laser Clinic; Cache Bank & Trust; Sather's Leading Jewelers; Social Media Pilots; DaVinci Sign Systems; Caldera Event Group, KUNC Community Radio.

**biXpo**

September 26, 2012
Embassy Suites – Loveland

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BLB and CFO are the kickoff events for Bixpo 2012. Nominations for CFO of the Year are open. Call 970-232-3132 for details. Sponsored by: Kennedy and Coe; Palmer Flowers; DaVinci Sign Systems; KUNC Community Radio and Social Media Pilots.

**biXpo ROCKS AFTER HOURS**

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# Brain powered

## Colorado's academic and federal research community serves up a rich mix of science, technology and jobs

BY PAULA MOORE

Colorado's growing status as an innovation center could help jumpstart and sustain the state's economy in coming years, and state research universities and their federal research partners are a major part of that equation. Those schools — from Colorado State University to the University of Colorado system — already account for thousands of direct and indirect jobs, and pump billions of dollars a year into the state economy.

CU's four campuses alone — CU-Boulder, CU Denver, Anschutz Medical Campus and CU Colorado Springs — contribute more than $6 billion a year to the state economy, through spending on goods and services. It is also one of the state's largest employers with more than 26,000 jobs. The university system has spawned 114 companies since the mid-1990s, and 85 of the 91 companies still in business have operations in Colorado.

Colorado State University in Fort Collins contributes more than $5.2 billion to the economy and employs 7,000 people. Its tech transfer program is one of the most active in the state and has generated 20 of spinoff companies in the past five years.

"Looking at the basics, when you're a high-priced market surrounded by thousands of miles of nothing, you better be an innovation center or you'll be a ghost town," said Tom Clark, CEO of the Metro Denver Economic Development Corp. "That innovation is driven by a concentration of scientists."

Collaboration between higher education research institutes and local federally funded research laboratories — including the National Oceanic and Atmospheric Administration (NOAA) lab and the National Renewal Energy Laboratory (NREL) — is key to expansion of the innovation economy, according to economic development experts.

This state is home to 24 federally funded labs, which are closely allied with local research universities. The labs accounted for more than 16,000 jobs, both direct and indirect, and contributed more than $1.5 billion to the Colorado economy in 2010 alone, according to CO-LABS Inc. CO-LABS is a Boulder-based nonprofit consortium of federal scientific labs, universities, businesses and other groups launched in 2007 to make Colorado a global leader in research and technology, and to help create businesses.

"The relationships between the research institutions of higher education and federal labs is a critical driver of … economic development and job growth across the state," said Ken Lund, executive director of the Colorado Office of Economic Development and International Trade (OEDIT). "Federal funding, as it relates to research labs, is critical."

Following are snapshots of research activities at major Colorado research universities.

### Of space, renewable energy and Nobel laureates

The University of Colorado Boulder is a Tier 1 research university, meaning it receives among the highest amounts of research funding, with projects in areas from space science and computing to engineering. It's the only university in the Rocky Mountain West that belongs to the prestigious Association of American Universities, a group of 61 top public and private research universities in the U.S. and Canada.

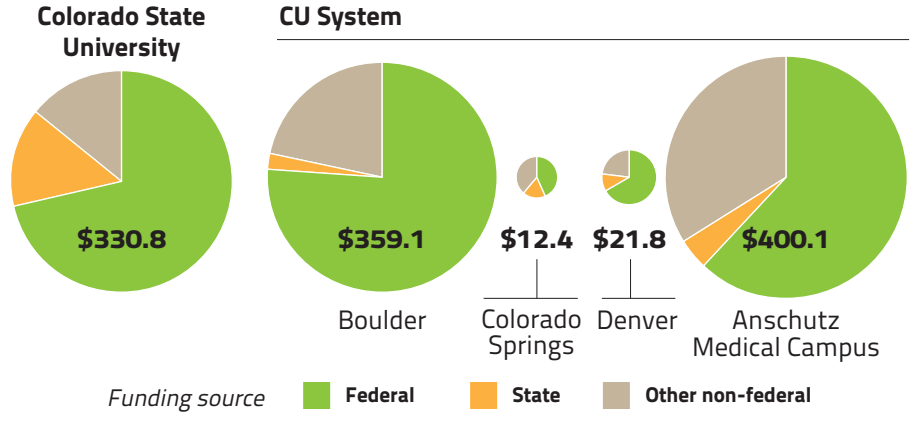
CU-Boulder — whose location at the base of the Flatirons makes it one of this


COLORADO STATE UNIVERSITY

**Lab technician Mike Russell looks at a culture dish in the Veterinary Diagnostic Laboratories at Colorado State University. CSU's veterinary medicine and occupational therapy graduate programs were ranked among the best in the country in March 2012 by *U.S. News and World Report*.**

## Sponsored program awards

*In millions*




Sources: Colorado State University; University of Colorado Boulder, Office of Contracts and Grants; University of Colorado Denver, Office of Grants and Contracts; University of Colorado Colorado Springs, Office of Sponsored Programs

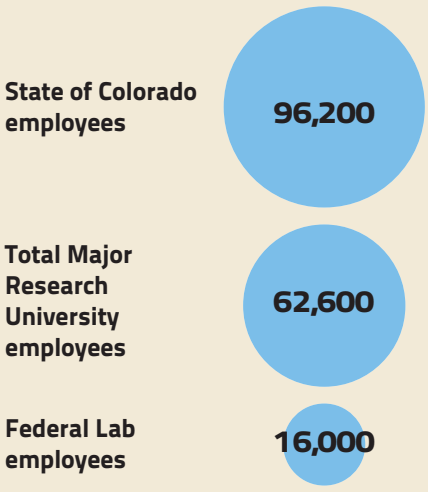
country's most scenic campuses — received $359 million in research funding in fiscal 2011, or 45.4 percent of the total $790 million in funding received by the University of Colorado System. The bulk of the system research funding — 78 percent — comes from federal sources such as the National Institutes of Health (NIH) and National Science Foundation (NSF).

Brian Lewandowski is a research associate in the Business Research Division at CU-Boulder's Leeds School of Business who tracks the economic impact of academic and federal research in the state. "There are lots of benefits associated with the Colorado economy — technologies that are licensed by the university, companies spun out of universities and com-

*Continued on next page*

**Research Employment Compared to Total Employment by the State**

The number of major research university employees is almost equal to two-thirds of the total number of State employees.




Sources: 2010 Annual Survey of Public Employment and Payroll; University of Colorado Boulder's 2012 Colorado Business Economic Outlook; CO-LABS

# An engine of employment

This year, the state's higher education institutions, including major research universities, will employ an estimated 62,600 people, representing nearly two-thirds of the state's total public work force, according to the University of Colorado Boulder's 2012 Colorado Business Economic Outlook and the Colorado Department of Labor & Employment.

Those jobs include administrators, instructors (many of whom are engaged in research) and support staff. The estimated total for all state employees this year is 96,200 people.

"Colorado's research economy is a talent magnet," said Martin Shields, regional economist at Colorado State University's Office of Economic Development.

Industries closely related to local research universities include bioscience, which employs an estimated 16,000 people in the state, and aerospace with some 24,700 employees, according to the Colorado Office of Economic Development and International Trade.

"We have a fabulous reputation for attracting the best and the brightest research talent, and we need to stay attractive to those individuals," said Ken Lund, OEDIT executive director.

— Paula Moore

*Continued from previous page*

panies that want to be close to university research."

CU-Boulder's research component consists of more than 90 research centers, institutes and laboratories, and a faculty that includes four Nobel Prize winners. One of the Nobel laureates is chemist Tom Cech, who returned to the university in 2009 after serving as president of the Howard Hughes Medical Institute in Chevy Chase, Md.

Colorado companies that have spun off from CU-Boulder research include OPX Biotechnologies Inc. (OPXBIO) of Boulder, a clean-tech company that produces bio-based chemicals and fuels and has roughly 50 employees. Broomfield-based ARCA biopharma Inc., a university spinoff with some 20 employees, is developing genetically targeted therapies for the treatment of heart disease.

## Taking the cure

Much of the University of Colorado Denver's research focus is at its internationally renowned Anschutz Medical Campus, located on the former Fitzsimons Army post in Aurora. The school calls itself Colorado's No. 1 research university, attracting the most research funding — at some $421 million — in the CU system for fiscal 2010-2011.

The economic impact of the Anschutz-Medical Campus on the state includes more than $2 billion a year in direct campus expenditures. The campus employs more than 8,000 people directly and contributed to the creation of another 9,700 jobs. A growing player in technology transfer, it starts five to seven companies a year.

"The Anschutz/Fitzsimons campus is a real crown jewel for the entire state of Colorado," Lund said.

The campus' largely health-related research specialties include treatments and cures for cardiovascular disease, cancer, diabetes and spinal cord injuries as well as biomedical engineering.

"Biomedical engineering is about the creation of new devices — from tiny pediatric heart pumps and ocular devices to prosthetics," said Lilly Marks, vice president for health affairs at the University of Colorado and executive vice chancellor of the Anschutz campus. "New drugs, devices and therapies are percolating out of our basic research. The economic impact is huge; it starts new businesses."

## High tech, high impact

Colorado State University in Fort Collins is a top national research university, whose veterinary medicine and occupational therapy graduate programs were ranked among the best in the country in March 2012 by *U.S. News and World Report.*

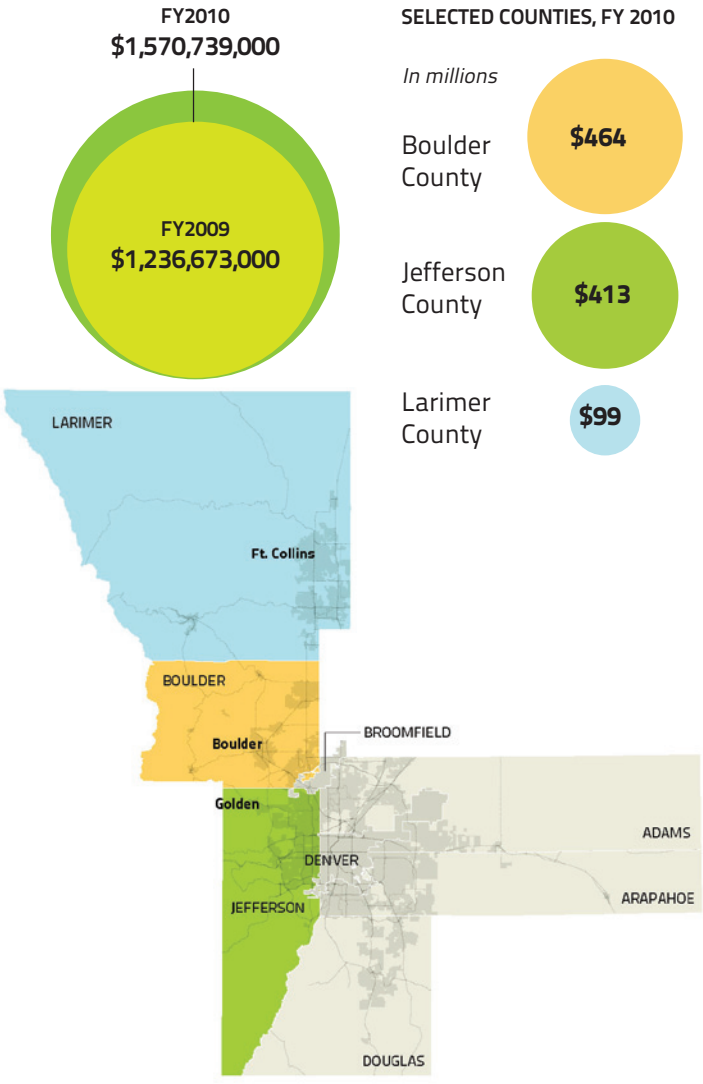
CSU's regional economist Martin Shields notes that the university expends more than $330 million a year for research without a medical school. "From a real basic perspective, that puts people to work," he said.

It attracts more in-state students than any other public university in Colorado and it educates these students for roughly the same amount today, on an inflation-adjusted basis, as it cost 20 years ago.

Known for its renewable energy, medical and veterinary research, the university helped spawn companies such as

## CO-LABS IMPACT ON COLORADO

### ECONOMIC BENEFITS




**SELECTED COUNTIES, FY 2010**

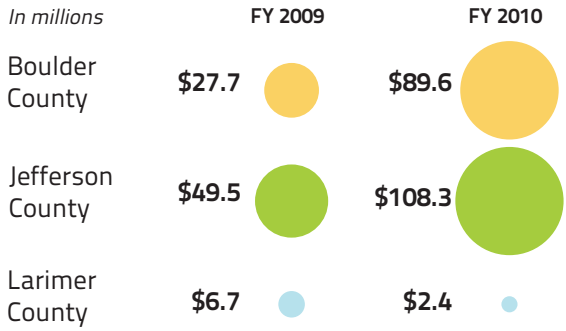
*In millions*



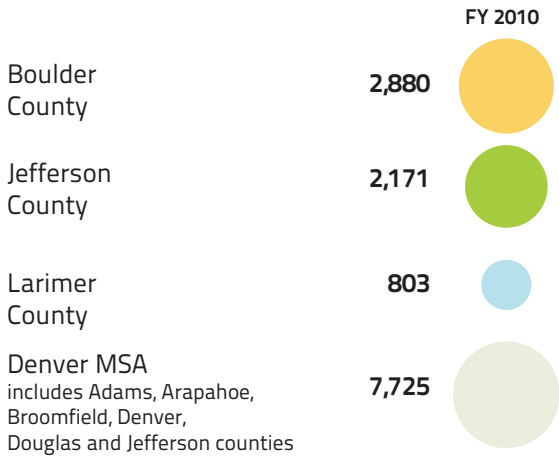

### CO LABS FOOTPRINT

The facilities occupy 4.7 million square feet of leased and owned real estate in Colorado.

The Colorado portion of construction at Colorado's federal research facilities totaled approximately $84.1 million in FY 2009 and $201.0 million in FY 2010.




### LAB WORKERS RESIDENCES




Sources: CO-Labs Impact Study March 2011

Abound Solar, a maker of next-generation solar modules for generating electricity, and Heska Corp., a provider of advanced pet-care testing and specialty products. Both businesses are based in Loveland. "The poster child for technology transfer is Abound Solar, since it came out of CSU's research," said Clark.

## More than mining

Located in Golden, the Colorado School of Mines is a global leader in advanced technology research, and its students, faculty and staff make a "significant economic and social impact" on the state, according to the university. The school has 95 patents. Companies created by Mines research include MicroPhage Inc. of Longmont, which develops technology for the treatment of bacterial infections, and Golden-based MetaFluidics Inc., a developer of portable cell-handling devices.

Mines research centers on traditional and renewable energy as well as the environment, but also space, biomedical and humanitarian engineering projects. (Humanitarian engineering involves improving the well-being of poor and otherwise underserved groups of people.) The school is famous for developing hydrate chemical compounds, including one used to unplug oil lines in the North Sea in the 1980s.

"We started off looking at traditional energy sources — mining and petroleum — but we also continue to look at alternative energies like solar and wind … We've been pushing our bio-strengths as well," said Will Vaughan, Mines director of technology transfer.

The university received $46.7 million in research funding in fiscal 2011. Roughly a dozen federal agencies including the NSF and U.S. Department of Energy contributed more than half that money — $25.3 million — and private industry kicked in $13.1 million.

# Colorado's Federal laboratories

## and the $1.5 billion they bring to the state have been vital to Colorado's overall economy over the years.

The 24 federal labs operating in Colorado create 16,000 direct and indirect jobs. In metro Denver, where most of the labs are headquartered, the labs mean millions of dollars to local economies. And they are important partners to researchers at the state's universities.

Economic benefits from the labs to Boulder County, for instance, totaled $463.8 million in 2010; Jefferson County was $413.2 million and Larimer County totaled $523 million, according to an analysis by the University of Colorado Boulder's Leeds School of Business.

And thanks to the American Recovery and Reinvestment Act (ARRA), even during the recent downturn, construction spending to improve and in some cases expand the labs, brought more money to the state. Construction spending at federal labs jumped from $2.7 million in 2009 to $102.7 million in 2010.

In the last 10 years, George Douglas, a spokesman for the National Renewable Energy Laboratory (NREL) in Golden, described funding trends as a roller coaster, with budgets rising in the later years of the Bush Administration.

Still, research at the labs is central to key national initiatives. The National Institute of Standards (NIST) in Boulder is helping create a National Cybersecurity Center of Excellence and it is working on the Obama Administration's National Strategy for Trusted Identities in Cyberspace initiative.

— Tracee Sioux






**Below is a list of federally funded research entities in Colorado identified by CO-LABS:**

## BOULDER

### Cooperative Institute for Research in Environmental Sciences (CIRES)
University of Colorado Boulder
216 UCB (CIRES Building Room 318)
Boulder, CO 80309-0216
http://cires.colorado.edu/

### JILA
University of Colorado
440 UCB
Boulder, CO 80309-0440
http://jilawww.colorado.edu/

### National Oceanic and Atmospheric Administration (NOAA)
- Earth System Research Laboratory (ESRL)
- National Geophysical Data Center (NGDC)
- National Weather Service (NWS)
- National Environmental Satellite, Data, and Information Service (NESDIS)
- Space Weather Prediction Center (SWPC)

325 Broadway
Boulder, CO 80305-3337

### National Institute of Standards and Technology (NIST)
Boulder Labs
325 Broadway
Boulder, CO 80305-3328
http://www.boulder.nist.gov/

### Institute for Telecommunications Sciences (ITS)
National Telecommunications and Information Administration
U.S. Department of Commerce
325 Broadway
Boulder, CO 80305–3328
http://www.its.bldrdoc.gov/

### National Center for Atmospheric Research (NCAR) and University Corporation for Atmospheric Research (UCAR)
1850 Table Mesa Drive
P.O. Box 3000
Boulder, CO 80307-3000
www.ucar.edu

## COLORADO SPRINGS

### US Air Force Academy HQ USAFA/DFER
2354 Fairchild Drive Suite 4K25
USAF Academy, CO 80840-6200
http://www.usafa.af.mil/

## DENVER

### Bureau of Reclamation
Denver Federal Center
6th & Kipling, Bldg 67
P.O. Box 25007
Denver, CO 80225-0007
http://www.usbr.gov/pmts/tech_services/

## FORT COLLINS

### Centers for Disease Control and Prevention Lab (CDC/DVBID)
3150 Rampart Road
Fort Collins, CO 80521
http://www.cdc.gov/ncidod/dvbid

### Cooperative Institute for Research in the Atmosphere (CIRA)
Colorado State University
Fort Collins, CO 80523-1375
http://www.cira.colostate.edu

### National Center for Genetic Resources Preservation
1111 South Mason, Fort Collins, Colorado 80521-4500
The **U.S. Department of Agriculture Area Office** for the Great Plains Region is in Fort Collins, along with the **U.S. Department of Agriculture's Agricultural Research Service** and the **Natural Resources Research Center**.

### National Wildlife Research Center
4101 LaPorte Avenue
Fort Collins, CO 80521
http://www.aphis.usda.gov/wildlife_damage/nwrc/about/about.shtml

### Rocky Mountain Research Station
U.S. Forest Service, Research and Development
2150 Centre Avenue, Building A
Fort Collins, CO 80526
http://www.fs.fed.us/rmrs/

## GOLDEN

### National Renewable Energy Laboratory
US Department of Energy
Denver West Center
1617 Cole Blvd.
Golden, CO 80401-3393
http://www.nrel.gov/science_technology/

## LAKEWOOD

### U.S. Geological Survey (USGS)
Denver Federal Center
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# A factory for health advances

## Joint replacement, battlefield Band-Aids and drugs for healthier hearts

BY LISA MARSHALL

In a windowless fourth-floor lab high above the University of Colorado's Folsom Field, postdoctoral research associate Brooke Harrison squints through a microscope at a pulsing cell from a rat heart. Nearby, a 6-foot-long Burmese python lies coiled in its cage.

What would happen if you bathed the heart of a mammal in the blood of a just-fed python?

This seemingly obscure question has driven Harrison's research for months, as he and colleagues in the lab of biology professor Leslie Leinwand work to unravel the mysteries behind the python's unique physiology in hopes of developing better drugs for human heart disease.

"It won't be next year or the year after, but I think it could happen within five," said Harrison. "You always want the work that you do to end up helping people. But it takes time."

Harrison is among the thousands of biomedical researchers patiently hunkering down each day in lab coats in academic research centers across the state, working on projects that could ultimately save or improve lives. According to the Colorado BioScience Association, the state's research institutions spin off 20 new bioscience companies annually, fueling a growing local industry that employs 20,000 people across 600 companies. In FY 2010-2011 alone, CU's glistening new Anschutz Medical Campus in Aurora drew $248.5 million in research funding from the U.S. Department of Health and Human Services. Across CU's four campuses, biomedical research led to 176 new patent filings that year. Combined with the millions of research dollars flowing into labs at Colorado State University and elsewhere, that funding has helped turn the state into a factory for health advancement, with biologists, engineers, chemists, and clinicians collaborating to churn out everything from new cancer drugs to better joint replacement materials to novel painkillers.

"We have become much more known for this type of research," said Sue James, PhD, who founded CSU's School of Biomedical Engineering in 2005 to serve as a "nexus of biomedical researchers" from her campus and beyond. "Colorado is attracting some of the greatest minds in this area."

### Bio-Band-Aids and lifelike cartilage from CSU

It was nearly 19 years ago in a CSU lab that James, an engineer with a doctorate in polymers from the Massachusetts Institute of Technology, set out to develop a material that would make artificial joints work better and last longer.

Nationwide, according to the American Academy of Orthopaedic Surgeons, roughly 229,000 people have hip replacements annually while 497,000 have knee replacements – numbers that are expect-

JONATHAN CASTNER

ed to double as active Baby Boomers succumb earlier to joint degeneration. The problem: Those artificial joints wear out in 10 or 20 years, meaning patients must wait as long as possible for surgery, or expect they will have a second one.

Two decades of chemistry experiments and mechanical testing by James and her graduate students has now yielded a new plastic that better mimics human cartilage and that wears 40 percent less after five years, according to simulations.

"We basically took this hard plastic that they use to make these implants out of and we gave it a snotty, lubricious surface," said James.

In 2010, James teamed up with Indiana-based Schwartz Biomedical to license the technology, called Bio-Poly. And in January, two knee-resurfacing patients walked out of a London hospital with the first partial implants made with her technology. In the future, she sees it being used not only for total joint replacements but also for artificial cardiovascular tissue.

**CU researchers believe that studying a python's unique blood and plasma could lead to novel drugs for preventing or treating heart failure and other diseases.**

"It's very exciting," James said. "It's been a long time coming."

Melissa Reynolds may also see her

*Continued on next page*

JONATHAN CASTNER

**Two decades of chemistry experiments and mechanical testing by Sue James, PhD, and her graduate students has now yielded a new plastic that mimics human cartilage and wears 40 percent less after five years, according to simulations.**

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brainchild lead to better patient care in the coming years. In March 2011, the CSU chemistry professor received a $1.3 million grant from the Department of Defense to expedite her work developing a wound-healing material for use on battlefields and the sites of natural disasters.

With the help of 19 undergrads and seven grad students, she developed a novel nitric-oxide infused bandage that aims to boost the body's infection-fighting ability and promote healing. It could be placed on deep cuts on the skin or over deeper internal wounds and would absorb into the body over time. Her team has also filed for a patent and founded a start-up company to commercialize it.

"We could package them in water-safe bags and drop them from planes so people could apply them to the wound right away," she said, noting that the technology would have been ideal for situations like the 2010 Haiti earthquake or 2011 Japan tsunami.

## Personalized cancer care at Anschutz

While CU's Anschutz Medical Campus has been a mecca for biomedical research in many areas, it is gaining particular fame for its role in helping develop a new, more personal approach to treating cancer, one in which doctors screen patients for specific genetic drivers or "oncogenes" that fuel different cancer subtypes, then use molecularly targeted drugs to inhibit them.

For instance, instead of giving everyone the same treatment for lung cancer, drug choice can now be based, to a degree, on the type of lung cancer a patient has.

"We now know that what is driving the cancer is different between different cancers. If we can screen people for these oncogenic drivers and give them the right drug to interfere with the one they have, we can have a real impact," said Dr. Ross Camidge, MD, director of the Thoracic Oncology Clinical Program at the CU Cancer Center at Anschutz Medical Campus. "One-size-fits-all treatments are yesterday's paradigm. This is personalized medicine."

A prime example is the drug Crizotnib, which gained Food and Drug Administration approval in August, based in part on CU-led research. The yellow pill works by inhibiting an oncogene called anaplastic lymphoma kinase (ALK), believed to turn healthy cells into cancer cells in roughly 4 percent of lung cancer patients. Only those who have the ALK mutation are eligible for the drug, but for them it has been remarkably effective. One trial Camidge led showed that of 82 patients treated with Crizotnib for six months, 47 saw their tumors shrink or disappear and 27 stabilized. All this in a disease for which the gold standard of treatment has long consisted of, as Camidge put it, "chemotherapy, more chemotherapy, and then hospice."

# CU research paving way for new ways to treat chronic pain

After two decades of exploring the root causes of chronic pain, a CU-Boulder neuroscientist has begun testing a novel drug which could provide hope for millions of patients stuck with painkillers that don't work, are addictive, and come with nasty side-effects.

"The definition of a 'good drug' for chronic pain is that it only fails 80 percent of the time," said psychology professor Linda Watkins, PhD. "They are good for acute pain but when it is chronic they fail miserably."

Most painkillers target neurons. But Watkins' own research has indicted another type of cells, called glial cells, for the unrelenting, neuropathic pain that can make a warm shower, the brush of a shirt sleeve, or "even the bed sheets" hurt in certain patients with cancer, AIDS, multiple sclerosis, nerve damage, and other disorders.

Glial cells are essentially "immune cells for the brain and spinal cord," she said. They normally serve to ward off invaders, like viruses, setting off an inflammatory response that can temporarily aggravate the nervous system, causing pain. Glial cells can turn from benevolent to destructive if the process is set into overdrive somehow and doesn't shut off.

Using a grant from the National Institutes of Health, Watkins has teamed up with San Francisco-based biotech start-up, Xalud Therapeutics Inc., to bring a new drug, XT-101, to market which would "quiet" overactive glial cells. Initial tests in rodents have gone well, and the first dog, a 13-year-old German Shepherd named Liberty, was recently treated with promising results.

If all goes well, Watkins hopes to get clinical trials in humans underway within two years.

— Lisa Marshall

The Crizotnib success story has paved the way for studies of other similar drugs, and scientists in various CU departments are now collaborating to make them happen.

CU cytogeneticist Marileila Garcia, PhD, who developed one of the world's first screening tests for ALK mutations, is now working on tests for others.

The CU-led Lung Cancer Mutation Consortium has identified 10 other oncogenes for lung cancer, and is working to develop drugs for them.

And local clinical trials are showing promise for similar drugs for other cancers.

In February, CU cancer specialist Karl Lewis, M.D., co-wrote a report in the New England Journal of Medicine on Vemurafenib, a new oncogene-targeting drug for metastatic melanoma patients. It showed that 50 percent of patients benefited from the drug, with cancer growth halting for nearly seven months.

"Rarely do we see results this dramatic," said Lewis.

## Snake oil for heart patients and a new home for researchers

CU-Boulder biology professor Leinwand first started studying Burmese pythons six years ago, after reading a paper suggesting that by looking at the extreme physiological responses of certain species (such as bears and squirrels that hibernate), humans might be able to come up with new ideas on how to treat human disease.

Pythons are known to fast for months, then gorge on animals bigger than they are. Once the python eats, its metabolism increases fortyfold, and its heart bulges by 60 percent before returning to normal.

By studying pythons right after they eat, Leinwand, Harrison, and their colleagues have learned several things: 1) the heart growth in a just-fed python looks a lot like the healthy heart growth in a trained athlete (not the unhealthy growth that can occur in people with high blood pressure); 2) the magic potion fueling that healthy heart growth is a combination of three fatty acids coursing through the snake's blood; and 3) when that blood is injected into a rodent, its heart grows in a healthy way, too.

If that unique milky plasma could be replicated and patented (it has) and commercialized (through a company called Hiberna, also in the works), Leinwand believes it could lead to novel drugs for preventing or treating heart failure and other diseases.

"The problem with people with heart failure is that many of them can't exercise enough to get much of that benefit," she said. "This would help them get the cardiovascular benefits of exercise with the exercise."

But snake oil is hardly Leinwand's only focus.

She recently teamed up with Nobel Laureate Tom Cech to found the new CU-Boulder Biofrontiers Institute, an effort to bring together scientists from across multiple disciplines in the name of advancing human health.

This summer Leinwand will move her lab — snakes and all — to a new 330,000-square-foot, $160-million building on the Boulder campus, which the new institute will share with the Department of Chemical and Biological Engineering and the Division of Biochemistry.

By fall, 600 researchers — from tissue engineers to computer scientists to biochemists — will arrive daily to do their work.

"We are attracting people who really want to solve problems of human health, and we are hoping for many patents to come out of this," said Leinwand, the new institute's chief science officer. "We're going to energize the biotech community across the state."

NASA

**NASA's SORCE satellite was designed, built and is controlled from the University of Colorado Boulder campus.**

# THE PLACE FOR SPACE

## Decades of research and legions of alumni have put CU's Department of Aerospace Engineering Sciences in rarefied air

**BY CHARLIE BRENNAN**

A perch one mile above sea level is not all that separates the University of Colorado Boulder's aerospace department from its peers in the field.

A more substantive distinguishing feature is suggested by its complete name — the CU-Boulder Department of Aerospace Engineering Sciences.

"We do space science and oceanography and atmospheric science," said Jeff Forbes, PhD, the department chair.

"We integrate science with the engineering in a unique way in our department. We're the only one that has that name, and we're the only one that does that to the extent that we do. For us it's an intentional marriage."

CU's Department of Aerospace Engineering Sciences has garnered increasing attention in recent years, having been ranked among the top four schools in the country by the 2010 National Research Council Assessment of Ph.D programs.

"It's a very big deal, as that's one of the metrics that people use for establishing what are the best places to go for a PhD," said Forbes.

*U.S. News and World Report* this year has ranked the CU-Boulder aerospace program 14th overall and 10th among public undergraduate programs; it was also ranked 12th overall and eighth among public graduate programs.

The ambitious array of 21st Century disciplines represented in the department's curriculum includes aerospace technology and science, astrodynamics and satellite navigation systems, vehicle systems, bioastronautics, structures and material systems, remote sensing, earth and space sciences.

CU aerospace alumni are now working at top companies and research labs, such as the Johnson Space Center, the Boeing Company, Lockheed Martin and the Jet Propulsion Laboratory.

CU has a long history of placing alumni in space; 19 astronauts with CU ties

## Colorado's role in the aerospace industry

**Colorado has over 400 companies and suppliers and has experienced 6.9 percent growth in space employment from 2006-2011.**

AEROSPACE EMPLOYMENT

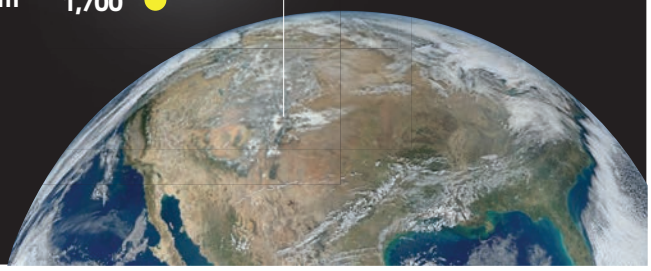
**Employed in space-related jobs** — 163,890

**Employed by private space companies** — 24,890

**Employed in program management, engineering and mission support functions at United Launch Alliance's headquarters in Metro Denver.** — 1,700

POTENTIAL SPACEPORT

There is a pending application by the state to the FAA asking to be designated as a spaceport, facilitating creation of a facility for launching space-bound payloads. A potential site is Front Range Airport near Watkins.



Source: Colorado Space Coalition

have flown to date, starting with 1949 graduate Scott Carpenter, who flew on the second manned orbital flight in 1962.

And, with President Obama's National Space Policy directive of June 2010 placing greater emphasis on promoting the commercial aspects of space exploration, CU-Boulder's program is right in step with the changing dynamics of the aerospace field.

The CU program was one of a half dozen collegiate programs named in the wake of the presidential directive as part of an FAA Center of Excellence for commercial space transportation, focusing on areas such as crew and passenger safety, space launch operations and traffic management.

CU's participation in that program dovetails neatly with its ongoing partnership with the Sierra Nevada Corporation of Louisville, which helps sponsor CU's eSpace: The Center for Space Entrepreneurship. eSpace includes an aerospace business incubator, as well as the Straight to Space program, which steers job candidates from traditional and non-traditional backgrounds into the aerospace industry.

Another commercial orientation for the CU aerospace community includes its BioServe Space Technologies, specializing in microgravity life science research, design and development of space flight hardware.

A pending application by the state of Colorado to the FAA asking to be designated as a spaceport, facilitating creation of a facility for launching space-bound payloads, is one more reason for growing excitement around the CU program.

"We are one of the few departments in the country that is very much into this commercial space activity," said Forbes.

## What's up?

A sampling of projects around the state:

**MIZOPEX** - The Marginal Ice Zone Observations and Processes Experiment is a $3 million study funded by NASA and led by CU-Boulder Research Professor James Maslanik, aimed at better understanding environmental factors in the decline of sea ice in the Arctic Ocean. It will utilize CU-designed unmanned aircraft.

**Gojett** – A graduate student team headed up by professor Ryan Starkey is developing a small supersonic unmanned aerial vehicle (UAV) dubbed the Gojett (graduate organization jet engine technology team), planned as the world's fastest small UAV.

**Colorado Space Grant Consortium** – COSGC is a NASA-selected program consisting of 12 Colorado colleges, universities and one foundation. Since 1989, more than 2,000 students have been involved in its satellite development program. It has launched so far three sounding rockets, three Space Shuttle payloads, two orbiting satellites and more than 200 BalloonSats.

**CloudSat** – CSU Atmospheric Science researchers spearheaded one of the few university-led NASA Earth Science missions with the 2006 launch of CloudSat, the world's first cloud-profiling radar that tells scientists how much precipitation is in clouds. CSU's Cooperative Institute for Research in the Atmosphere – a partnership with NOAA – collects and distributes data from CloudSat to scientists across the globe.

# Public-minded

## Children's health, food safety among new school's priorities

BY LISA MARSHALL

Can an expectant mom's diet impact her baby's chances of developing diabetes? Does childhood exposure to dust mites or air pollution cause asthma? How do natural gas wells really impact surrounding water and air quality? And how can foodborne illnesses, like the deadly listeria outbreak traced to a Colorado cantaloupe farm last summer, be prevented?

These are just some of the pressing questions being posed by researchers at the Colorado School of Public Health. Just four years after opening its doors, the unique three-university collaboration already boasts a student body of 533, 150 faculty members, and $30 million in federal research grants, making it one of the largest producers of academic research in the state and one of the region's premier schools for doctors and scientists specializing in epidemiology, biostatistics, and occupational, environmental, and preventive health.

"Many of the major improvements in health populations over the years have been a result of public health interventions, rather than one-on-one treatments," said former Interim Dean Judith Albino, PhD, pointing to the thousands of lives saved through campaigns to promote milk pasteurization in the 1920s, safe sex in the 1980s, and smoking cessation in the 1990s. "Public health is about disease prevention and health promotion, but you also have to have research underlying your interventions in order to know what's really going to make a difference. That's what we are about."

The school was founded July 1, 2008, to fill a gaping hole in public health education in the West. Today it remains the only accredited school of public health in the nine-state Rocky Mountain region, and the only public health school in the nation that joins more than one university — the University of Colorado, Colorado State University, and the University of Northern Colorado — under one banner.

Albino said CU's history of medical research, CSU's grounding in agriculture and veterinary science, and UNC's education and community-based programs have enabled the collaborative school to provide training, outreach and research on everything from environmental health to food safety and school wellness.

One of the largest studies under way this year is the National Children's Study, the most sweeping long-term study ever conducted on environmental and genetic influences on children's health. The national, federally funded study will follow 100,000 children from birth to age 21 to explore how exposure to different food, chemicals, media, and other factors impacts health. Douglas County is one of 105 participating sites, the only one in Colorado. Dana Dabelea, M.D., PhD, an epidemiologist from the School of Public Health, aided by 15 fellow researchers, will head up the study here, taking umbilical cord blood samples at births, collecting household dust and water from

> **"If we can identify early risk factors for things like childhood asthma, diabetes, and ADHD, we can implement prevention programs and save billions of health care dollars."**
>
> — Dana Dabelea, M.D., PhD , Colorado School of Public Health

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JONATHAN CASTNER

**Jill Litt, PhD, at the MoonDog urban garden near downtown Denver. 'Gardening has everything to do with public health,' she says. 'If you grow your own food you eat it because it is fresh ... It draws people out.'**

# A little dirt doesn't hurt

Can getting your hands dirty in a community garden measurably improve your health?

In more ways than you would expect, according to new research from the Colorado School of Public Health.

One study, published in the American Journal of Public Health last year, looked at 436 Denver residents across 58 diverse city blocks. It found that those who worked in a community garden ate far more fruits and vegetables on average per day (5.7) than those who had their own gardens (4.6) or had neither (3.5). A whopping 56 percent of community gardeners met the federal Five-A-Day recommendations, while fewer than one-quarter of non-gardeners did.

A second study found that the mere touch and smell of the soil, and interaction with fellow gardeners in the fresh air, seemed to lift spirits and foster relationships – potentially leading to less depression and safer neighborhoods. Gardening also got people moving. And 60 percent of participants said they gave their excess bounty away to food assistance programs.

"Gardening has everything to do with public health," said Jill Litt, PhD, principal investigator for the Gardens for Growing Healthy Communities Initiative, a multi-year research project at CSPH. "If you grow your own food you eat it because it is fresh. But there is also a lot more going on. It draws people out."

— Lisa Marshall

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children's homes, and conducting interviews. Already 150 families have signed up; 1,000 will participate.

"If we can identify early risk factors for things like childhood asthma, diabetes, and ADHD, we can implement prevention programs and save billions of health care dollars," said Dabelea.

Dabelea is also heading another study, Healthy Start, which will follow 1,500 pregnant women and their children to determine whether diet and exercise habits during pregnancy can influence a child's risk of becoming obese or developing diabetes.

Already, preliminary results suggest that excess weight and high blood sugar during pregnancy may lead to a higher percentage of body fat in infancy, which could set kids up for problems.

"The recommended levels of physical activity and weight gain for women during pregnancy may have to change," said Dabelea. "They may need to gain less and exercise more."

> "In five years I believe we will be considered one of the top five schools of public health in the country. We are just getting started."
>
> — former Interim Dean Judith Albino, PhD, Colorado School of Public Health

Another study, in collaboration with Garfield County, which has seen an explosion in oil and gas drilling in recent years, is looking at the impact of those projects on air and water quality.

The school also hopes soon to unveil a new Center for Food Safety and Prevention of Foodborne Diseases, which will research food safety issues "from the farm to the plate," said Marisa Bunning, PhD, an assistant professor in CSU's department of Food Science and Nutrition.

Bunning said the 2011 listeria outbreak, which killed at least 30 people and sickened more than 140 nationwide, served as an alarm bell that food safety is still a critically important issue, and that collaboration is critical.

"Food safety can be really challenging because it requires so many different kinds of experts, from experts in agricultural production and processing to food microbiologists to epidemiologists to consumer educators," she said. "This center would be a connecting point."

Albino notes that student enrollment continues to grow 20 percent annually and the school has big plans for the future.

"In five years I believe we will be considered one of the top five schools of public health in the country," she said. "We are just getting started."

# The ROI on innovation has never been stronger.

## The Power of Partnership

The University of Colorado Denver | Anschutz Medical Campus has established a national leadership position in transforming university innovations into real-world medicines.

We are a catalyst—bringing faculty inventors and researchers together with biotechnology, pharmaceutical, device and information technology companies—to translate ideas into products that make a difference.

It's a partnership that provides seamless collaboration between our researchers and clinicians, and your company—supported by our broad range of research labs, affiliated hospitals and bio-specimen facilities. We offer the kind of connections and services that ensure ideas are leveraged to their greatest potential and improve clinical outcomes.

**To learn how your company can take advantage of our fresh thinking, research expertise and partnership approach, visit ucdenver.edu/PartnerNow.**

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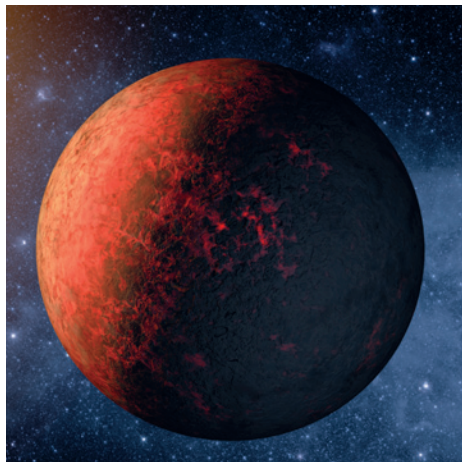
University of Colorado
Denver | Anschutz Medical Campus



# 10 LIFE-CHANGING IDEAS

## Colorado research that is improving and saving lives

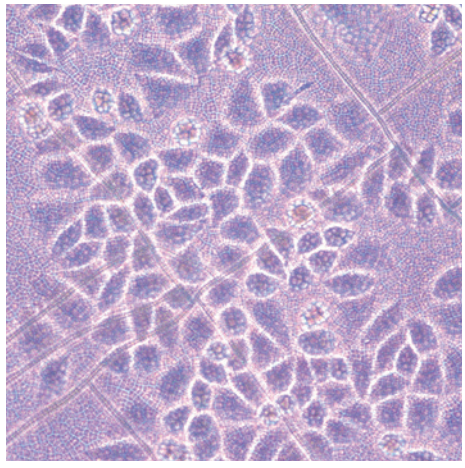
BY PAULA MOORE

Colorado research universities are involved in cutting-edge research that promises to change the world and improve our lives. Following are 10 potentially life-changing projects happening right here at home.

**1 Using Less $H_2O$** — With American cities facing water shortages driven by climate change, growing populations and crumbling infrastructure, the National Science Foundation teamed with Colorado School of Mines in 2011 to come up with new, sustainable strategies for managing urban water. Mines will provide its expertise in water reclamation and reuse, subsurface modeling and contaminant reduction. One idea is to include natural water systems in the urban water infrastructure, to improve water quality, boost water storage, and enhance habitats and urban landscapes.





**2 Curing Paralysis** — Anschutz Medical Campus researcher Stephen Davies, a CU medical school super scholar, is on the verge of a cure for spinal cord injuries using stem cells. In a recent breakthrough, the researcher developed a way to turn stem cells into nerve cells that fix injured spinal cords quickly, without chronic, debilitating pain. Davies has restored near-normal movement to rats with severe spinal cord damage, and is working to replicate that success in humans. His work is partly funded by a $150,000 grant from Christopher Reeve's foundation. The actor was paralyzed in a horse riding accident and eventually died of complications from the injury.

**3 Inhabiting Space** — The University of Colorado Boulder's Laboratory for Atmospheric and Space Physics (LASP) designs instruments for space research. That information may someday allow humans to inhabit other planets. LASP is the only lab in the world with instruments collecting data on all the planets in the Earth's solar system. Started in 1948 and predating NASA, the lab's instruments are on the state-of-the-art Hubble Space Telescope, which has made major discoveries such as planets beyond our solar system and phenomena such as dark energy.

**4 Down Syndrome Solutions** — The Linda Crnic Institute for Down Syndrome at the Anschutz Medical Campus is the first global institute to combine basic and clinical research with clinical care to improve the lives of those suffering from Down syndrome. The institute's research focuses on genetics studies as well as finding new treatments for Down patients' cognitive problems, such as hearing loss and poor language development, and improving motor development.

**5 Plugging Vehicles into "The Grid"** — Colorado State University's InteGrid Lab is developing infrastructure to integrate more renewable resources into the electric grid. The school is one of only 16 U.S. universities involved in the U.S. Department of Energy's EcoCAR program with General Motors Corp. As part of the work, students are converting a Chevy Malibu into a next-generation hybrid/electric or fuel-cell vehicle. In 2011, CSU received a $44.5 million in-kind software award from Siemens AG for the project, the largest of its kind in the university's history.

Chemistry Professor Amy Prieto founded Prieto Battery, a company expected to produce batteries theoretically up to 1,000 times more powerful and 10 times longer lasting and cheaper than traditional batteries. The development

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of this technology could revolutionize the military, automobile and healthcare industries.

**6** **Smart Houses, Smart Cars** — CU-Boulder's Renewable and Sustainable Energy Institute (RASEI), a partnership between the university and NREL, is working with Toyota and Xcel Energy on a study whereby participants track their household electricity, including power used by their electric cars, using smart-grid technology. In early 2012, Toyota loaned the institute 10 Prius plug-in vehicles, in part to study how Toyota's lithium-ion drive battery performs in cold weather and mountainous terrain.

**7** **Predicting Tornadoes** — CSU engineering professor V. "Chandra" Chandrasekar is helping revolutionize how meteorologists detect tornadoes and other devastating storms. Chandrasekar's low-power radar system, being introduced in the Dallas-Forth Worth area this year, is an inexpensive, reliable way to detect twisters and rain, hail and snow earlier to lessen potential damage. The new technology collects better data on particle shapes, thereby providing more accurate information about storms.

**8** **Life-saving Cookstoves** — CSU spinoff Envirofit International has won major international awards for its cleaner burning cookstoves that are directly helping households across the developing world where indoor air pollution is the leading cause of death for women and children under age 5. CSU students and faculty helped develop a proprietary alloy for the cookstove's combustion chamber as well as an orifice plate that helps the stoves reduce smoke and toxic emissions by up to 80 percent. Students continue to work to improve the technology. More than 300,000 stoves have been sold across India, Africa, Southeast Asia and Latin America. Envirofit is a private, non-profit technology leader using sustainable, scalable business models to solve global health and environmental problems.

JONATHAN CASTNER

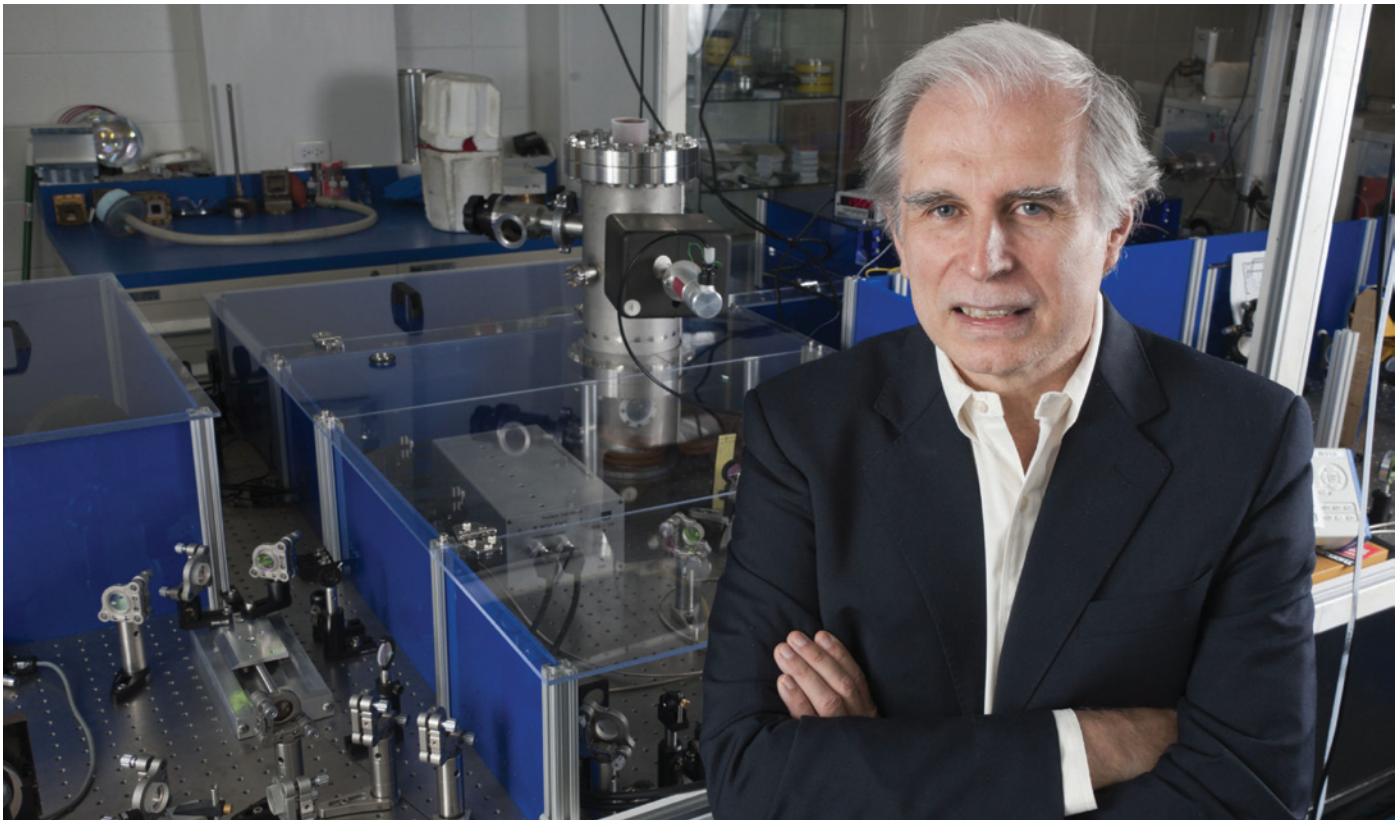
**At CSU's InteGrid lab, students are converting a Chevy Malibu into a next-generation hybrid/electric or fuel-cell vehicle.**

JONATHAN CASTNER

**Ryan Holloway, right, of the Colorado School of Mines, works with an Osmotic Membrane Bio-Reactor experiment led by Andrew Wait that pulls potable water from raw sewage.**

**9** **Parkinson's Breakthrough** — Researchers at CU's Anschutz Medical Campus have discovered a drug that stops the progression of Parkinson's disease by turning on a protective gene in the brain. Drugs currently used just treat the symptoms, but the new CU drug — now being tested on humans after successful testing on mice — stops it from getting worse. More than 1 million Americans suffer from the degenerative illness.

**10** **"Talking Cells"** — Scientists at the University of Colorado at Colorado Springs are investigating how cells and tissues in the body communicate, and how cellular metabolism affects the immune system. The idea is to find ways to direct cells to treat illnesses such as diabetes, multiple sclerosis and cancer. Their work is supported by CU's Institute of Bioenergetics and the National Institutes of Health.



COLORADO STATE UNIVERSITY

**Jorge Rocca, director of the National Science Foundation's Engineering Research Center for Extreme Ultraviolet Science and Technology, and his colleagues at CSU developed a microscope that was named one of the top 100 advancements in 2008.**

# Laser focus

## Colorado: World leader in advanced laser development

**BY DEBRA MELANI**

Right now, some of the best minds in laser research are toiling away in Colorado's university labs, searching for answers to questions of the tiniest proportions. But the answers these pioneers seek, often in collaboration, could open closed doors to scientists and change the face of technology.

At Colorado State University, Professors Jorge Rocca and Carmen Menoni are gaining international attention for their laser work, much of which is done in conjunction with their CU colleagues at the National Science Foundation's Engineering Research Center for Extreme Ultraviolet Science and Technology. The center, based at CSU and directed by Rocca, has already generated nearly $30 million in NSF funding.

One of the center's breakthroughs, a tabletop microscope developed by a Menoni-led team, made R&D Magazine's list for the Top 100 most significant technological advancements in 2008. Using light from Rocca's own unique EUV laser, the microscope can "see" objects 1,000 times smaller than a human hair. "This microscope is used to image nanostructures that are not visible when

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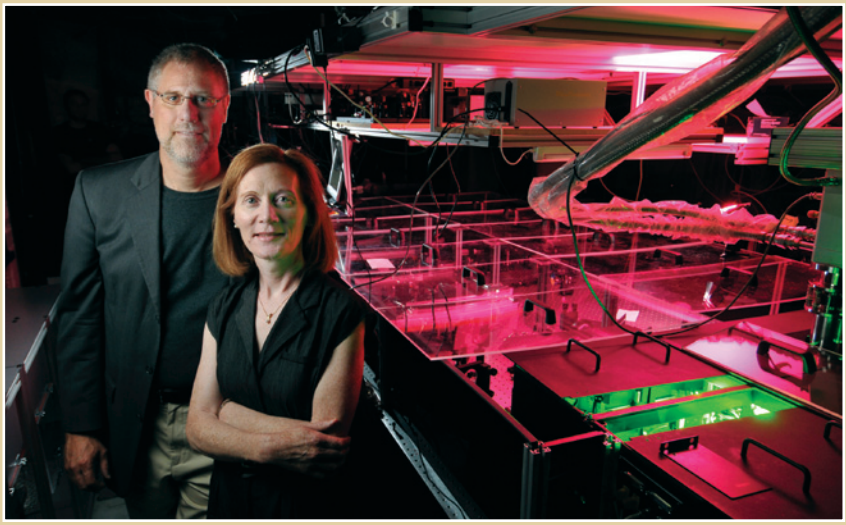

UNIVERSITY OF COLORADO

**Henry Kapteyn and Margaret Murnane are multiple award-winning professors at the University of Colorado Boulder.**

# KM Labs: 'We had customers before we had the company'

It all started in the basement of their Michigan home. World-class scientists Margaret Murnane and Henry Kapteyn, now University of Colorado professors, launched KM Labs in 1994 to provide access to their groundbreaking discoveries in laser research.

"We had the customers before we had the company," said Murnane, noting that many people wanted the completed technology, not the build-it-yourself guidebooks the couple was offering. When the two moved to Colorado in 2000, a graduate student took the reins, and the company hit full trot, never requiring outside funding.

Today, KM Labs has 30 employees (many of them former students of Colorado universities) and distributors in 10 countries, Murnane said. "Our products are in national labs and university labs around the world, and we're on a continued trajectory for growth."

— Debra Melani

*Continued from previous page*

using visible light (as with traditional microscopes)," Menoni said. The team is developing microscopic technology that can identify defects at the nanoscale on lithography masks, which can improve the next generation of semiconductor chips.

At the University of Colorado Boulder, Professors Margaret Murnane and Henry Kapteyn are considered world leaders in their work with ultrashort-pulse lasers and ultrafast coherent EUV (extreme ultraviolet) sources.

Through their own company (KM Labs), the two have marketed their ultrashort-pulse–mode-locked titanium-sapphire (Ti:S) laser, which is being used to further research in hundreds of national and university laboratories around the world.

"We develop new types of lasers that generate very short pulses of light," Murnane said. "We also develop methods to convert these visible lasers into the X-ray region of the spectrum." By doing so, they open previously locked windows into science at the nanoscale.

Potential applications in nanotechnology are endless, but Murnane offered the problem of overheating laptops as an example. With such tiny structures in today's increasingly smaller laptops, thermo-management has remained a challenging and unanswered issue. "That's partly because it's not well-understood how heat flows in very small structures." But with their technology, those questions can be answered and potentially influence the design of the next generation of electronics, she said.

At Colorado School of Mines, Professor Jeff Squier and colleagues are focusing on applications for this ultra-fast laser technology. The pulse of his femtosecond laser is a millionth of a billionth of a second long. "That's powerful enough that we can actually cut with them, and with unprecedented precision," said Squier, who is also working in conjunction with CU's medical school to improve laser eye surgery. Calling the laser technology the "ultimate 3-D prototyping tool available," Squier explains that he can cut tiny channels through glass.

"Ultimately, we'd like to flow blood through these channels," Squier said. This would enable his "Lab on a Chip" idea, a project being partially funded by KM Labs. "Then we have other lasers that we've mounted on this little chip that we've created (like laser tweezers) that can actually stretch the blood cells mechanically." The goal: With something the size of an iPod, healthcare givers (or even patients at home) can measure properties of blood, Squier said, adding that the range of potential diagnostic applications remains untapped.

Scientists from all schools agreed: Colorado provides an exciting home for laser researchers, and the collaboration between universities boosts success. "Any one of us might not have all one needs to either develop a product or do a research project or compete for a grant," Murnane said. "So by having a strong connection with each group, which has a unique set of strengths, it's more likely we can compete internationally."

Researchers have a support network at CSU for commercializing innovation in the marketplace.

# Colorado State University is open for business

**By CSU President Tony Frank**

Every day, business leaders from Fort Collins to Grand Junction, from Seattle to Atlanta, from Moscow to Tokyo ask themselves whether they have the products, talent and technology to compete and thrive in today's lightning-fast, global marketplace.

At Colorado State University, we've worked hard to support a culture of innovation and entrepreneurship focused on academic programs and research endeavors that will deliver the next generation of products, talent and technology. In the following pages, you'll get a very clear look at how CSU is supporting business in Colorado and having an impact throughout the state, across the nation and around the globe.

## A history of supporting business

You might say that supporting the business community is part of CSU's DNA. This year marks the 150th anniversary of the signing of the Morrill Land Grant Act—the ground-breaking legislation authorized by President Abraham Lincoln in 1862 that created a system of public colleges and universities across the country "to promote the liberal and practical education" of the sons and daughters of the working class.

The legislation was about making sure that all Americans, regardless of economic status or family background, have access to the benefits of higher education, but it was also about feeding a growing nation and ensuring the availability of a highly trained workforce to support a thriving economy in all sectors—business, engineering, technology, and more.

CSU is a land-grant institution that was founded in 1870, and I can unequivocally say that our mission is as relevant today as it was 142 years ago. From humble roots, CSU has grown to be-

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come one of the nation's leading public research universities. Today, Colorado State is ranked in the top tier of universities in *U.S. News and World Report's* rankings of "America's Best Colleges and Universities," while *Kiplinger's Personal Finance Magazine* named CSU one of the top public universities in the United States in terms of educational quality and affordability.

## Our students, your workforce

We often say that CSU is the "university of choice" for Colorado residents. From our student body of about 30,000, approximately 80 percent come from Colorado families. Bottom line—more Colorado high-school students choose to enroll at CSU than any other college or university in the state.

These students are the foundation of Colorado's future workforce. In 2011, CSU awarded more than 6,100 degrees. In fact, 30 percent of all of Colorado's science, math, engineering and tech degrees—more than any other four-year institution in the state. In addition, CSU offers among the very best professional programs in the United States in veterinary medicine, occupational therapy, journalism, agriculture, construction management and more.

So whether you're hiring electrical engineers or a chief financial officer, keep an eye out for CSU graduates next time you're looking at resumes. We have more than 99,000 alumni who live and work in Colorado, and I'm confident you'll find them to be among the most qualified and well-prepared to serve your business needs.

## Research driving innovation

In 2011, CSU's research expenditures totaled more than $330 million, making CSU No. 2 in the nation in research productivity among universities without a medical campus. Last year, CSU research

**"CSU is working to make sure that the discoveries and inventions that are coming out of on-campus labs are moving into the private sector faster than ever."**

produced 277 patents, patent filings and invention disclosures. Ultimately, this research is fueling innovation in important and diverse sectors, including agriculture, engineering, biophysics, veterinary medicine, chemistry, atmospheric science and business.

CSU is working to make sure that the discoveries and inventions that are coming out of on-campus labs are moving into the private sector faster than ever. In the past five years, CSU has created 20 startup companies based on technologies that have come out of the university and licensed 136 technologies to companies in Colorado (195 technologies in total).

If you work for a company that is looking for an academic partner, I encourage you to connect with CSU Ventures, our tech transfer outfit, to see if there's a way to build a long-term relationship that will help you leverage the research power of CSU for your business needs.

## Partnerships preserve quality

I'll conclude by noting that CSU has learned a lot of lessons from the private sector in recent years and applied them to the way we run the university. Like so many of you, we've had to become leaner and more efficient to maintain our high quality and competitive standing in the face of continued resource constraints.

As we've noted many times over the years, the level of state funding for higher education has decreased dramatically, and CSU, like so many Colorado businesses, has had to make do with less. I'm very proud that the cost of educating a student at CSU is the same today as it was 20 years ago on an inflation-adjusted basis, even while CSU has moved into the top tier of American public universities. Unfortunately, students and families are paying an increasing share of that cost because of declines in public support: While the state 20 years ago paid two-thirds of a Colorado student's public education, today it pays just one-third. That cost burden has shifted to students and families, and innovative partnerships with donors and the private sector are increasingly essential.

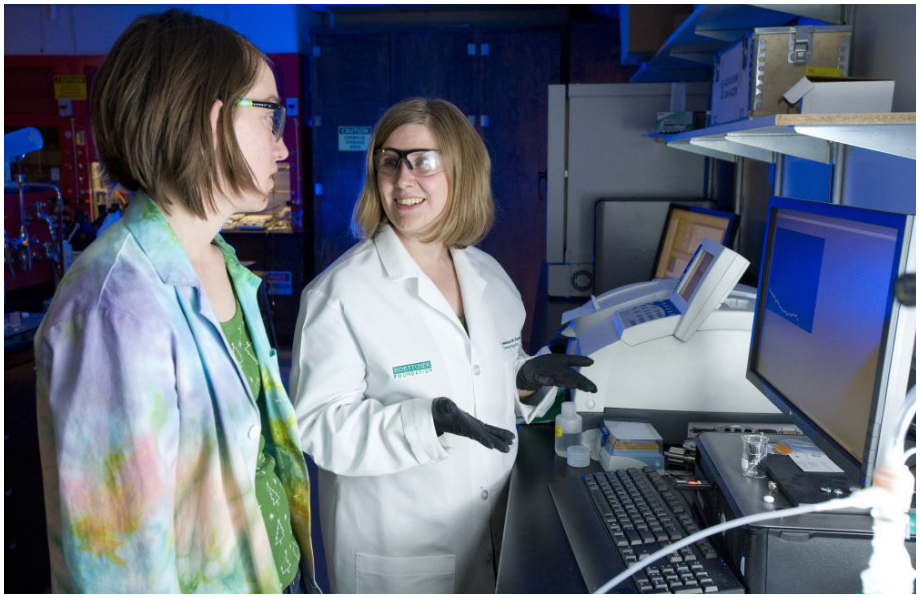
Today, our relationship with the private sector is more important than ever. Partnerships with industry create new revenue streams for CSU that help maintain our world-class academic programs and top-tier research activities. In return, our private-sector partners have access to all the benefits that come from a deep relationship with a world-class university —including access to research, leading experts, interns and so much more.

Ultimately, we recognize that the global face of business is evolving, and CSU is committed to evolving with it. We've been doing it for 142 years and we aren't going to stop now.

**Ranks 2nd** In the nation among all public universities without a medical school for annual research expenditures

# Innovation key at CSU

## Patent generation tops national charts



**CSU has filed a patent application for Chemistry Professor Melissa Reynolds, center, and is helping her form a company for accelerating the time-to-market for a biodegradable polymer with healing properties that could be used inside or outside the human body.**

At Colorado's only land-grant institution, Colorado State faculty and students create new companies and jobs critical to Colorado's economy, prepare students for the workforce and enable innovation. The university has influenced state and national economic development activities and enacted major initiatives to improve partnerships in the community and encourage entrepreneurship.

"Partnerships between Colorado State and the economic development community are critical to a strong economy," said Bill Farland, vice president for research at Colorado State and formerly a top federal scientist. "We can provide the technology that will help position the state as a leader in innovation and develop partnerships to ensure a healthy job base."

The university works in tandem with state and local economic development leaders, such as the Fort Collins Area Chamber of Commerce, to promote job creation and facilitate partnerships that lead to economic health of the community.

"CSU, in combination with the high technology sector of the economy, drives innovation," said David May, president and CEO of the Fort Collins Area Chamber of Commerce. "A synergy is created that is hard to describe but very real. Our community generates 11.45 patents per 10,000 population—four times the national average."

### Colorado State University's leaders in Economic Development

Kathay Rennels, CSU assistant vice president for economic development, was selected by Gov. John Hickenlooper to help with his "Bottom-Up" economic development initiative because of the university's deep connection to communities statewide through its extension offices.

Former Colorado Gov. Bill Ritter heads the Center for the New Energy Economy. In addition to developing the center as a credible source of unbiased, science-based information, data and research, Ritter convenes national and statewide discussions among policymakers, scientists, business, environmental organizations and others.

Martin Shields, professor of economics and director of the Regional Economics Institute, researches what's happening with Colorado's economy, including the impact on typical households and various job sectors. In 2011, he published a report on the economic changes occurring across Colorado that showed signs of life emerging in south-central and western Colorado, despite substantial job losses and negative effects on nearly every sector of the economy.

Ron Sega, vice president for Energy and the Environment at Colorado State, joined a select group of business and economic development leaders to prepare "Colorado Competes," a report on Colo-

**Continued on next page**

**U.S. leader** In veterinary medicine, consistently ranked among top three by *U.S. News & World Report*

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rado innovation and job creation that was submitted to President Obama in 2011.

## Highlights of other Colorado State economic development activities

### Superclusters™

Entrepreneurial faculty work together to increase collaboration among disciplines to develop marketable solutions to challenges in cancer, clean energy and infectious disease. Within several years of creating the Superclusters, faculty invention disclosures as much as tripled in some of these areas.

**http://www.supercluster.colostate.edu/**

### CSU Ventures

This private, nonprofit advocacy arm of the university handles technology transfer activities and supports the Superclusters with technical, business and industry expertise to commercialize university inventions. As part of the effort, the university has created a startup guide—an overview meant to assist inventors who would like to found a company based on technology that they have created during the course of their CSU activities.

**http://www.csuventures.org**

### CAMT Northern Colorado Manufacturing Extension Partnership

The Colorado Association for Manufacturing and Technology (CAMT) and the CSU Office of Community and Economic Development are partners in the CAMT Northern Colorado Manufacturing Extension Partnership Regional Office at CSU. This partnership focuses on aerospace and clean energy and is part of a statewide effort to connect Colorado businesses with partners, leveraging federal funds and attracting private capital investment in the Colorado region.

**http://outreach.colostate.edu/econdev/camt.html**

**As part of an NSF program, a high school student shows off research he completed with the help of CSU graduate students and advisors at a recent Engineering Exploration Day at CSU.**

### Industry Partnership Committee

The Industry Partnership Committee is made up of representatives from across the university working to improve and encourage the university's relationship with industry. The committee aims to assist businesses to more easily connect with the extensive intellectual assets of the university.

### Federal Demonstration Partnership

Colorado State participates in the Federal Demonstration Partnership convened by the National Academy of Science's Government-University-Industry-Research Roundtable. The FDP is a cooperative initiative among 10 Federal agencies and 98 institutional recipients of federal funds; its purpose is to reduce administrative burdens for faculty and staff engaged in research and to enhance research effectiveness.

**http://sites.nationalacademies.org/PGA/fdp/index.htm**

**Top 4** Nationally for solar power at major public research university

# New initiative maps Ag value chain

A lifelong rancher and small business owner, Kathay Rennels has been working in rural communities her whole life. She has carried that passion to CSU, first through her work as commissioner with Larimer County and past president of Colorado Counties Inc. and now by connecting the university to the needs of Colorado as it rebuilds from the economic challenges of the past few years.

As CSU's assistant vice president for community and economic development and three-time Larimer County Commissioner, Kathay Rennels put 6,400 miles on her car traveling throughout Colorado as part of Gov. John Hickenlooper's "Bottom Up" economic development initiative.

**Kathay Rennels, Assistant Vice President**

As a result of the initiative, the state has identified 11 key industries on which it will focus. Rennels will take the lead on agriculture as a key industry for Colorado. Working with the Colorado Department of Agriculture and Colorado State, she is helping produce an industry study that will map economic relationships among sectors tied—perhaps unexpectedly—to farm and ranch production.

Called the Agricultural Value-Chain Analysis and led by Professor Greg Graff, the new study will show the many linkages within Colorado's broad agricultural industry and highlight sectors that many Coloradans might not immediately associate with agriculture, including biotechnology, finance, ag tourism and the food and beverage sector.

Colorado agriculture annually contributes an estimated $40 billion in sales to the state economy. Analyzing economic industry connections is a key step in understanding critical issues, common challenges, emerging policy needs and opportunities for growth in agriculture.

"We're trying to shine a light on all the different facets of agriculture," Rennels said. "We want to create foundational knowledge about the depth and breadth of the agricultural industry, how it is linked across industries and its role as an economic driver."

"Colorado Agriculture and its associated industries do such a great job of producing fine-quality products and services that there is a natural tendency to assume its permanence," Rennels said. "Having the opportunity to have this discussion will create a continued partnership and awareness of the importance of agriculture and all its ties to the state of Colorado."

For information about the Colorado Agricultural Cluster Industry and upcoming meetings, contact Kathay Rennels, CSU assistant vice president for community and economic development, (970) 491-7304; or Tom Lipetzky, director of the Colorado Department of Agriculture Division of Markets, (303) 239-4114.

### University Industry Demonstration Partnership

The University Industry Demonstration Partnership consists of universities and companies seeking a stronger relationship. The organization provides a forum for discussion of contracting and intellectual property policy, publication and technology transfer preferences, and other issues.

**http://sites.nationalacademies.org/PGA/uidp/PGA_049074**

**Almost 2X** CSU licensing revenue increase between 2007-2011 over the previous five-year period

# CSU tops in recruiting in-state students, and in statewide outreach

From Antonito to Holyoke, from Dinosaur to Walsh, Colorado State University serves the state of Colorado, enrolling more Colorado high school students than any other university campus and providing outreach and economic development resources to industries that range from agriculture to the arts.

Rural economic and community development are central to CSU's outreach and engagement efforts, and through CSU Extension, the university has lived in and served Colorado's rural communities for almost 100 years. CSU's goal is to strengthen economies and communities by understanding unique community needs and opportunities.

## Highlights of CSU's outreach across Colorado

Extension serves 59 of 64 Colorado counties, and as a statewide network, it is uniquely positioned to provide local and regional community development assistance by providing timely economic and community data, bringing together key stakeholders and facilitating discussions about community and economic development issues.

To provide communities with university-backed economic data, the CSU Regional Economics Institute extends economic research and analyses to urban and rural communities across the state. Like Extension, the Institute is part of the CSU Office of Community and Economic Development.

CSU is one of the few universities in the country to host a state Forest Service (through the Warner College of Natural Resources). Colorado State Forest Service employees participate in Incident Management Teams that coordinate and manage wildland firefighting efforts in Colorado and around the country. The CSFS also is a co-sponsor of the annual Colorado Wildland Fire and Incident Management Academy, which trains firefighters and others interested in participating on Incident Management Teams for wildland fire and other natural disasters.

As a member of the Colorado Bark

**A CSU student conducts research on the Arkansas River as part of a CSU river monitoring and modeling project.**

**Leader in** Educating Colorado students in Science, Technology, Engineering and Mathematics (STEM)

Beetle Cooperative and the Northern Front Range Mountain Pine Beetle Working Group, the Colorado State Forest Service also collaborates with communities to mitigate the impacts of mountain pine beetle infestation and help protect communities, infrastructure, watersheds and other natural resources from falling trees and wildfires.

As the state's agricultural research leader, CSU provides great benefits to the wheat industry. Estimates from Colorado wheat industry leaders indicate that end-use quality enhancements from cultivars developed at Colorado State provide an average of $20 million per year increased income for Colorado wheat producers. Since inception of the program in 1963, CSU's wheat breeding program has released more than 26 improved wheat cultivars.

CSU's wine grape research is examining cultivars from around the nation and world to find species, cultivars or clones that will allow grape growers and wineries to be more competitive in the marketplace and thus improve the economic viability of the Colorado grape and wine industry.

The state climatologist is based at Colorado State University. Nolan Doesken, who holds that position, has 36 years of professional experience in weather research and climate studies that include snow totals and impacts on drought, weather observation, historical climate data, precipitation and seasonal weather patterns. He also works with state and local officials on agricultural, recreational, hydrologic and industrial applications of climate information.

The Colorado Water Institute, a state-funded affiliate of Colorado State University, exists for the express purpose of focusing the water expertise of higher education on the evolving water concerns and problems faced by Colorado residents.

# CSU's Menon to lead the Colorado Innovation Network

Colorado State University's Ajay Menon, dean of the College of Business, has been chosen to lead the Colorado Innovation Network as the state's first chief innovation officer.

Gov. John Hickenlooper created the network to promote collaboration among Colorado's private, public and academic organizations and to stimulate economic growth, help create jobs and attract new businesses. Work began in March.

"We are thrilled to have Ajay Menon's vision and experience in leading this effort," Hickenlooper said.

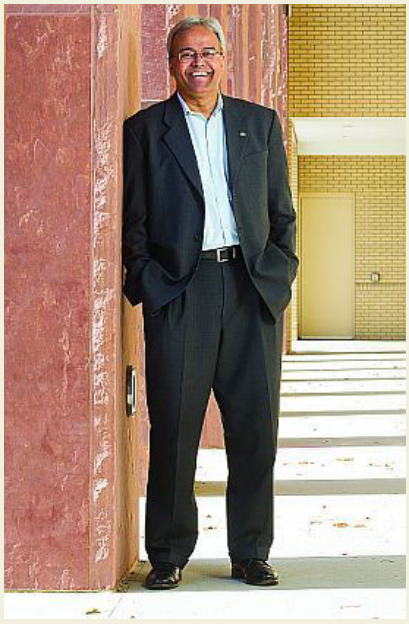
The network's goal is to develop an ecosystem in Colorado that cultivates entrepreneurial and innovative activities. Menon is volunteering 20 hours per week for the state in addition to his full-time job as dean of the College of Business.

"The Colorado Innovation Network is a roadmap for making Colorado the best state for innovation," Hickenlooper said.

The Colorado Innovation Network's objectives are to:

- Foster innovation
- Retain jobs and support growth in key industry clusters
- Pursue capital for project funding
- Establish Colorado's reputation as the most innovative state
- Create a workforce with the right talent and job skills
- Develop innovation-oriented performance metrics to demonstrate COIN's economic growth impact

As dean of the College of Business at Colorado State, Menon provides strategic direction for the College of Business. His responsibilities include developing and maintaining relationships with all external stakeholders, and obtaining financial resources for the College to achieve its vision for success.



**Business Dean** Ajay Menon

Menon, a member of the marketing faculty since 1991, holds a doctorate in marketing and has research expertise in international marketing, new product development & management and strategic market planning. His research interests focus in the areas of customer loyalty, new product management and strategy implementation.

Menon's research has been widely published and he's been honored multiple times, including being named "Professor of the Year."

**Ranks 3rd in U.S.** In entrepreneurship research by the College of Business faculty

## CENTER FOR THE NEW ENERGY ECONOMY

# Economy helps government, industry with sustainable energy solutions

As director of the Center for the New Energy Economy at Colorado State University, former Colorado Gov. Bill Ritter is working to help government and industry plug in to the promise of the new energy economy with common sense solutions and policies to fuel long-term, sustainable economic growth.

"Just as the industrial revolution created the jobs of the 20th century, we now usher in a new century of innovation, creativity and entrepreneurial vigor," said Ritter, who also serves as a senior scholar within CSU's School of Global Environmental Sustainability. "The new energy economy is creating the pathway to these careers and a new American century of leadership."

Founded in February 2011, the Center for the New Energy Economy is a privately funded initiative to support the growth of a clean energy economy across the nation. Under the leadership of Ritter, who earned his bachelor's degree at Colorado State, the center is able to tap the clean energy expertise of researchers and scientists at CSU as well as other national experts in clean energy research, development and commercialization.

With an approach that is grounded in research and science, the center works directly with industry and government leaders—governors, legislators, regulators, planners, policy makers—to provide technical assistance to help them create the policies and practices that will facilitate the transition to a clean energy economy.

**Former Gov. Bill Ritter, right, now director of the Center for the New Energy Economy at CSU, on a tour of the university's Engines and Energy Conversion Laboratory with Gov. John Hickenlooper, CSU President Tony Frank and Professor Bryan Willson, lab director.**

"CSU is at the forefront of driving alternative energy solutions to the marketplace, and no one has been a more active and articulate advocate for the creation of a new energy economy than Gov. Bill Ritter," CSU President Tony Frank said. "This center is a natural partnership that capitalizes on his extraordinary experience and knowledge in this arena while building on CSU's well-known innovative, entrepreneurial approach to clean energy research and development."

Today, more than 200 faculty from all eight CSU colleges are involved in sustainability science and clean-energy research. The Center for the New Energy Economy is part of CSU's School of Global Environmental Sustainability, an umbrella organization created to develop and promote new strategies for global sustainability.

For Ritter, it's vital that government and industry work together to build a more sustainable energy future. The stakes couldn't be higher.

"For me, the New Energy Economy has always been about our future, our kids' future, our grandkids' future," Ritter said. "I think in order to survive in this created space we inhabit, we need to produce and consume energy differently. If we don't, then our legacy for our children will be a Colorado inferior to the Colorado that we live in."

**In Top 25** Engines and Energy Conversion Laboratory ranked one of the 'Most Awesome College Labs' by *Popular Science*

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BCBR's CEO Roundtable is an invitation-only, monthly forum where Boulder & Broomfield county CEOs, Presidents and company owners/partners meet and discuss current trends of the local economy in the Boulder Valley and Denver/Boulder Corridor. Roundtable attendees exchange insight and information in a non-competing, cohesive environment. Follow-up articles are published in the BCBR print edition following the roundtable. 2012 sponsors for BCBR's CEO Roundtables include Berg Hill Greenleaf & Ruscitti, LLP and EKS&H, PC.

MERCURY 100

**May 24, 2012** 5:30 – 7:30 p.m.
Plaza Hotel Convention Center, Longmont CO
Celebrating the Top 100 Fastest-Growing Private Companies in the Boulder Valley Mercury 100 is the event at which to meet and honor up and coming businesses at a reception in their honor. Companies are ranked by their percentage of revenue growth over a three-year period. Sponsors for the 2012 BCBR Mercury 100 Awards include the Better Business Bureau Serving Denver/Boulder; Bolder Staffing; Flatirons Bank; foreThought.net; Freeman Myre Property Advisors; Photocraft Imaging/GraphX; Wells Fargo Bank, and KUNC Community Radio.

green summit
BLENDING BUSINESS & THE ENVIRONMENT

**June 12, 2012** 7:30 a.m. – 5:30 p.m.
Millennium Harvest House, Boulder CO
The Boulder County Business Report Green Summit demonstrates that businesses and environmental stewardship blend to advance global well-being. This day-long event includes speakers and panels addressing diverse aspects of "going green" including energy conservation, recycling, and green building plus environmental topics. Sponsors for the 2012 BCBR Green Summit include the Better Business Bureau Serving Denver/Boulder; Photocraft Imaging/GraphX, and Western Disposal.

iQ

**August 22, 2012** 5:30-7:30 p.m.
Boulder Theatre, Boulder CO
The Boulder County Business Report IQ Awards honors the most innovative new products and services developed by companies and organizations headquartered in the Boulder Valley. The evening's excitement will mount as pitches by award finalists are presented to panels of judges knowledgeable in specific industries, and the winners are announced in live, breaking-news style from the stage. 2012 sponsors for BCBR's IQ Awards include Freeman Myre Property Advisors; Boulder Staffing; forethought.net; Wells Fargo Bank; Colt Printing Services; Photocraft Imaging/GraphX, and KUNC Community Radio.

biXpo

**September 26, 2012**
Embassy Suites – Loveland

The 8th annual Bixpo Business and Technology Expo is a must-do, top-of-the-list business connection event. Sponsorships and exhibit spaces available – 2011 was a sellout! Sponsored by: CSU Ventures, a subsidiary corporation of CSURF; Better Business Bureau; Palmer Flowers; DaVinci Sign Systems; KUNC Community Radio and Social Media Pilots.

Boulder Valley REAL ESTATE Conference & Forecast

**November 15, 2012** 7:30 a.m. – 5:30 p.m.
Millennium Harvest House, Boulder CO

Trends in Boulder Valley real estate are the focus of this full-day conference. Speakers and panels will present insights and information about recent movements in real estate as well as related industries that affect development, sales and invest in Boulder and Broomfield counties. An end-of-day forecast will lead into a reception designed for attendees to make strategic business connections. Sponsors for the 2012 Boulder Valley Real Estate Conference & Forecast include ReMax of Boulder; Gibbons White, Inc.; Better Business Bureau Serving Denver/Boulder; Boulder Creek-Life and Home; Colorado Lending Source, Fidelity National Title; Land title Guarantee Company; Wells Fargo Bank; Photocraft Imaging/GraphX, KUNC Community Radio.

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COLORADO STATE UNIVERSITY

**Surgeons work to repair a horse's leg at Colorado State University.**

RESEARCH: VETERINARY MEDICINE

# What we learn from animals

## Breakthroughs in regenerative medicine, bioterrorism and tuberculosis

**BY TRACEE SIOUX**

From stem cell therapy to infectious disease, the research being conducted at Colorado State University's College of Veterinary Medicine and Biomedical Sciences has as many implications for humans as it does for animals.

The college is a trailblazer in regenerative medicine, conducting extensive stem cell research for various diseases and injuries using sheep, horses and rodents. While treating animals for various conditions, the school conducts clinical studies that often translate to new human cures and treatments.

The nationally known school has a research budget of about $54 million, with most of that coming from the National Institutes of Health and the U.S. Department of Agriculture. CVMBS employs 1,289 scientists, researchers, professors, graduate students, post-doctorate students, lab techs, and undergrads.

*Continued on next page*

# Harnessing the power of animals and humans to fight cancer

Colorado State University College of Veterinary Medicine and Biomedical Sciences and the University of Colorado Anschutz Medical Campus are working together, studying new techniques to treat cancer, among other things, in humans and animals. One of the largest collaborative projects is at the Anschutz Cancer Center, the only National Cancer Institute designated comprehensive cancer center in Colorado.

The two schools share graduate students, explore pharmacology, look at how drugs affect humans and animals, conduct studies in cancer nutrition, and conduct clinical trials for new treatments in humans and people. Weekly seminars are conducted during which investigators can explore new information and discoveries together.

"There are so many similarities in the cancers that humans and animals get. Many treatment modalities for cancer are used both in humans and animals," said Susan Vandewoude, associate dean for research and graduate education.

Medical imaging is among the most vital innovations. New laser sharp machines can be used to achieve clear images in real time with minutely precise results.

— Tracee Sioux

*Continued from previous page*

Though 80 percent of funding comes from the federal government, smaller private entities also play a role. The Gates Foundation has been an increasing source of support for research that benefits Third World countries.

"We have a strong program in infectious disease; quite a number of grants from the Gates Foundation have been related to infectious disease, like tuberculosis," said William Farland, CSU's vice president for research.

People from all over the world bring their animals, sick with cancer, to the world-renowned Animal Cancer Center, advancing cancer research that is also useful in human cancers.

"We are known for our cancer work. People literally come from around the world to bring their companion animals to the best animal cancer center in the country. About 3,300 cancers come through that facility annually and it allows us to do the equivalent of human trials," said Farland. "We experiment with therapies, drugs and treatment techniques, much like a clinical hospital would do clinical trials for human treatments."

> **"These are treatments that they are starting to use in people based on our findings."**
>
> — Susan Vandewoude, associate dean for research and graduate education, Colorado State University

Currently, the Equine Orthopedic Research Center is studying whether the use of stem cells is effective in managing arthritis in race horses. Stem cell therapy is already being used to treat injuries race horses sustain while racing and training, but there have been few official studies to evaluate the effectiveness of the treatment and why it may work.

"There is initial evidence that there is a benefit," said Susan Vandewoude, associate dean for research and graduate education, CVMBS. "Now we're looking at 'why?' What is it about the stem cells that causes the improvement of condition?"

Sheep, having physiological similarities to humans, are being used to research ways to implant stem cells in tendon injuries, heart implants or muscular-skeletal problems. Scientists are working to cure renal disease in cats and liver disease in dogs, also using stem cells.

"These are treatments that they are starting to use in people based on our findings," said Vandewoude. "They take the stem cells out of a person [or animal], they grow them in a culture and put them back in the place of injury."

The Microbiology, Immunobiology and Pathology group is studying weapons of bioterrorism, plague, the encephalitis virus, outbreaks of epidemics and potential vaccines. They study containment of diseases that are transferred from animals to humans or livestock, such as malaria, tuberculosis, West Nile virus and chronic wasting disease.

"Many diseases people get come from animals. We have a group in Senegal, Africa right now studying how we might be able to control the ability of mosquitos to transmit diseases like malaria to people," said Vandewoude.

Chronic wasting disease, a contagious neurological disease that can result in death, and is related to Mad Cow Disease, is currently found in 25 percent of Colorado deer and elk. The MIP group is studying how it is transmitted, how it might be eliminated, and whether the virus can be transmitted to domestic livestock and into the food supply.

The department has made a breakthrough in tuberculosis treatment, discovering a weakness in the cell wall coating and finding a class of drugs able to breach the wall coating so the disease can be treated more rapidly. Previously, it took six to nine months for TB drugs to make their way through the cell barrier and provide the patient with relief. Researchers believe these new drugs will speed the process dramatically.

At the school of reproductive physiology, scientists have been developing in vitro fertilization techniques, removing the eggs from a valuable older mare and placing fertilized eggs into a less valuable younger mare. This protects the older breed mare from the strain of pregnancy, while still producing the desired offspring.

University of Colorado Boulder electrical engineering professor Lucy Pao is working with the National Renewable Energy Laboratory to create control systems for wind turbines. NREL completed two dozen licensing transactions in the last fiscal year.

GLENN J. ASAKAWA/UNIVERSITY OF COLORADO

# MOVING IDEAS TO MARKET

## Spinning research into startups is a driver of Colorado's economy

**BY CHARLIE BRENNAN**

Colorado has fared better than some states through the recent economic slowdown, and its continued recovery will require sustained vigor in technology transfer, sparked by the states' top research universities as well as federal labs.

Colorado is a hotbed for tech transfer — research and development of scientific innovation through the phases of invention and patent, leading ultimately to licensing of intellectual property into the business community.

The 2010 report *New Economy States*, released by the Ewing Marion Kauffman Foundation and the Information Technology and Innovation Foundation, ranked Colorado sixth in the nation for its innovation capacity, and technology transfer was a factor contributing to that high ranking.

"We absolutely have to be great at tech transfer," said Tom Clark, CEO of the Metro Denver Economic Development Corp. "I think we're good now. We used to be mediocre. We still have a ways to go, to be great."

Colorado's top academic institutions are playing a critical role. The Bayh-Dole Act of 1980, giving universities, small businesses and nonprofits control of inventions and intellectual property developed through federal funding, stoked their incentive for pushing new technology to the marketplace.

CU researchers secured more than $790 million in sponsored research funding during fiscal year 2010-11, representing about a $50 million boost over the previous year's totals. In the same year's annual report, CU showed 253 U.S. patent applications filed and 33 patents granted. Further, 11 startup companies were formed from CU intellectual property, and $3.9 million realized in licensing revenue.

For the year 2010, the Association of University Technology Managers credited CU with nine business startups resulting from technology transfer, placing it twelfth that year among just over 152 schools ranked.

CSU Ventures, the office for technology transfer at Colorado State University, currently boasts more than $330.8

"We push out the technologies that we have to the companies ... and we want them to reach into us and pull things out, as well."

— Todd Healey, president, CSU Ventures

million in annual sponsored research funding. In fiscal year 2010-11 it generated 142 patent applications, saw 15 patents issued, spawned five new startup companies and pulled in $1.33 million in licensing income.

In Golden, the Colorado School of Mines also hosts a vibrant Office of Technology Transfer, listing 95 patents granted for innovations ranging from oxidation resistance coasting for refractory metals to microfluidic devices employing field switchable colloidal particles.

Ken Lund, executive director for the Governor's Office of Economic Development and International Trade, said, "I think the research and development and transfer of technology positions us well, because we have a strong backbone in that area, for a quicker recovery than some other states."

David Allen, CU's associate vice president for technology transfer, said successfully pushing the school's new technology to the marketplace depends on a number of factors. They include developing an understanding of what the applications of its "over-the-horizon" technologies might be, while also working with what he called "serial entrepreneurs" with a proven "sensing" skill to make new technologies commercially viable.

"That's what is so beautiful about the Front Range business community," said Allen. "There are a lot of people who understand how that sensing works."

According to Allen, a total of 52 companies have been launched based on intellectual property created through research conducted in the labs at CU, and 44 of them — 85 percent — have operations within the state.

Success stories include Ribozyme Pharmaceuticals Inc., located in Boulder with 135 employees. The company was founded on the discovery of Thomas Cech, a Nobel Prize-winning CU-Boulder Professor of Chemistry, that RNA could behave like an enzyme.

At CSU, the bulk of the school's newly invented technology is developed through the College of Engineering and the College of Veterinary & Biomedical Sciences. The Colleges of Natural Sciences and Agricultural Sciences are also major players on the technology transfer front at CSU.

A vital technology transfer program, according to Todd Headley, president of

*Continued on next page*

**Tech transfer facts for selected Colorado schools 2010–11**

| | CU–Boulder/Denver | CSU | School of Mines* |
|---|---|---|---|
| Licensing revenue | $3.9 million | $1.3 million | $120,000 |
| Patent applications | 253 | 142 | 16 |
| Patents held | 33 | 15 | 95 |
| Spinoffs | 11 | 5 | 2 |

*For 2011

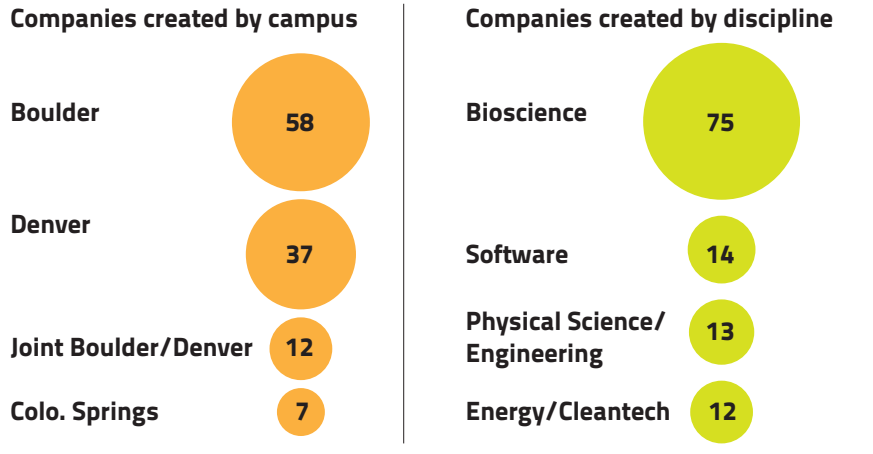
Sources: CU 2010-11 Tech Transfer Annual Report; CSU Ventures; Colorado School of Mines

## The sustainability of companies created based on CU intellectual property

In the last 18 years, 114 companies have been formed based on CU Intellectual Property. Twenty-three are known to be non-operational.

Of the 91 companies known to be operating:

- 85 have operations in Colorado (although the headquarters may be located out-of-state)
- 19 have received CU Technology Transfer Office Proof of Concept investments
- 7 have "gone public," becoming publicly traded companies (either through an IPO or via a reverse merger)
- 17 have been acquired by public companies (including five from the above seven that have gone public)



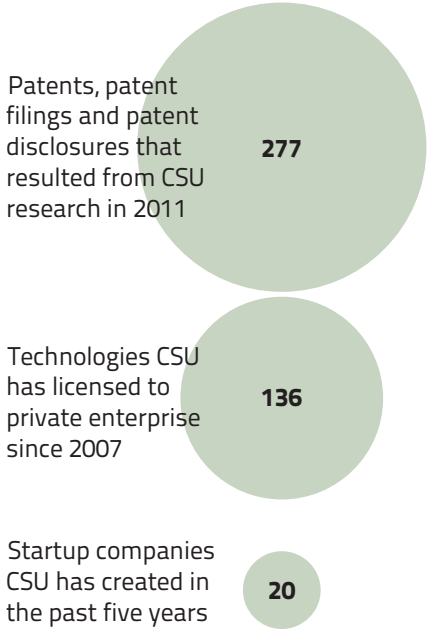

Source: CU TTO Records and public information

COLORADO STATE UNIVERSITY

**The college of Agricultural Sciences is a major player in Colorado State University's technology transfer program. A vital technology transfer program requires an active two-way street between researchers and the marketplace, said Todd Headley, president of CSU Ventures.**

## CSU's innovation engine

During the past six years, research spending at Colorado State has increased 24 percent, even at a ime of significant cuts in federal research funding nationwide.




Source: Colorado State University

*Continued from previous page*

CSU Ventures, requires an active two-way street between researchers and the marketplace.

"We push out the technologies that we have to the companies," he said, "and what we also want to do is establish the relationships with industries and companies who know what we're working on, broadly, and we want them to reach into us and pull things out, as well."

The leading federal laboratory in Colorado engaged in technology transfer is located in Golden at the National Laboratory for Renewable Energy. In the last fiscal year, NREL completed two dozen licensing transactions, primarily involving patents or copyrighted software, according to Bill Farris, vice president for commercialization and technology transfer.

"Universities and labs are in the technology or innovation business, but we rely on partners to do the business-building part of it," said Farris.

Allen, at CU, said that although the recession of 2008 took its toll on the field of technology transfer, there are indications of better days ahead.

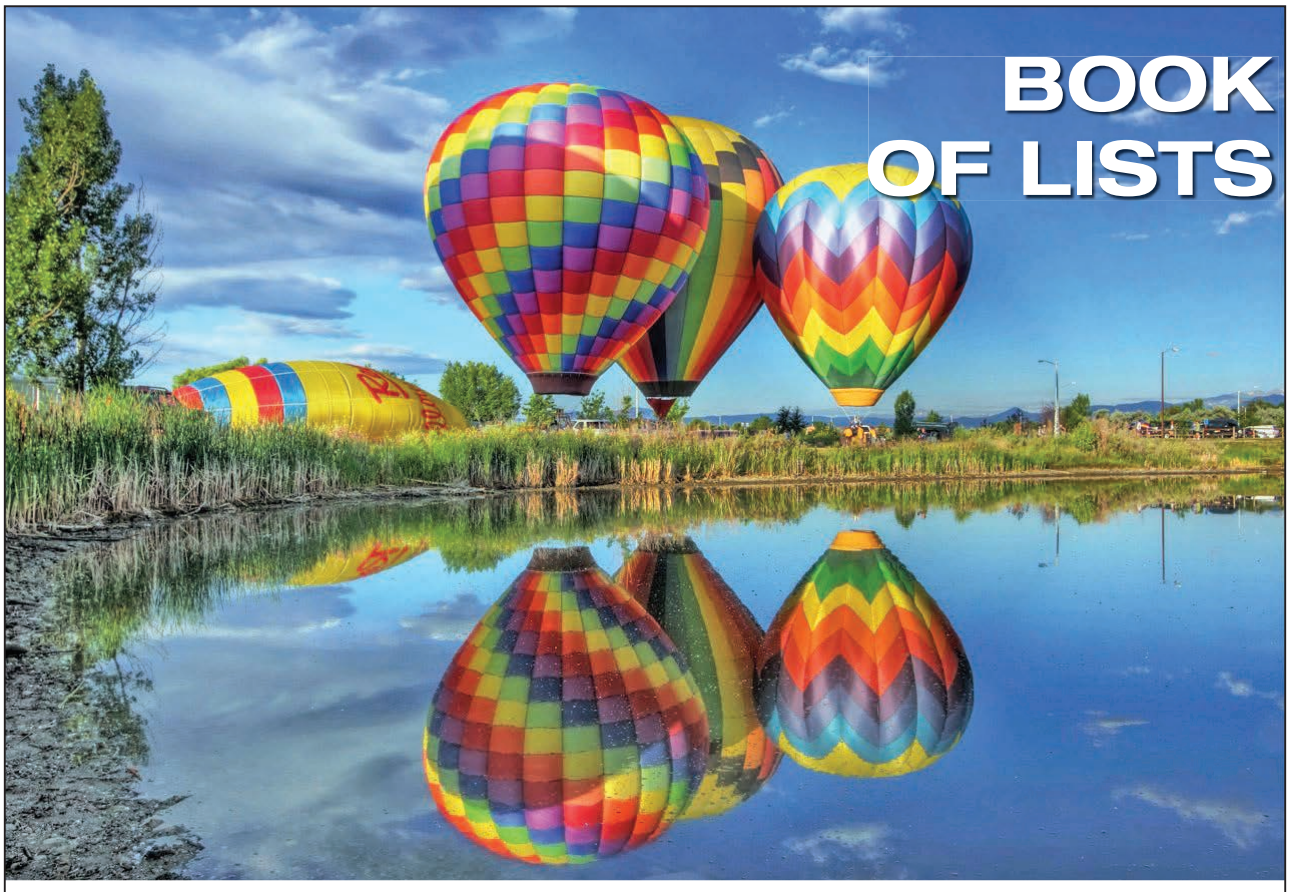
"I think there is some slow improvement in the venture community," he said. "What is important is mergers and acquisitions and public offerings, and there has been a pretty decent uptick in those kinds of activities in the last year.

"That creates an updraft, if you will, and we're seeing some of that," Allen added. "We're at the earliest stage of the process of commercialization, the raw invention, and it takes a big draft to have an impact at the stage we participate."

A lively spirit of mutually beneficial cooperation exists among the universities and the federal labs in Colorado engaging in technology transfer, according to Farris.

In fact, the Alliance for Sustainable Energy, which manages NREL for the Department of Energy, has on its board representatives of CU, CSU and the Colorado School of Mines, as well as Stanford University and the Massachusetts Institute of Technology.

"We see each other regularly, we're active in the same community, and we have very common interests, everything from sharing best practices to trying to support economic development in the state of Colorado," Farris said of his research peers. "I think we get along extremely well."

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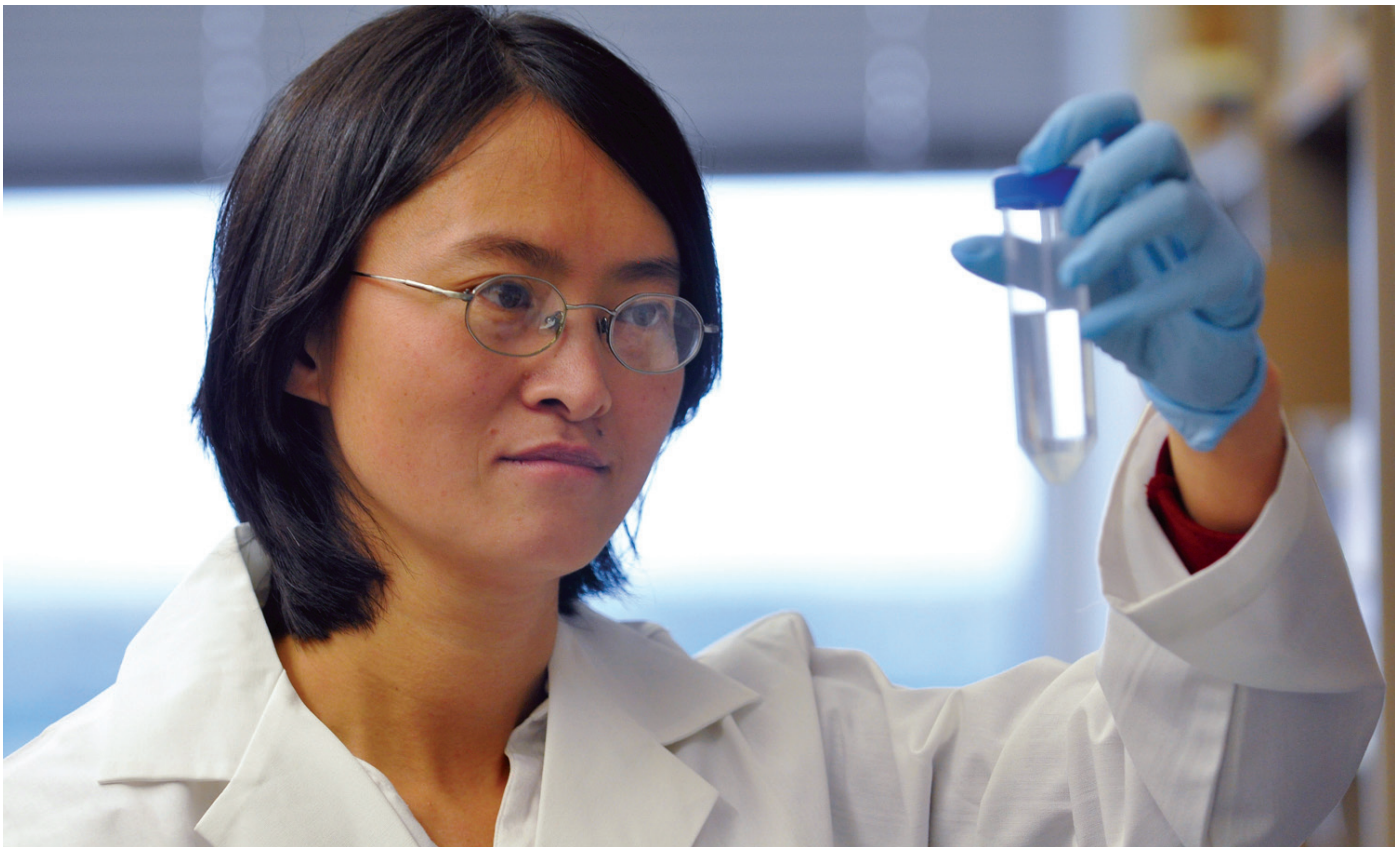

CU-DENVER

**Colorado saw a 15 percent increase in the number of international scholars in 2010-11, 34 percent of whom are doing work at the University of Colorado Denver | Anschutz Medical Campus.**

# Think globally, act globally

## Colorado is a vital partner in an international research community

**BY CHARLIE BRENNAN**

Fort Collins and Shanghai aren't often mentioned in the same sentence. But that was the case in June 2011 when Colorado State University and East China Normal University announced their Joint Institute for New Energy and the Environment.

That partnership, focused on developing new energy solutions and addressing the impact of energy on air quality, land use, climate and water resources, is just one among hundreds of such collaborative agreements that now link Colorado researchers with their peers around the globe.

Colorado's research community is expanding its global reach every year, due to the ever-increasing connectivity of 21st Century society and a vibrant culture of innovation and exploration at its leading research institutions.

According to the Institute of International Education's annual Open Doors report, there were 115,113 international scholars from 193 countries conducting research on U.S. campuses in 2010-11.

Of those, 1,805 were working in Colorado — up 15.3 percent from the previous year. And 574 of those in Colorado — or 32 percent — were at CU Denver and the Anschutz Medical Campus.

Not incidental is the fact that international student enrollments in Colorado last year contributed $315.5 million to the Colorado economy, according to the

Open Doors report.

CSU now lists nearly 100 international pacts — including student exchanges and faculty swaps, as well as larger-scale research projects — on its web site, involving countries on every continent but Antarctica.

Rick Miranda, Provost and Executive Vice President at CSU, contends that university is now one of the premier research universities in the United States.

"I wouldn't doubt that our international reputation in civil engineering and agriculture and veterinary medicine and areas like ecology and life sciences are driving the relationships forward," said Miranda, "although I think we have international activity all over campus, by now."

Agreements such as the CSU-ECNU pact, while proliferating, are hardly new. The Colorado School of Mines, for example, in 2001 entered an agreement to assist the Abu Dhabi National Oil Company (ADNOC) with the formation of the Petroleum Institute, a degree-granting university focused on engineering and applied science as it relates to the United Arab Emirates oil and gas industry.

And Stein Sture, Vice Chancellor for Research at CU-Boulder, said international partnerships have been a strong part of the institutional fabric for the 30 years he has been on the faculty there.

"In the College of Engineering and Applied Science, with 200 faculty members, it's fair to say just about every faculty member has two to three collaborations internationally," said Sture.

High-profile collaborations on the Boulder campus include physics department faculty and staff who are part of the $3.8 billion Large Hadron Collider project in Switzerland. The menu of CU-Boulder partnerships also includes its participation — along with universities in Canada and Germany — in a $110 million astronomy project in the Atacama Desert, Chile.

Many of these international scholars are doing what is called STEM-field research, in the areas of science, technology, engineering and mathematics, according to David Clubb, senior director in the office of International Affairs at CU Denver.

"Global competence for students and teachers and researchers used to be a catchy add-on thing for your resume, a feather in your cap, but now it's the baseline," said Clubb.

"You have to know what's going on in China and India, because you're going to be in labs where you're going to be collaborating with people from around the world; it is not an extra, anymore. It's a given."

> **"You have to know what's going on in China and India, because you're going to be in labs where you're going to be collaborating with people from around the world; it is not an extra, anymore. It's a given."**
>
> — David Clubb, senior director, International Affairs at CU Denver

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**Bryan Willson is director of the Engines and Energy Conversion Laboratory at Colorado State University.**

# Collaborating on clean energy

## Finding renewable solutions in the 'Collaboratory'

**BY PAULA AVEN GLADYCH**

Colorado has a long history in the energy industry, so it's no surprise that the state also is well-established as a leader in renewable energy research.

With energy prices rising and oil and gas supplies diminishing, three Colorado research universities and the National Renewable Energy Laboratory (NREL) in Golden are working together to find solutions.

The Colorado School of Mines in Golden, Colorado State University in Fort Collins and the University of Colorado Boulder formed a partnership with NREL called the Colorado Renewable Energy Collaboratory, which works closely with public agencies, private enterprise and nonprofits to increase the production of renewable energy sources and to support economic growth through renewable energy industries in urban and rural areas.

The Collaboratory's centers conduct research on biofuels and biorefining, solar energy, wind energy, carbon management and energy systems integration.

The project was initiated by former Colorado Sen. Ken Salazar, now Secretary of the Interior, because he saw the need and value of closely linking NREL to strong state research universities, said Dag Nummedal, director of the Colorado Energy Research Institute at the Colorado School of Mines. "We work hand-in-hand on everything we do."

The Colorado School of Mines has numerous programs that relate to renewable energy research, including the Renewable Energy Materials Research Science and Engineering Center, a partnership with NREL that researches and develops photovoltaic technologies. The Colorado Energy Research Institute brings industry, government and aca-

*Continued on next page*

# CSU lab is 'solutions-oriented'

The Colorado State University Engines and Energy Conversion Laboratory has spent 20 years helping the energy industry solve some of its most daunting problems.

The lab, founded in 1992, began researching ways to improve engine efficiency and reduce harmful engine emissions. The large natural gas engines that power pipelines needed to be retrofitted so they could pass Environmental Protection Agency performance standards, said Morgan DeFoort, co-director of the lab.

Energy companies "needed someone to help develop new technologies and test technologies for engines for the industry," he said. The lab, housed in an old Fort Collins power plant, has since grown and expanded to include research into how renewable energy technologies can safely attach to the electric grid and how different biofuels work with different engines. The lab has focused much of its attention on the emissions of biodiesels made from locally grown vegetable oils such as soybean, canola, Camelina sunflower and algae.

"We have specialists in biofuels and power systems, but really, the lab is a place where people collaborate in the field of energy and develop specific solutions," DeFoort said. "It is very industry focused. We receive more funding for work from private industry than federal or state grants. It keeps us very solutions-oriented."

— Paula Aven Gladych

*Continued from previous page*

demic interests together to tackle energy issues, including finding new renewable energy resources and positioning Colorado as an energy industry leader.

"Every university in Colorado has areas of expertise. More and more, big energy problems require collaboration," said Morgan DeFoort, co-director of the Engines and Energy Conversion Laboratory at Colorado State University. The more seamlessly the universities work together to find solutions to problems, DeFoort said, the more competitive Colorado's research and development industry will become.

CSU has more than 120 faculty members involved in the renewable energy arena, where the research focus is on biofuels and biorefining, wind and solar.

"What we're really looking at now is a transition strategy toward cleaner, more efficient production and use of traditional fuels," said William Farland, CSU's vice president of research. "That transition, from there into renewables, is going to take some time, but it makes sense for us to focus on traditional fuels and renewables as we do our research and move the field forward." The university's energy work brings in between $50 million and $60 million a year in research dollars, he said.

The Renewable and Sustainable Energy Institute at the University of Colorado Boulder, RASEI, is working on getting both solar and wind energy to a point where they can make it commercially, said Carl Koval, associate director for research at RASEI. The biggest challenge is getting renewable technologies to a large enough scale that they can impact world energy use, he said. To do this, they must be incorporated into the energy economies of fast-growing, developing countries such as China and India so that those countries don't become dependent on fossil fuels.

A recent Department of Energy report showed that the United States uses a total of 100 quadrillion British thermal units a year. Wind already produces 1 quad per year, but solar produces much less.

"Any technology that can't get to 1 percent of that by 2030 is not a player in the game," Koval said.


# University of Colorado Boulder research advances Colorado's economy and quality of life

**CU-Boulder research encompasses thousands of scholarly, scientific and creative endeavors at any given time.**

The combined resources of Colorado Front Range universities and federal research labs form a powerful research and development engine for the state's economic growth—and the University of Colorado Boulder plays a key role in making that engine hum.

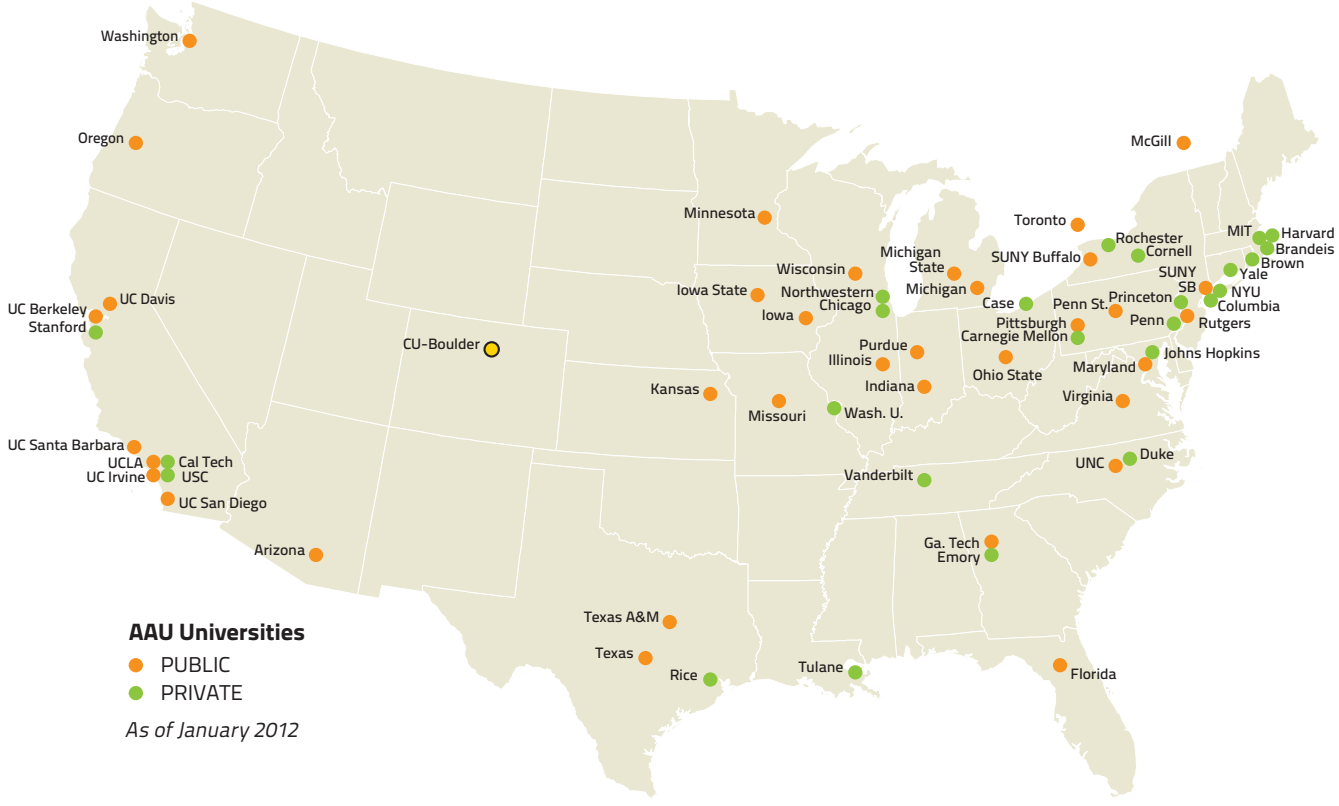
With more than 4,000 funded research efforts at any given time, CU-Boulder discoveries and innovations generate:

- Millions of dollars in new business development each year—a large portion of the combined impact of universities and laboratories on the Colorado economy.
- Highly skilled workers in growth industries like aerospace, renewable energy, geological sciences, biotechnology and computer sciences, to name a few.
- Research connections beyond the state that bring national and global business interests to Colorado.

With a dynamic roster of local research partners, a legacy of discoveries that lead to economic growth and a broad range of opportunities for business engagement and community impact, CU-Boulder's robust research enterprise plays a strong part in advancing the overall growth of Colorado's economy.

**In Colorado and beyond, CU-Boulder research is good for business.**

## THE ONLY AAU MEMBER IN THE ROCKY MOUNTAINS




As one of only 34 public research universities in the Association of American Universities (AAU) and the only member in the Rocky Mountain region, CU-Boulder maintains relationships with leading national and global research peers and helps promote the research and innovation of partner universities along the Front Range.

In addition, the proximity of several federal research laboratories to CU-Boulder has led to a healthy, high-impact environment for collaborative research efforts, including Nobel Prize-winning research in physics, chemistry and climate change, a national hub for renewable energy research, decades of world-leading space science innovation, and a strong pipeline of biotechnology business start-ups—not to mention a large portion of the University of Colorado's combined $5.3 billion in economic impact in 2011, according to a new Leeds Business Research Division Study.

### CU-Boulder's Move to Pac-12 Conference Strengthens Research Enterprise

In addition to providing a boost to its athletics programs and enhancing connections to its largest alumni populations outside of Colorado, CU-Boulder's move to the Pac-12 Conference strengthens its long history of collaboration with the nation's strongest research universities, such as AAU peers Stanford University; University of California, Berkeley; University of Oregon; University of Washington; University of California, Los Angeles; University of Southern California; University of Arizona.

## Research Highlights

**66** Companies formed since 1994 based on CU-Boulder technologies

**$1B+** Follow-on funding for companies formed based on CU-Boulder technologies


## Federal Lab Partners in Colorado

- Bureau of Reclamation, U.S. Department of the Interior (BuRec)
- Centers for Disease Control and Prevention (CDC/DVBID)
- Cooperative Institute for Research in the Atmosphere (CIRA)
- **National Oceanic and Atmospheric Administration (NOAA)***
- **National Institute of Standards and Technology (NIST)***
- **National Renewable Energy Laboratory (NREL)***
- National Telecommunications and Information Administration (NTIA)
- National Center for Atmospheric Research (NCAR)
- U.S. Department of Agriculture – Agricultural Research Service (ARS)
- U.S. Department of Agriculture – Rocky Mountain Research Station (RMRS)
- U.S. Department of Agriculture – National Wildlife Research Center (NWRC)
- DOT/FRA – Transportation Technology Center(TTC)
- U.S. Geological Survey (USGS)

***Joint institute partner with CU-Boulder**

SOURCE: www.co-labs.org/thelabs.html

### CU-Boulder's Active Reciprocal Affiliations with Institutions in Other Countries*


*As of October 2011

CU-Boulder is actively engaged in ongoing collaborations with partner institutions on every continent. This international reach fosters an exchange of knowledge and expertise that expands the overall quality of its research output, opens up new opportunities for Colorado's economic growth and provides a world-class academic experience that leads to sophisticated CU-Boulder graduates who are well equipped to compete in the global marketplace.

### What's the end benefit?

A dynamic and self-sustaining research enterprise that pushes the boundaries of business development and economic growth along the Front Range.

**553** CU-Boulder inventions submitted to the University of Colorado Technology Transfer Office in the past five years

**156** License and option agreements signed in the past five years

## CU DISCOVERIES

CU-Boulder researchers push boundaries to develop innovative solutions for some of the world's most daunting challenges, going inside the atom, around the world, up the highest peaks and even into space, seeking new ways to improve the quality of life.

The wide range of CU-Boulder research and creative work has long resulted in high quality and broad impact as measured via citations of faculty by subsequent research efforts, important national and international collaborations, and discoveries that lead to viable commercial business development.

From creating a new form of matter, to devising tomorrow's large-scale energy sources, to improving the delivery of vaccines, CU-Boulder's research has a history of delivering tangible benefits that often lead to profitable business opportunities.

### World-class physics breakthroughs

- CU-JILA and NIST researchers Carl Wieman and Eric Cornell won the 2001 Nobel Prize in Physics for their creation of the first Bose-Einstein Condensate, a new form of matter that exists at extremely cold temperatures. CU, SRI International and a Boulder-based company called ColdQuanta Inc. recently finalized an agreement to commercialize this cutting-edge discovery.
- CU-JILA professor and NIST fellow John Hall won the 2005 Nobel Prize in Physics for his contributions to laser-based precision spectroscopy, including the optical frequency comb technique, leading to the development of extremely accurate clocks and improved Global Positioning System (GPS) technology, among other widely used laser technologies.

### Revolutionary biotechnology research

- Tom Cech, CU Distinguished Professor of Chemistry and Biochemistry and Howard Hughes Medical Investigator, won the 1989 Nobel Prize in Chemistry for his discovery that RNA in living cells is not only a molecule of heredity but also can function as a catalyst.
- The new CU Biofrontiers Institute is creating collaborations among the university's most talented faculty in chemical and biological engineering; molecular, cellular and developmental biology; neuroscience; medicine; and biophysics, to advance human health and fuel the growth of Colorado's biotech industry.
- CU-Boulder biotech research has led to 19 new startup businesses during the past five years.

### Pioneers in aerospace engineering and space exploration

- Of the 19 astronaut-affiliates from CU—18 from CU-Boulder and one from University of Colorado Colorado Springs—16 flew on a total of 40 NASA space shuttle missions.
- CU-Boulder has flown dozens of science payloads on NASA's 135 space shuttle missions. BioServe

## Center for Humanities and the Arts

The Center for Humanities and the Arts (CHA) is a focal point for humanistic research, creative work and scholarly innovation at CU-Boulder. CHA serves all faculty and students in the arts and humanities and provides a dynamic interface between the community and the university. The center awards competitive fellowships to faculty and graduate students, invites speakers and funds interdisciplinary research. By funding faculty initiatives across departments and organizing symposia, workshops and visits from prominent intellectuals and artists, CHA helps stimulate a broad range of research and creative innovation at CU-Boulder.

**$26m** Licensed technology royalty income in the past five years

**100** Research centers, laboratories and institutes in eight colleges and schools that span virtually every academic discipline

Space Technologies, a NASA-funded center in the aerospace engineering sciences department, has launched experiments onboard space shuttles 39 times since 1991.
- The university's Laboratory for Atmospheric and Space Physics (LASP) has a long history of involvement in space missions dating to the 1960s, including science direction and research, engineering of an individual instrument or component, engineering of an entire instrument suite, and mission operations.

## Pursuing tomorrow's renewable energy sources

The Renewable and Sustainable Energy Institute (RASEI) is a joint institute between CU-Boulder and the National Renewable Energy Laboratory, working to expedite solutions that transform energy by advancing renewable energy science, engineering, and analysis through research, education and industry partnerships.

RASEI's four goals are:
- To create a world-leading venue for energy research and education that benefits from the concentration of academic institutions, federal research laboratories, and businesses involved in the green economy along Colorado's Front Range.
- To develop a comprehensive and multidisciplinary approach to research that meets the scientific and institutional energy challenges of the 21st century.
- To provide programs, lectures, and opportunities that prepare students to become the energy leaders of the future.
- To engage industry partners in comprehensive programs involving energy research, education, policy and technology development.


PHOTO COURTESY OF SCOTT PALO

**Aerospace engineering professor Scott Palo at the South Pole**

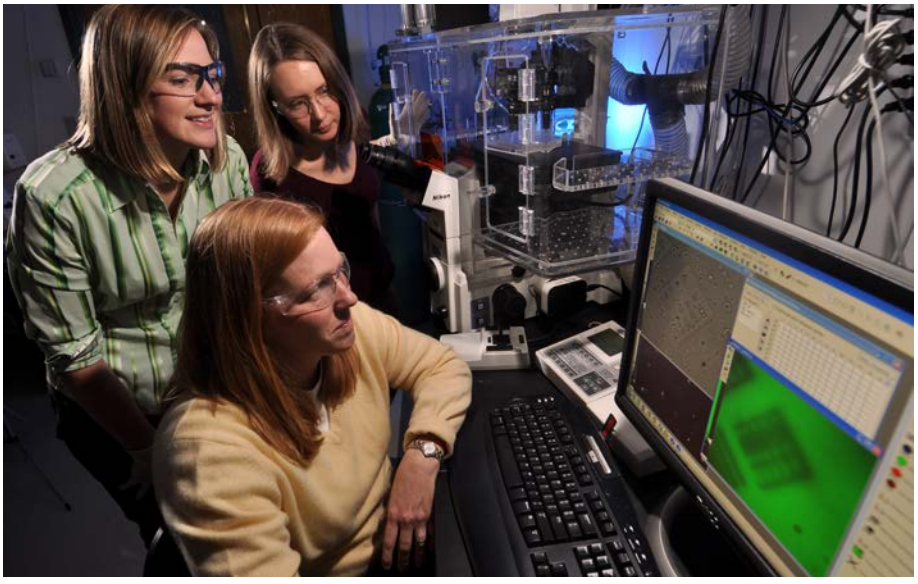


PHOTO BY GLENN ASAKAWA, UNIVERSITY OF COLORADO BOULDER

**Kristi Anseth, chemical engineering professor, foreground, works with graduate students in the microscope lab studying tissue cells.**

**Top 10** Ranking among the top research universities in funding for environmental science research

**$359m** Sponsored research funding in fiscal year 2011

## CU DISCOVERIES

### A global leader in environmental sciences

- The Institute of Arctic and Alpine Research (INSTAAR), dating back to 1909, develops scientific knowledge of physical and biogeochemical environmental processes at local, regional and global scales, and applies this knowledge to improve society's awareness and understanding of natural and human-caused environmental change.
- The Cooperative Institute for Research in Environmental Sciences (CIRES)—a joint institute between CU and NOAA—is committed to identifying and pursuing innovative research in earth system science and communicating its findings to the global scientific community, to decision-makers, and to the public.
- Several CU-Boulder research faculty shared the 2007 Nobel Peace Prize with former U.S. Vice President Al Gore for their contributions to the international report of the Intergovernmental Panel on Climate Change.

### Outreach to Colorado and beyond

- CU-Boulder connects its research and learning with community needs and interests—whether they are across Colorado or around the globe. Outreach enriches both the CU-Boulder academic mission and the communities it serves, bringing enriching experiences on topics ranging from K-12 science exploration, to climate change symposia, to teacher training, to engineering water and sanitation solutions in collaboration with developing communities all over the world.

PHOTO BY CASEY CASS, UNIVERSITY OF COLORADO BOULDER

**The Janus Supercomputer at CU-Boulder—one of the 75 fastest computers in the world.**

### Ongoing investments in discovery

- The Jennie Smoly Caruthers Biotechnology Building, dedicated in spring 2012, is designed to advance Colorado biotech research and grow the state's biotech industry by helping enhance the way university interdisciplinary research collaborations fuel innovation and support industries, ranging from renewable energy to medicine to bioengineering.
- The expansion of the JILA facility on the CU-Boulder campus will bolster the Nobel Prize-winning work of CU and NIST researchers engaged in explorations into quantum physics, the design of precision optical and X-ray lasers, the fundamental principles underlying the interaction of light and matter and processes that have governed the evolution of the universe for nearly 14 billion years.
- The Janus Supercomputer at CU-Boulder—one of the 75 fastest computers in the world—is enabling a broad range of scientific inquiry in research areas that require high-performance computing power for computer modeling, complex programming and advanced visualization methodologies, including climate and weather prediction; geosciences and Earth system science; aerospace, manufacturing and engineering design; astrophysics and planetary sciences; bioinformatics and biology; digital arts; material sciences; renewable energy; computational chemistry and molecular dynamics; fusion energy science; and computational physics, among others.
- CU-Boulder partnered with the Mind Research Network in Albuquerque, N.M., to bring a state-of-the-art, 25,000-pound Siemens 3T Trio Magnetic Resonance Imaging System to campus. The MRI scanner significantly enhances the neuroimaging capabilities on campus, bringing together researchers from Boulder, the Front Range and New Mexico to use the new system to investigate how the brain works and how it influences our behavior.

**Ranked first** in atomic/molecular/optical physics every year since 2006 in *U.S. News & World Report*.

**4** National Medal of Science winners

## CU RESEARCH GROWTH

Despite an economic recession in the late 2000s, the CU-Boulder research enterprise has expanded in scope and quality.

### Companies formed based on CU-Boulder Technology, 2009–11

- **Xalud Therapeutics** – Therapeutic use of cytokines for chronic pain
- **AmideBio** – Novel peptide and method for peptide purification initially for research applications
- **Flashback Technologies** – Novel method for diagnosis of patient hemodynamic state and other applications (joint UCD/UCB)
- **Tigon EnerTec** – Novel gearbox design for hybrid aircraft engines
- **Clean Urban Energy** – Energy storage solutions optimize performance of buildings, utilities and grid operators
- **Mosaic Biosciences** – New class of synthetic materials to support tissue regeneration
- **OnKure Inc.** – Biotechnology
- **Red Wave Energy** – Infrared thermography, visual inspection and industrial photography
- **Suvica Inc.** – Early-stage cancer drug discovery and development
- **Clarimedix** – Light-based medical device to treat Alzheimer's Disease
- **BioSIPs Inc.** – Creating fiber residues into petroleum-alternative, high-performance building materials
- **Shape Tech** – Shape memory polymer devices for treating ophthalmic conditions
- **Double Helix** – Optical-digital technologies used in range estimation, super-resolution and 3-D imaging

Source: www.cu.edu/techtransfer

### Sponsored Research Awards, FY 2006–11*

In millions of dollars


*Awards funded over 2,000 research projects in 2011 from the National Science Foundation (NSF), NASA, Department of Health and Human Services, Department of Commerce, Department of Defense, other federal agencies, private industry, non-federal laboratories and state of Colorado sources.
Source: www.colorado.edu/VCResearch/reports

### National Research Council (NRC) Rankings, October 2010

**20 CU-BOULDER GRADUATE PROGRAMS IN THE TOP 20 OR 20%**

| PROGRAMS RANKED AS HIGH AS THE TOP 5 OR TOP 5% | BEST RANK | BEST PERCENT |
|---|---|---|
| Geography | 2 | 4% |
| Aerospace Engineering Sciences | 2 | 6% |
| Integrative Physiology | 4 | 6% |
| Astrophysical and Planetary Sciences | 4 | 12% |
| Psychology | 6 | 3% |
| Mechanical Engineering | 6 | 5% |
| Civil Engineering | 7 | 5% |
| Physics | 8 | 5% |
| **PROGRAMS RANKED AS HIGH AS THE TOP 10 OR TOP 10%** | | |
| Applied Mathematics | 6 | 18% |
| Atmospheric and Oceanic Sciences | 7 | 14% |
| Chemical Engineering | 8 | 8% |
| Spanish | 8 | 13% |
| Chemistry and Biochemistry | 12 | 7% |
| Geology | 13 | 9% |
| **PROGRAMS RANKED AS HIGH AS THE TOP 20 OR TOP 20%** | | |
| Ecology and Evolutionary Biology | 11 | 12% |
| Theatre | 12 | 44% |
| Linguistics | 13 | 25% |
| Neuroscience (joint PhD Program) | 15 | 16% |
| Philosophy | 15 | 17% |
| Molecular, Cellular, and Developmental Biology | 21 | 17% |

Source: sites.nationalacademies.org/PGA/Resdoc

**Among the leaders**

Of the nation's universities all-time in NASA research funding

**4** Nobel laureates (three in physics, one in chemistry)

## In Colorado and beyond, CU-Boulder research is good for business.

Connected to dynamic research partners in Colorado, across the nation, and around the world, CU-Boulder occupies a unique position in the research landscape—with an ongoing mission to push the boundaries of knowledge and innovation in order to advance the economy, culture and health of Colorado, the nation and the world.

The university serves as an incubator for research and development, offering a wide range of investment opportunities, a dynamic entrepreneurial environment and a strong pool of highly trained talent.

Learn more about opportunities to partner with CU-Boulder:

**CU TECHNOLOGY TRANSFER OFFICE**
www.cu.edu

**OFFICE OF THE VICE CHANCELLOR FOR RESEARCH**
www.colorado.edu/VCResearch

**CAREER SERVICES OFFICE**
careerservices.colorado.edu

**CU FOUNDATION**
www.cufund.org

**RESEARCH AT CU-BOULDER**
www.colorado.edu/research

**GRADUATE ADMISSIONS**
admissions.colorado.edu/graduate

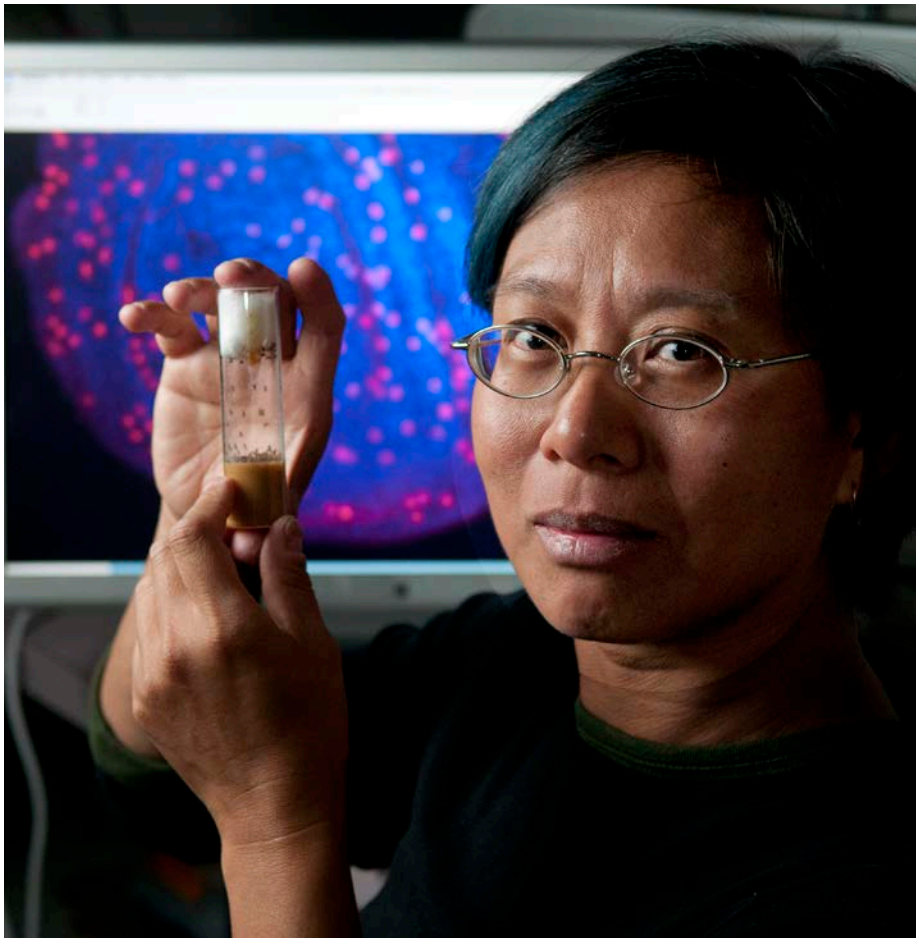


PHOTO BY GLENN ASAKAWA, UNIVERSITY OF COLORADO BOULDER

**A technology developed by professor Tin Tin Su uses fruit flies to screen for new cancer treatments and was licensed in 2011 to a Colorado biotech company—one of many CU discoveries with the potential to advance Colorado's biotech industry.**

## CU-Boulder Research Institutes

- Alliance for Technology, Learning, & Society (ATLAS)
- Biofrontiers Institute
- Cooperative Institute for Research in Environmental Sciences (CIRES)
- Institute for Behavioral Genetics (IBG)
- Institute of Arctic & Alpine Research (INSTAAR)
- Institute of Behavioral Science (IBS)
- Institute of Cognitive Science (ICS)
- JILA
- Laboratory for Atmospheric & Space Physics (LASP)
- Renewable & Sustainable Energy Institute (RASEI)
- University of Colorado Museum of Natural History

**See the full list of CU-Boulder institutes and centers at www.colorado.edu/research.**

# A national leader

In Science, Technology, Engineering and Math (STEM) education

University of Colorado Boulder

# Cuts cause ripple effect

## Competitiveness, grant writing, research infrastructure could all suffer with continued erosion of state funding

BY CHARLIE BRENNAN

State legislators are poised to slice $29 million from higher education funding, reducing state funding from the current year's $519 million to $490 million, and there is worry in some circles about how those cuts might impact university research infrastructure.

Of the state's leading research universities, the University of Colorado is looking at a proposed cut of nearly $11.8 million. Colorado State University could take a hit of about $6.6 million, and the Colorado School of Mines would lose just over $1.3 million.

The expected cuts continue a trend that has plagued higher education in Colorado since the recession started making itself felt in 2008.

STATE FUNDING

State funding to Colorado's universities and colleges peaked at $706 million in fiscal year 2008-09 and 2009-10, but only by supplementing the state's money with millions of federal American Recovery and Reinvestment Act (ARRA) dollars. By fiscal year 2010-11, state funding slipped to $615 million — plus another $29 million in ARRA funds.

The loss of state funding increases the importance of efficiencies that come through joint research collaborations, most notably the Colorado Renewable Energy Collaboratory, through which CU, CSU, Mines and the National Renewable Energy Laboratory pool resources in operating research centers focusing on biofuels and biorefining, solar energy and wind power.

State Sen. Mike Johnston, D-Denver (District 33), who sits on the Senate's education committee, is concerned about the cuts' implications for research in Colorado.

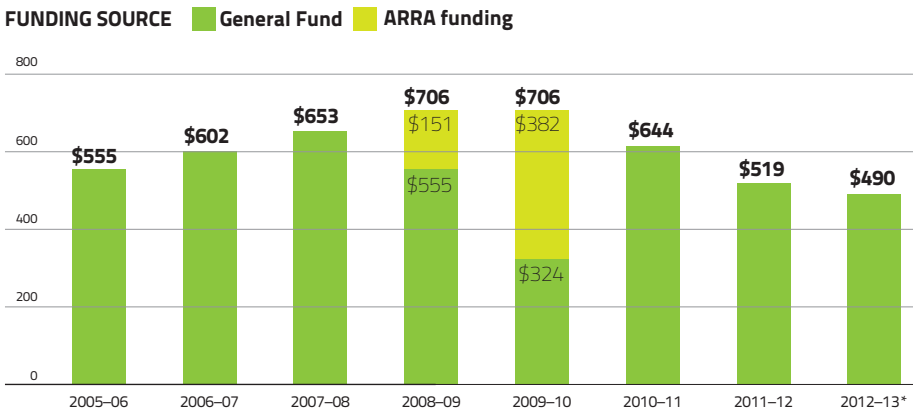
"When you think about the roles the universities play in this state, it's not just about educating the next generation of Coloradans; it's also that they serve as major economic engines for their communities, through the dollars generated by such things as research, patents, salaries to scientists and support staff," said



LARRY HARWOOD/UNIVERSITY OF COLORADO; UNIVERSITY OF COLORADO DENVER; JOHN EISELE/COLORADO STATE UNIVERSITY

## State funding for public institutions of higher learning

*By fiscal year, in millions*




*Joint Budget Committee, March 5, 2012 Figure Action Setting for FY2012–13 Source: Colorado Department of Higher Education

Johnston. "I think that's a big part of our concern."

Peter Han, Mines chief of staff, said "The continued decrease in state funding does impact our ability to support research initiatives.

"For example, the decrease in state funding and the uncertainty of the state budget forecast has limited our ability to hire additional faculty to match increased student enrollment. This also limits our ability to react to increased research opportunities in areas that Mines has global recognition."

Rick Miranda, Provost and Executive Vice President at Colorado State University, said that even though most of the school's research dollars come from federal agencies and other non-state sources, the contemplated state cuts still pose a threat to the vitality of CSU's research culture.

"Frankly, I am worried about our ability to compete in research if the state funding continues to erode," said Miranda.

The primary resource for writing research grants is faculty, he said, and a shortfall in state funds directly imperils the ability to hire and retain the professors who generate those grants.

"One of the effects of state funding cuts is that everyone has to step up and do more with less," said Miranda. "And then, at some point, the ability to do more hits the wall. And one of the things that may hit the wall earlier, rather than later, is research activities."

CU-Boulder Vice Chancellor for Research Stein Sture is more optimistic. He said the effects of the cuts would likely be felt "very little" on his campus.

"The research infrastructure here in Boulder is mainly, although not entirely, supported by federal research funds from a large number of agencies," said Sture. About 90 federal agencies and labs help finance work at CU, including NASA and the National Institutes of Health. "That funding is fairly stable and durable."

Still Sen. Johnston remains concerned.

"We'd like to be cautiously optimistic," Johnston said, "But we know that even if we have seen the worst of it, just maintaining the current levels of funding is going to be problematic."

# Unlocking the secrets to safer, more efficient energy production

BY PAULA AVEN GLADYCH

After the energy bust in the 1980s, many felt that Colorado would never again be a leader in the energy industry. But more than 25 years later, Colorado is again a player, with major oil and gas companies partnering with the state's research institutions to discover new ways to reach traditional fossil fuels in the state and bring them to market economically.

Fracking and horizontal drilling are just two of the innovations that have helped move Colorado's industry forward in the past decade, but much more research is going on in all aspects of oil and gas drilling and production.

Oil shale has become the country's next great hope for energy production. Its problem has always been that oil and gas locked within tiny pores in the shale are much harder to reach than large reservoirs of oil and gas.

That's where the state's universities come in. The Colorado School of Mines, Colorado State University and the University of Colorado Boulder are all working toward making the world's existing energy production technologies more efficient and more environmentally friendly.

"There's a lot of talk about how there is no [commercially viable] technology, but that's not true," said Jeremy Boak, director of the Center for Oil Shale Technology and Research at Colorado School of Mines. "There are some experimental approaches out there that are quite novel. Rather than mining it and sticking it in a specialized furnace, another approach is

**Oil shale presents a big opportunity if techniques can be developed to make it commercially viable. Major companies have partnered with the Colorado School of Mines Center for Oil Shale Technology Research to make it happen.**

to cook it underground. Shell has been working on that for 20 years or more. We're still making technological advances; there are still interesting developments going on, like how do you get the heat into the rock? How do you get the hydrocarbons out once the heat is generated?"

Learning how to manage horizontal wells and how to fracture successfully in them has been one of the biggest developments in the industry, he added.

At least in Colorado, oil shale is the next big opportunity if the right technology can be found to make it economically viable. Many of the major companies own leases on the Western Slope and two — Exxon Mobil and Total—have partnered with CSM's Center for Oil Shale Technology and Research.

Horizontal drilling really opened up the idea of unconventional petroleum systems, said David Budd, a professor in geological sciences at the University of Colorado Boulder. "Rather than drill oil in reservoirs, why not drill where [the hydrocarbons] formed? Get it directly out of the source," he said.

Fracking means breaking up the rocks into little pieces so that the hydrocarbons trapped in the porous rocks can be tapped. Budd and his colleagues examine different types of rocks to find out how much fuel is trapped in their pores. They also look for networks of pores so companies can angle their drills to get at larger pockets of hydrocarbons.

Colorado State University also is working with the oil and gas industry to solve issues around oil and gas development.

"We see a strong interface between energy, the environment, water and sustainability," said William Farland, vice president of research at CSU. "Those are all coming together now as we look at how we address these systems."

Led by Professor Bryan Willson, CSU has done more than any group in the world to address impacts of natural gas production, helping industry partners reduce environmental effects of natural gas compression as well as improve efficiency.

"My hope is that as we pool the talents of the universities, national laboratories and industry together [we] have critical mass for Colorado to be a leader in this area," Farland said.

COLORADO STATE UNIVERSITY

**Colorado State University geosciences professor, Sara Rathburn, talks with a student on a field trip to explore the geologic belts of central Colorado.**

## Programs fill learning gaps

The University of Colorado Denver, in a bid to better serve energy companies, has formed two new programs in recent years, one focused on energy management and another on commodities.

The Global Energy Management (GEM) program, founded in 2009, came about because Encana Corp. came to the university saying it couldn't find enough people with accounting backgrounds and an understanding of energy, said CU Denver Business School Dean Sueann Ambron.

GEM is a graduate program focused on educating the energy industry's next executives. Colorado's energy bust scared many people away, so "there is a gap between the people who are going to retire and those people who are ready to take the reins," said Cathy Steffek, associate director of strategic planning and marketing for the GEM program.

The Center for Commodities, set to open this August, came about because a former alumnus, the president of Cordillera Energy Partners, cited a need for more commodities expertise in energy. "I have to say that I wasn't sure this was a good idea," Ambron said. "But we did a feasibility study. It was very clear there was a definite gap in the academic programs in this area. Not just here, but everywhere."

The CU Denver Business School wants to become a global center for research and education in the commodities, focusing on energy, agriculture and minerals.

— Paula Aven Gladych

# The returns on investment

At the University of Colorado Denver | Anschutz Medical Campus, real returns come from the investments made in education and research programs. The university, headquartered in the metropolitan heart of the Rocky Mountain region, offers comprehensive undergraduate, graduate and professional programs for students on two campuses, the Denver Campus downtown and the Anschutz Medical Campus in Aurora.

The university is home to more than 90 centers and institutes, extending the reach of instruction and research into the community, covering subjects from entrepreneurship and education policy to medical and health concerns across the state. Its faculty and researchers contribute significantly to the strong national and global reputation of the university and its partner industries.

## Economic impact

The University of Colorado Denver | Anschutz Medical Campus drives economic development and innovation, providing a high return on investment. In 2010 the state economic impact of the university exceeded $2 billion through direct campus expenditures in payroll, operations and student spending. For every $1 in direct spending, the university created an additional $1.25 in purchased goods and services in Colorado.

## The value of a degree

The average salary of health care occupations is nearly twice the average of all other occupations, allowing graduates of the Anschutz Medical Campus programs to contribute more in payroll taxes and personal expenditures to the state economy than graduates of other programs.

**Experts at the University of Colorado Denver | Anschutz Medical Campus pursue research breakthroughs that contribute to the health and the economy of Colorado.**

As an employer, the university is home to more than 10,000 faculty, residents, staff and student workers. An additional 13,800 jobs in the state are supported indirectly by the university, for a total impact of over 24,000 jobs in Colorado. As a result, the university creates a payroll impact of $1.43 billion in the state, with $849 million in direct wages, salaries and benefits. For every $1 in compensation paid to a campus employee, up to 60 cents in additional income is provided to the state.

**Continued on next page**

"The University of Colorado Denver | Anschutz Medical Campus is an important engine for the state's economy. Our education, research, training and clinical care drives more than $2 billion to the economy. The contributions these areas bring to the economy by creating jobs, providing care and service to our community, and by generating additional revenues have a total state economic impact of more than $4 billion. The real value of all of this is what can't be counted with numbers—the contributions made to strengthen our communities and our state."

— Chancellor Don Elliman

**Continued from previous page**

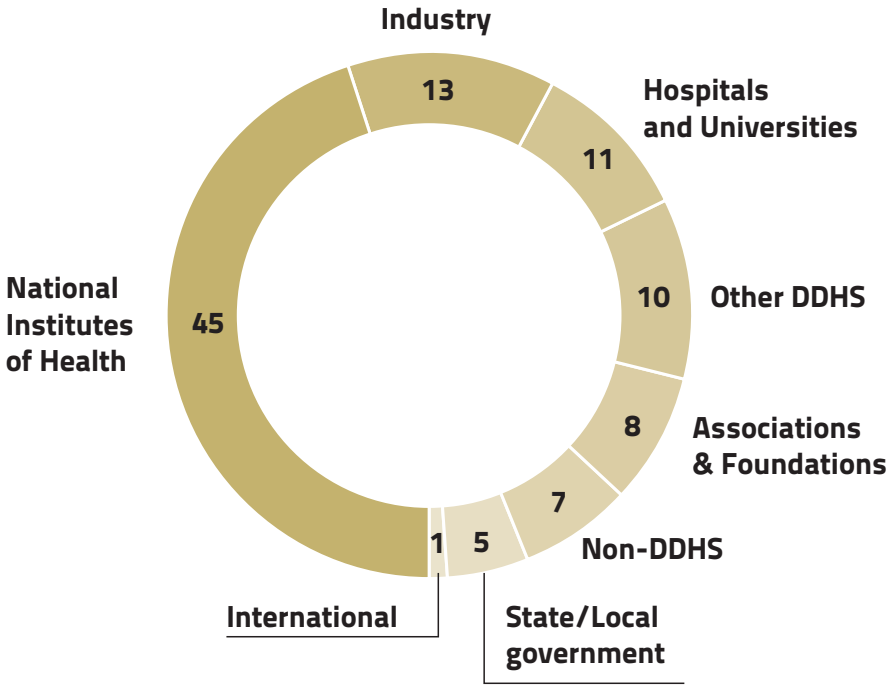
Based on university employment, the state receives more than $60 million in individual income tax and sales tax revenue from direct and indirect spending at the university, $46 million of which is from the Anschutz Medical Campus. Beyond annual payroll and tax revenue, the Anschutz Medical Campus creates operating revenue in excess of $1 billion. Revenue from clinical health services represents 38 percent of all revenue, and federal grants and contracts account for 29 percent. State-appropriated resources in fiscal year 2010, excluding one-time state fiscal stabilization funds, contributed 4.3 percent to total revenue.

## Over $400 million in sponsored project research

In fiscal year 2011 the University of Colorado Denver | Anschutz Medical Campus sponsored project research was valued at $422 million, the highest among Colorado's research universities. The largest proportion of research funding was contributed through grants and contracts made by the U.S. Department of Health and Human Services (DHHS) National Institutes of Health.

### Anschutz Medical Campus sponsored project research

*Funding source, by percent*




Source: University of Colorado Anschutz Medical Campus

## Top 20

Compared to Colorado businesses, revenue from the University of Colorado Denver | Anschutz Medical Campus would place the university in the top 15 among publicly traded companies.

By itself, the Anschutz Medical Campus would place in the top 20.

## Industry access to research resources

The university is home to several labs and centers with industry-accessible resources. Among these is the College of Engineering's Colorado Advanced Photonics Technology (CAPT) Center, home to state-of-the-art measurement and fabrication equipment.

As a nonprofit organization, the CAPT Center provides cutting-edge technical services and human resources to its corporate and educational partners. The CAPT Center is the only photonics resource in Colorado that can deliver surface roughness measurements, optical testing, contract measurement services, prototyping, precision metrology, environmental testing, use of photonics equipment and facilities, training for current employees and connections with future employees.

# Energy and educational connections

The Global Energy Management (GEM) program, housed within the CU Denver Business School, is breaking new ground with a curriculum and delivery method that is in lock-step with both energy industry needs and student goals. The GEM program provides business professionals with the knowledge and skills essential for advancement in today's rapidly evolving energy industry.

Developed in partnership with leading energy companies, GEM curriculum goes beyond theory, addressing the practical considerations and challenges that energy companies face on a daily basis. GEM is designed to equip future leaders with the tools needed to find solutions to the issues and opportunities found in conventional (oil, gas, coal), nonconventional (nuclear, coal gasification), and renewable (solar, wind, biofuels) energy businesses. This real-world curriculum is taught by faculty members with extensive experience in the energy industry.

# The Business School, a transformative hub for education and partnerships

In the heart of Denver's business district, the new Business School building will be the hub for all aspects of business education. The facility will be a powerhouse for collaboration in a community that values education and business.

Located at 1475 Lawrence Street in Denver, the new building centralizes programs and classrooms currently dispersed across 15 locations. Anchoring the Lawrence Street education corridor, it is Denver's gateway to higher education. The facility houses core programs as well as new initiatives—and provides the technology to link them. The building renovation created a variety of spaces to facilitate learning, collaboration and creativity.

The building houses the new J.P. Morgan Center for Commodities, the first U.S. university center to provide a comprehensive education in commodities such as energy, minerals and agriculture. Destined to become a global hub for commodities research and education, the commodities center builds on the Business School's impressive track record of creating innovative programs.

Use your smartphone to learn more

The Global Energy Management program, launched in 2008, is a ground-breaking hybrid online master's of science program that prepares graduates for top positions in the energy field. The Risk Management and Insurance program, begun in 2011, is the first specialized degree program in risk management and insurance in the West.

The Business School is a hub of discovery and innovation, impacting regional industry, national business and the global economy. With the new building, the Business School stands poised for even greater regional collaboration and global recognition.

"GEM will allow me to get a much better feel in terms of what's happening, what's relevant and where I may fit into the whole spectrum of the energy industry." **— GEM student Norma Mozee**

# Revolutionizing human potential

After thinking you could only manage a few laps following an injury, you're able to jog five miles. You're able to read without glasses for the first time since you were 12 years old. How is this possible? Bioengineering—the intersection of engineering and modern medicine—is advancing the knowledge and applicability of techniques that impact human health and improve the quality of life.

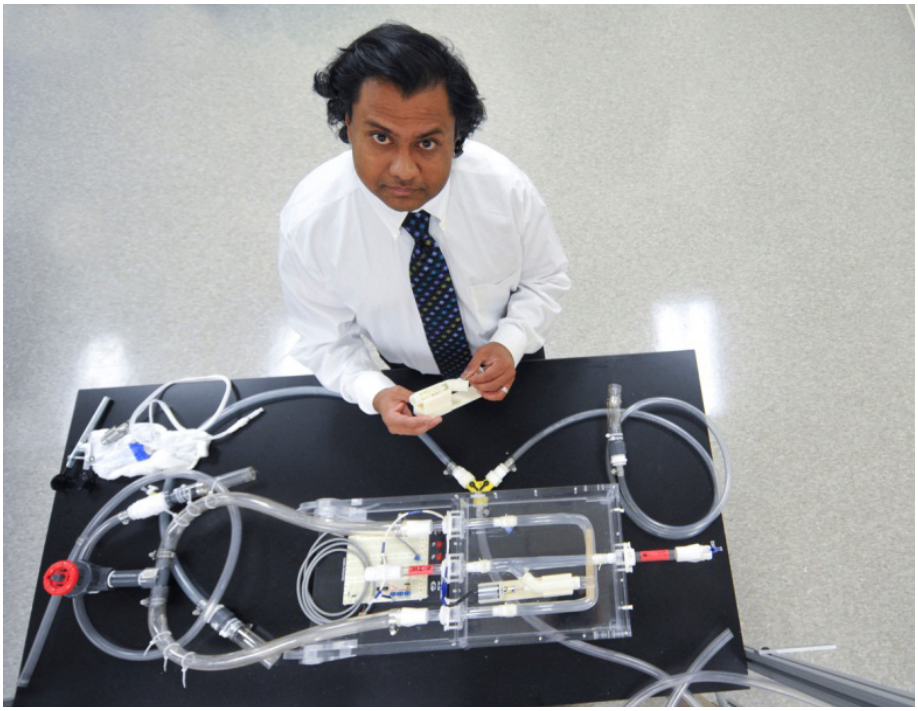
The Department of Bioengineering is the first of its kind in Colorado, built on the collaborative expertise of the College of Engineering and Applied Science and the School of Medicine. Here, researchers improve human health and solve clinical problems through medical and biological application of engineering principles and techniques. The department is producing life-changing improvements such as artificial hands and heart valves, implanted insulin pumps, and medical imaging for diagnostics.

It brings together engineers, clinicians and medical researchers to offer interdisciplinary master's of science and doctoral programs in bioengineering. Distinctive aspects of the program include direct interaction with clinicians and surgeons and a strong emphasis on entrepreneurship. Students learn not only how to design new medical devices but also how to move their innovative ideas and research into clinical development, production and marketing.

## Engineering a healthier tomorrow

Beyond the program's curriculum, the university boasts an extensive bioengineering research portfolio with the potential to change the way we address issues of health and disease:

- **Cardiovascular Biomechanics and Hemodynamics**—Faculty are developing novel structural models of vascular mechanics, evaluating structure-function relationships in extracellular matrix, studying myocardial mechanics in heart failure, and examining the role of blood flow in changes in vascular cell expression and the role of flow factors in bicuspid aortic valves and the hemodynamics of congenital heart disease.
- **Diabetes**—Researchers are examining the biology and biophysics of insulin secretion, metabolic imaging of insulin action, pancreatic islet transplantation and understanding of diabetic complications. The department interacts with the university's Barbara Davis Center for Childhood Diabetes to address fundamental questions relating to the etiology and pathogenesis of diabetes and the design of new approaches for clinical therapy and prevention of Type 1 diabetes.
- **Imaging and Biophotonics**—Research has led to the development of new transducers and instrumentation, analysis of clinical imaging data from MRI, PET, SPECT, angiography, ultrasound modalities, development of next-generation post-processing tools, coupling of 3D imaging with patient-specific computational modeling and development of advanced optical imaging techniques for live tissue histopathology.
- **Neuroscience Engineering**—The interface of neuroscience and bioengineering creates research opportunities in the evaluation of neuromuscular disorders, diagnosis of neural processes using functional MRI and development of next-



**"We urge students to ask questions about clinical needs or research gaps and think about how they can use their bioengineering training to address these issues." Robin Shandas, PhD, professor and chair of the Department of Bioengineering**

generation brain telemetry systems.

- **Ophthalmology**—Research in ophthalmology and bioengineering revolves around new imaging techniques for high resolution optical imaging, development of new devices to treat glaucoma, new surgical instruments for corneal transplant surgery and evaluation of eye mechanics.
- **Orthopedic Biomechanics**—Researchers evaluate gait in children with congenital diseases, neuromuscular control, knee and spine biomechanics and rehabilitation engineering.
- **Surgery and Urological Sciences**—The Department of Bioengineering has strong links with the Department of Surgery. Several projects are underway on new designs for artificial hearts, novel robots for in vivo biomechanical assessment, minimally invasive surgical methods, next-generation methods to diagnose and treat urinary incontinence, and assessment of aortic valve mechanics.

## Commercializing medical research

Discoveries on the Anschutz Medical Campus lead to improvements in medical devices, pharmaceuticals, diagnostics, treatment of debilitating conditions and cures for diseases.

In fiscal year 2010, 118 patent applications were filed, five patents were granted and 31 license/option transactions were executed by the campus research enterprise. In addition, more than 120 inventions were disclosed and five startup companies were formed utilizing campus intellectual property.

# Innovations for a better life

One in five people in the United States lives with a disability, but it is possible to make their lives easier. Faculty working with Assistive Technology Partners are on the leading edge in research, design, testing and application of appropriate technologies for those with cognitive, sensory or physical disabilities.

Together with their clients, faculty in Assistive Technology Partners created and developed the most comprehensive program in the field to identify, evaluate and test these technologies, and to help increase, maintain or improve the functional capabilities of those with disabilities or limitations due to aging.

Assistive Technology Partners, established in 1989 under a federal grant from the National Institute on Disability Rehabilitation Research, enables persons with cognitive, sensory and/or physical disabilities to reach their highest potential at home, school, work and play.

Today, Assistive Technology Partners is part of the University of Colorado School of Medicine Department of Physical Medicine and Rehabilitation, and includes programs in four major areas: clinical services, outreach and information services, research and engineering, education and professional development.

Use your smartphone to learn more

Since its founding, Assistive Technology Partners has provided information and services to more than 470,000 people around the world.

Assistive Technology Partners has been recognized by the U.S. Department of Education, the National Institute on Disability Rehabilitation Research, the National Institutes of Health, the Colorado Department of Education and other major funding sources through grant awards exceeding $15 million over the last 10 years.

# In the business of your health

The business of health care begins with the new health care capital of the Rocky Mountain West, the University of Colorado Anschutz Medical Campus in Aurora.

This leading-edge health care campus fosters collaboration among students, researchers and clinicians, providing a home for the university's health care professional programs. Campus architecture and technology bridge education and research with two world-class hospitals: the University of Colorado Hospital and Children's Hospital Colorado.

Campus researchers have a track record of innovating, discovering and commercializing therapies, drugs and medical devices. With access to new technologies and industry partnerships, they translate basic sciences into medical breakthroughs that are helping people around the world.

Campus researchers were the:

- First to develop a classification and numbering system for human chromosomes
- First to identify a genetic factor that converts normal cells into cancer cells
- First to learn that lymphocytes are pre-programmed to respond to antigens, the foundation of modern immunology
- First to learn how a human cancer gene functions
- First to learn that naturally occurring proteins in the blood prevent the AIDS virus from reproducing and spreading to healthy cells
- Identifier of the first gene that carries the risk of schizophrenia
- Identifier of key molecular mechanisms in the failing human heart that have led to successful development of effective therapies

"The University of Colorado Anschutz Medical Campus has a world-class research platform with more than $400 million research dollars at work, all aiming to advance science, improve health and lead to greater opportunities in drug development, new vaccines, devices, diagnostic tools and businesses that will help patients throughout the state, nation and world."

**— Lilly Marks, Vice President for Health Affairs and Executive Vice Chancellor of the Anschutz Medical Campus**

# Closing in on the breast cancer gene

A gene called Six1 plays a vital role in human development, directing an embryo's cells to divide and migrate to form organs and limbs. Once Six1 has done its job, it is supposed to lie largely dormant.

However, this powerful gene doesn't always stay slumbering. Reawakened in adult tissue, it becomes a killer.

Six1 is present in 90 percent of all metastasized breast cancers, and is linked to the most lethal forms of ovarian, prostate, colon and brain cancers as well as the pediatric tumor rhabdomyosarcoma.

For 15 years, Heide Ford, PhD, an associate professor of obstetrics and gynecology at the University of Colorado School of Medicine, has been on the trail of Six1.

**Heide Ford, PhD, associate professor of obstetrics and gynecology**

Ford, co-director of the hormone-related malignancies program at the University of Colorado Cancer Center, discovered Six1's role in breast cancer. She explained how it depends on an enzyme to play its deadly role in cancer development and metastasis. And now she may be closing in on a way to stop it.

"Finding this treatment could help half of all breast cancer patients and 90 percent of those with the most virulent form of breast cancer," said Ford. "This master regulator in the embryonic process turns out to be a master regulator in cancer as well."

In 1998, Ford was the first to identify that Six1 is present in breast cancer cells. A decade later, her lab published two seminal papers showing that when Six1 was present in mouse mammary glands, it not only caused the growth of mammary tumors but it also induced an epithelial to mesenchymal transition (EMT), which is associated with aggressive tumor formation and metastasis.

# Personalized cancer therapy

The University of Colorado Cancer Center, headquartered on the Anschutz Medical Campus, is making breakthroughs in lung cancer research by targeting a patient's unique genetic makeup.

Clinical trials show that a new lung cancer drug called Crizotinib inhibits a molecular mutation called anaplastic lymphoma kinase (ALK), believed to be responsible for turning healthy cells into cancer cells in a select subset of lung cancer patients. Only about four percent of patients possess the ALK mutation and are eligible for the drug. Extraordinary successes in early multicenter trials could lead to a shift in the way other cancers are treated.

Use your smartphone to learn more

"We now know that what is driving the cancer is different between different cancers. If we can screen people for these oncogenic drivers and give them the right drug to interfere with the one they have, we can have a real impact," said Ross Camidge, MD, director of the Thoracic Oncology Clinical Program at the cancer center and principal investigator for a number of ALK-inhibitor trials. "One-size-fits-all treatments are yesterday's paradigm. This is personalized medicine."

## Centered on health and wellness

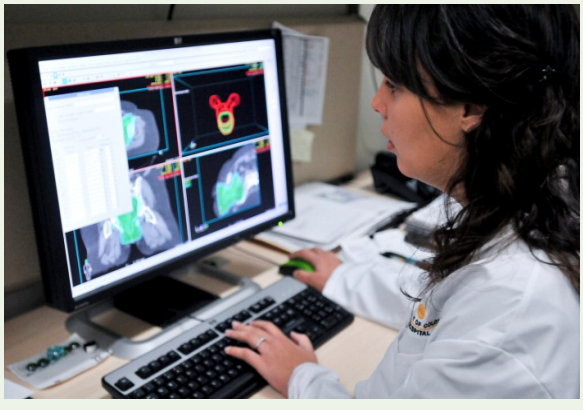
The obesity epidemic is capturing the interest and concern of employers, policymakers and health care providers across the country. The Colorado Center for Health and Wellness, opened in April 2012, provides an all-new research, education and patient facility devoted to combating obesity. The center empowers individuals, communities and organizations to make sustainable changes to achieve healthier lifestyles so that high obesity rates and related chronic disease no longer reflect the way we live as a society. Led by James O. Hill, PhD, a leader in the fight against global obesity, the center is set to create new models for healthier change.

Use your smartphone to learn more

## Nationally ranked programs

Academic programs at the Anschutz Medical Campus scored highly in the latest *U.S. News and World Report's* annual survey of graduate programs:

- School of Medicine: 3rd Family Medicine, 7th Rural Health, 5th Pediatrics, 11th Physician Assistant
- College of Nursing: 15th Master's program, 13th Midwifery, 5th Nurse Practitioner Pediatrics, 16th Nurse Practitioner Family
- Skaggs School of Pharmacy and Pharmaceutical Sciences: 24th Pharmacy



# Pathways from the classroom to careers

From the fine arts and liberal arts to hard sciences and health care, the University of Colorado Denver | Anschutz Medical Campus supports a top-quality educational experience and nurtures discovery and innovation through education and research.

The university offers more than 130 programs in 13 schools and colleges, representing a broad range of disciplines at the bachelor's, master's, doctoral and professional degree levels.

The metropolitan location gives students on both the Denver Campus and the Anschutz Medical Campus plenty of opportunities to get hands-on training outside the classroom. Industry experts collaborate with university faculty to create learning opportunities that prepare students for careers of the future.

## Health careers

In response to the need for trained professionals and research in health care and science, the CU Anschutz Medical Campus offers unparalleled training in programs across medicine, nursing, dental medicine, pharmacy, public health, and health administration.

## Continuing education

The university is committed to sustaining Colorado's workforce through continuing and professional education. Professionals can complete degrees, certifications, licensures, professional development, participate in pre-collegiate outreach and seek personal enrichment in a variety of specialty interests and disciplines.

### CONTACT INFORMATION

- **Website** www.ucdenver.edu
- **Facebook** www.facebook.com/UCDenver
- **Twitter** @cudenver

## Student Facts

- More than 18,000 students enrolled
- More likely than their peers to have an off-campus job
- Average class size of 29
- 72 percent are under age 24
- 6 percent are international
- 31 percent are students of color
- More graduate degrees awarded than by any other Colorado institution—one-third of all graduate degrees in the state

## Schools and Colleges

- College of Architecture and Planning | Denver Campus
- College of Arts & Media | Denver Campus
- Business School | Denver Campus
- School of Dental Medicine | Anschutz Medical Campus
- School of Education & Human Development | Denver Campus
- College of Engineering and Applied Science | Denver Campus
- Graduate School | Both Campuses
- College of Liberal Arts and Sciences | Denver Campus
- School of Medicine | Anschutz Medical Campus
- College of Nursing | Anschutz Medical Campus
- Skaggs School of Pharmacy and Pharmaceutical Sciences | Anschutz Medical Campus
- School of Public Affairs | Denver Campus
- Colorado School of Public Health | Anschutz Medical Campus

Bryan Scholl's hydrology research at the Daryl B. Simons building at the Engineering Research Center at Colorado State University.

COLORADO STATE UNIVERSITY

# Researching the environment, from pole to pole

BY TRACEE SIOUX

Colorado is home to some of the most important environmental research occurring in the world, with critical work being done on climate change, water and renewable energy. Hundreds of environmental researchers at the University of Colorado Boulder, Colorado State University in Fort Collins and Colorado School of Mines in Golden are making dramatic strides toward creating a cleaner earth and bringing billions of dollars to Colorado in the process.

At Boulder's Cooperative Institute for Research and Environmental Sciences (CIRES), a partnership between CU-Boulder and NOAA, for instance, researchers are studying the cryosphere, biosphere, solid earth sciences, atmosphere. CIRES employs 714 scientists, students and staff. The organization forecasted and responded to the Japan earthquake, a heat wave in Russia and the aftermath of the Deepwater Horizon oil

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spill. CIRES recently released the MASIE–NH (Multi-sensor Analyzed Sea Ice Extent–Northern Hemisphere), which allows users to see current Arctic sea-ice coverage by region. This information is critical for transportation, commerce, ecosystem protection and climate understanding.

Colorado State University, among other initiatives, has taken a leading role in water, creating a new institute to advance the study of water conservation and management. This year it has also formed a ground-breaking partnership with Coca-Cola, in part to share the university's knowledge of water conservation and management with the giant international drink manufacturer.

And Colorado School of Mines is helping bridge the gap between the past and the future, by helping traditional energy companies find more environmentally sound ways to collect oil and natural gas, even as they too focus on renewable energy technologies.

COLORADO SCHOOL OF MINES

**Assistant Professor Corrine Packard's research group at the Colorado School of Mines works on improving materials for applications in renewable engery.**


CASEY A. CASS/UNIVERSITY OF COLORADO

**Students in the Electrical & Computer Engineering Department at the University of Colorado Boulder.**

# High tech breakthroughs to end obesity and save lives

**BY DEBRA MELANI**

From cell-phone games that inspire kids to exercise more and snack less, to video cameras that film remote enemy territories and describe what they see in words to military-surveillance teams miles away, computer science projects at the University of Colorado and Colorado State University are targeting national issues.

At CU, Katie Siek and students are exploring ways people can use today's electronic gadgets for tracking health information. They hope to help end the nation's obesity crisis (which research shows disproportionately affects lower socioeconomic groups) by boosting the use of Personal Health Records (PHRs), an idea backed by health experts but in need of fine-tuning.

With PHRs, patients can self-monitor health and maintain control of their information when they see different doctors. Siek's students are working with two

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# AgentSheets teaches thinking skills

Alexander Repenning wants kids to like science. So, after more than a decade of research on human-computer interaction, end-user programming, and simulation tools at the University of Colorado Boulder, the computer science professor launched AgentSheets in 1996.

**Repenning**

Since then, more than 100,000 students, mostly middle-schoolers, have benefited from the company's educational applications, which encourage youth to use computational thinking in areas they like, such as game design. "We want them to learn that science is not boring, to say: 'I can do this,'" Repenning said.

The six-person company continues to grow, selling its products around the globe from Brazil to Japan, and signing up diverse clients, such as universities, NASA and the U.S. Army. With former students on staff and support from the National Science Foundation, Repenning predicts more growth as the company develops new tools and technologies.

— Debra Melani

WIKIMEDIA COMMONS

**Colorado State University's new computer science building opened in 2010.**

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low-income Denver neighborhoods to: 1) find what would motivate residents to enter health information (such as cellphone games for kids) and what special exercise and dietary obstacles they face (such as no parks in neighborhoods). To maintain a presence in the communities, the students tutor youth weekly, bringing a greater dimension to the project's value.

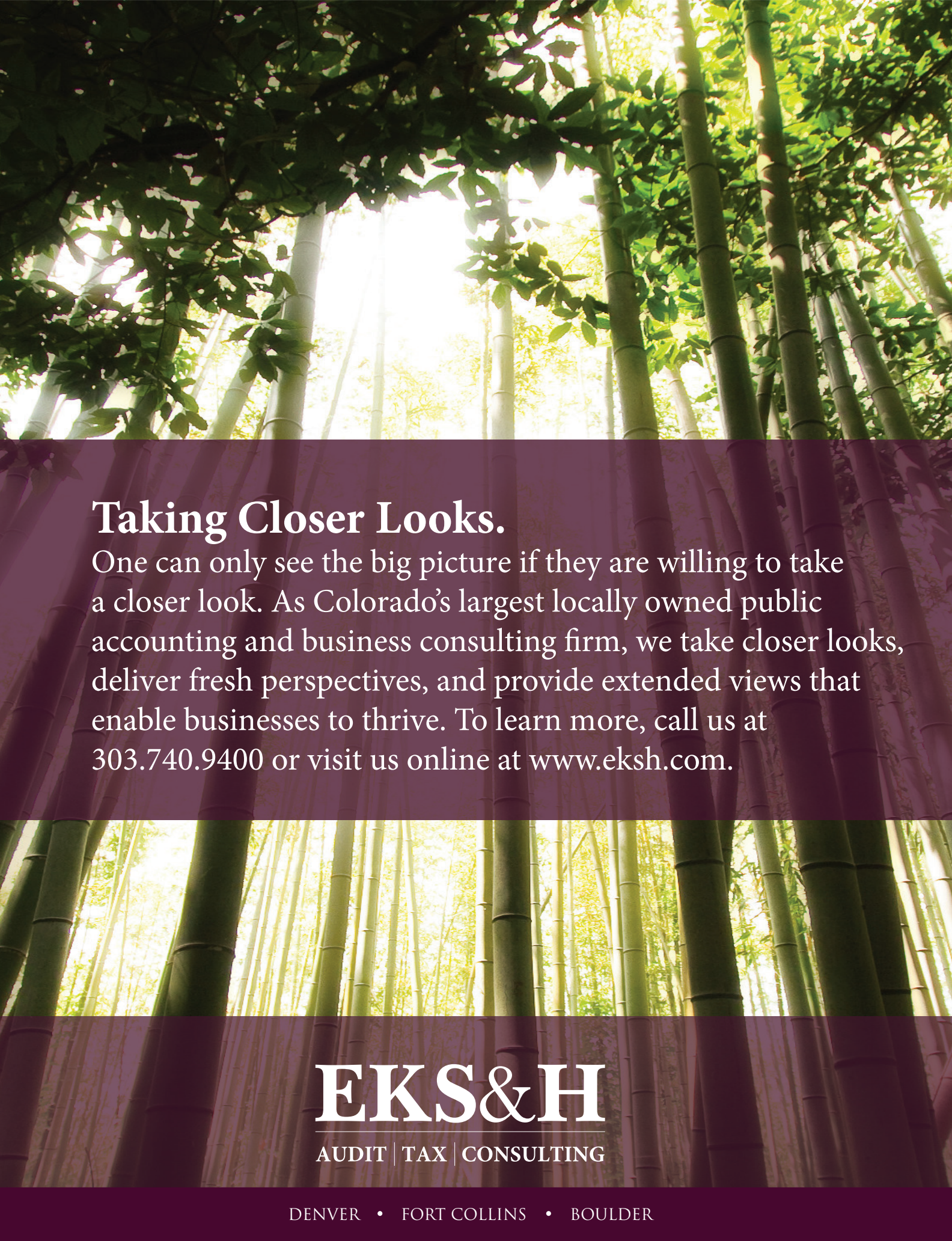
"My students are incredible," Siek said. "They don't just pop in for research and pop out. And the kids in that community get to see college students and talk to them and find out about engineering. Then my students come back to the lab all excited, saying: Now that's not going to work; we need to do x, y and z."

Siek has had one student go on to work in the electronic medical-records area, and she has had students in a side class invent potentially marketable games, most notably a stationary bike that controls a video game by pedaling: The faster you pedal, the better you do. The game won the People's Choice Award at the Engineering Design Expo. The PHR project, largely funded by the National Science Foundation, is a collaborative effort with the University of Denver.

At CSU, a team led by Bruce Draper is making inroads into the unthinkable: creating a program that can allow a computer to "learn," thus deciphering what it "sees" and then dictating that information in human language. Funded by an initial $625,000 grant from the Defense Advanced Research Projects Agency, or DARPA, the project is called Mind's Eye and has an ultimate goal of taking soldiers out of dangerous territory.

In the past, computer-vision systems relied on traditional engineering techniques to try to pull information out of pictures. "The key aspect of (Draper's) work," said Darrell Whitley, chair of CSU's computer science department, "Is that he is looking at how the brain processes information and trying to use computation based on that biological model. It is a very different approach."

While creating applications that can save military lives remains the focus, Draper's technology can have multiple applications, such as monitoring play areas or federal buildings, and even improving image searches on the web. His work, which involves a number of graduate and undergraduate students, has also led to a spinoff company called NeoFilter Labs in Fort Collins.



# Taking Closer Looks.

One can only see the big picture if they are willing to take a closer look. As Colorado's largest locally owned public accounting and business consulting firm, we take closer looks, deliver fresh perspectives, and provide extended views that enable businesses to thrive. To learn more, call us at 303.740.9400 or visit us online at www.eksh.com.

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