100 Years of Research and Beyond
Dear Friends and Colleagues:

In 2007 we celebrate our state’s 100th birthday. However, OSU has played an important role in shaping our state for more than 100 years. Rooted in agriculture, OSU’s land-grant mission guided early researchers committed to solving the state’s critical problems. Over time, OSU evolved into a comprehensive research university dedicated to almost all the arts, humanities and sciences. More recently, global and national pressures, such as national security and economic issues, have moved OSU beyond its former boundaries and into new and exciting research frontiers.

Vanguard 2007 looks at the latest research initiatives at OSU and in the state. Jim Mason, director of the Oklahoma Nanotechnology Institute (ONI), discusses the impact of the nanotechnology initiative on the state’s economy. OSU’s nanotechnology research will aid the ONI effort. OSU will lead another new initiative on microbial forensics and agriculture biosecurity. Jacque Fletcher, director of the National Institute for Microbial Forensics and Food & Agricultural Biosecurity, recognized Oklahoma’s many strengths as those needed to respond to this national priority.

OSU honored three award-winning scientists in 2006 for significant contributions in research. Donna Branson received the Christopher Columbus Fellowship Foundation Award for development of life-saving body armor, now used by the U.S. military in Iraq. Elizabeth Catlos received the Geological Society of America’s “Top Young Scientist Award” for contributions in earth sciences. Jim Smay received the Presidential Early Career Award for Scientists and Engineers for contributions in research leading to the development of advanced ceramic materials and for creating an outstanding education outreach program.

Guangping Chen received three grants valued at more than $1.5M for research on drug metabolizing enzymes. Chen’s research on sulfotransferases will have a significant impact on human health. Bill Barrow received additional funding from the National Institutes of Health (NIH) for an expanded drug screening program under way at OSU. The funding allows Barrow’s research team to screen more drugs with robotics and perform assays—a valuable resource for NIH researchers. The Center for Veterinary Health Sciences has received $7.9M from NIH for this project since it started.

Our vision for research at OSU has grown with plans for a new interdisciplinary research building on the Stillwater campus. A new OSU sensor research center in Ponca City and Stillwater will serve the nation by providing testing and evaluation services for the full spectrum of sensors. Additionally, the completion of OSU-Tulsa’s Advanced Technology Research Center will create opportunities for researchers working in advanced composites, nanotechnology and more. OSU’s Center for Health Sciences has initiated a new approach to telemedicine benefiting rural communities. And, OSU Okmulgee’s nanotechnology education program will help keep Oklahoma competitive.

What’s notable about the myriad of research programs at OSU is the part they play in enriching our lives while growing a stronger, more vital economy for Oklahoma’s next 100 years.

Dr. Stephen W.S. McKeever
OSU Vice President for Research and Technology Transfer
ONI: Building a Better Economy
Jim Mason directs the Oklahoma Nanotechnology Initiative created to promote Oklahoma’s emerging nanotechnology industry and its potential impact on the state.

Successful Retailers Tied to Satisfied Customers
Research findings by Tom Brown, OSU marketing professor, determined several variables prompted customers to make positive recommendations about a retailer.

Catlos Advances Profession Through Research
Named the GSA’s top young geologist for research related to crusts colliding in the Himalayas and extreme crustal extension in western Turkey, Elizabeth Catlos, OSU geology assistant professor, is dedicated to understanding extension in the lithosphere.

Student-Designed Solar Cells Energize Education
OSU students designed and manufactured a solar cell education experiment panel carried on board the space shuttle Atlantis when it took off from Kennedy Space Center for the International Space Station in 2006.

Drug Metabolizing Enzyme Impacts Human Health
Guangping Chen, associate professor of toxicology at OSU, received three grants valued at over $1.5M for research leading to a better understanding of sulfotransferases and the role they play in nutrition and optimal human health.

Microbial Forensics and Ag Biosecurity: A National Priority
Jacque Fletcher, director of the National Institute for Microbial Forensics and Food & Agriculture Biosecurity within the OSU system, recognized Oklahoma’s strengths in an area of research not being addressed anywhere in the country.

Making a Splash in Sanitation: Electrolyzed Water as AntiMicrobial
At OSU’s Food and Agriculture Product Center, scientists are investigating electrolyzed water’s antimicrobial properties because they remain effective considerably longer when compared to other natural sanitation methods.

Life-Saving Research Motivates Team
Body armor designed to protect a soldier’s arms, legs and back from shrapnel thrown by explosives as well as small arms fire has been life-altering for an OSU team dedicated to this life-saving research.

Drug Screening Program Moves Forward
Increased NIH funding will allow Bill Barrow and team, Center for Veterinary Health Sciences, to continue drug screening of various compounds for four more years.

All Eyes on Mars
New technology developed by Jay Hanan, OSU-Tulsa, and a team of scientists from the Jet Propulsion Laboratory, would make self-directed driving for rovers possible on the surface of Mars.

Scientists Developing New Dental Materials
Jim Smay, OSU-Stillwater, and Jay Hanan, OSU-Tulsa, are working with the New York University Department of Dentistry to develop a new approach for fabricating dental crowns.

Team Works to Harness Biomedical Signals
OSU-Stillwater and OSU-Center for Health Sciences researchers are working to find a way to interpret and apply routinely collected but vastly unused, and often discarded, complex biomedical signals to advance diagnosis and treatment of cardiovascular disease.

Throwing to the Future
OSU-Okmulgee will launch a new nanotechnology education program focused on the field of electrical engineering and designed to give students the hands-on experience with the tools of nanoscience with emphasis on instrumentation.

Inside Back Cover: Growing the Numbers: Research and Intellectual Property

Back Cover: America 101: Roth’s Reminder

About the Cover: “100 Years of Research and Beyond” commemorates OSU’s role in shaping the state for more than a century. Stillwater-based artist Tim Jessell illustrates OSU’s academic, artistic, economic and scientific contributions throughout the world.
Q1 What is the Oklahoma Nanotechnology Initiative?

The Oklahoma Nanotechnology Initiative (ONI) is a legislative initiative to promote nanotechnology in Oklahoma. The ONI is coordinated by The State Chamber through a contract with the Center for the Advancement of Science and Technology (OCAST). The primary ONI objectives are: 1) create a statewide awareness of the emerging nanotechnology industry and its potential impact on the state, 2) promote Oklahoma and its resources as a valuable site for nanotechnology-related industry location, 3) serve as a clearinghouse of information on nanotechnology to the academic, financial, industrial and business communities in Oklahoma and 4) work to create a Center of Excellence for Nanotechnology in Oklahoma.

Q2 How is this initiative different from other existing technology efforts in the state?

The Oklahoma Nanotechnology Initiative differs from many other existing technology efforts in Oklahoma primarily in that it is focused entirely on nanotechnology, with a business-oriented approach that is legislatively driven. It supports ongoing research efforts while focusing on commercial “applications” of nanotechnology.

Q3 How will the Oklahoma Nanotechnology Sharing Incentive Act impact the state’s efforts to stay competitive?

The Oklahoma Nanotechnology Sharing Incentive Act focuses on helping Oklahoma companies apply nanotechnology processes to improve existing or emerging products, thereby providing a global competitive advantage. Nanotechnology is an enabling technology which allows companies to make new and emerging products lighter, stronger, smaller, faster or more durable. In many cases it actually creates new products or ways of doing things that make current products or processes obsolete. The legislature appropriated $2 million to OCAST to be used to help Oklahoma companies adopt nano-
technology processes and achieve a competitive advantage in the marketplace.

**Q4** Will this Act improve Oklahoma’s ability to compete with other states that may already have strong nanoscience programs?

A number of other states are focusing larger amounts of funding on nanotechnology research. However, this Act builds on the other states efforts by assisting Oklahoma companies to take advantage of scientific discoveries in nanotechnology wherever they exist, by facilitating licensure or collaboration toward the commercial utilization of those discoveries. Our goal is to allow Oklahoma companies to be leaders in bringing nano-enhanced products to the marketplace. Currently Oklahoma and Pennsylvania are the two states most aggressively focusing on commercial applications of nanotechnology.

**Q5** What role will Oklahoma universities play in carrying out the overall goals of the Act?

Oklahoma universities play a key role in carrying out the goals of the Oklahoma Nanotechnology Sharing Incentive Act by fostering a collaborative relationship among researchers not only in Oklahoma but in adjacent states, by facilitating joint research projects and sharing information among the research and business communities.

Oklahoma researchers are doing world-class research in nanotechnology; however, Oklahoma suffers from small (but growing) numbers of nano researchers. Oklahoma is a leader in in-state collaboration, creating the Oklahoma Nano-Net in 2003 as part of the Oklahoma EPSCoR (Experimental Program to Stimulate Competitive Research). The Oklahoma Nano-Net is nationally recognized by the National Nanotechnology Initiative (NNI) as an early model for other states. The Nano-Net currently includes some 40+ university scientists working in nanotechnology who communicate and collaborate regularly. The ONI recently compiled an expanded database of 141 Oklahoma nano researchers that includes university faculty, private company researchers and some graduate students doing research in nano.

The State Chamber created a Nano Advisory Board in support of the ONI which includes university representatives from Oklahoma State University, Oklahoma University and the University of Tulsa, several private nano companies and several business leaders. The ONI communicates...
regularly with the technology transfer offices of each of these comprehensive research institutions to stay abreast of Oklahoma nano technologies that can be licensed or acquired for commercial application of nanotechnology.

The ONI seeks to support, assist and promote Oklahoma’s research universities as they increase the knowledge of nanotechnology, expand nanotechnology discoveries and train future researchers in nanotechnology. The ONI hosted its first Oklahoma Nanotechnology Conference in November 2005 to showcase Oklahoma nano research and build bridges between Oklahoma and the NNI, national labs doing nano research and nano researchers in nearby states.

Q6 Is this initiative an important step in building a research corridor in the state?

An Oklahoma research corridor continues to grow with the core of OSU, OU and TU but increasingly includes Oklahoma regional and community college faculty. The Oklahoma EPSCoR program and the Board of Higher Regents continue to build a strong foundation for nanotechnology research in Oklahoma by funding equipment, research projects, faculty positions and collaborative activities.

A unique, precedent setting nanotechnology course is currently being taught jointly and concurrently by faculty from OU, OSU and TU. This course is part web based and part lab based, which is a very rare arrangement. Students from all three institutions enroll in their own university but work collaboratively with classmates from all three universities on-line and in Saturday lab experiences rotating through each of the Universities.

The ONI recognizes that it must build relationships with nearby states to increase the total effort in nanotechnology and compete for funding nationally and is currently working on expanding collaboration with the leaders of nanotechnology initiatives in Arkansas, Texas, Colorado, Kansas and New Mexico. An excellent example of this collaboration is the Center for Semiconductor Physics in Nanostructures which is a joint collaboration between the University of Oklahoma and the University of Arkansas, and which also includes researchers from OSU.

The ONI in collaboration with Oklahoma EPSCoR coordinated an undergraduate nanotechnology symposium with students from Arkansas, Kansas, Oklahoma and Texas universities. Students presented their research posters, networked with Oklahoma nano researchers and learned about Oklahoma nano research projects. The ONI provided Nano T-shirts for the students.

Q7 How will it help build the state’s economy?

By utilizing nanotechnology to make new and better products, Oklahoma companies will have a competitive advantage and create wealth by bringing in money from outside the state in exchange for these new or improved products. This growing economy will add more new high paying jobs and will greatly improve the state’s overall economy.

The NNI is already investing over $1 billion in nanotechnology research annually and the private sector is making at least that investment. The NNI is estimating that in the next six years between 800,000 and 1,000,000 new jobs will be created in the United States because of nanotechnology.

As more companies adopt nano processes, the private sector will need trained workers who have backgrounds in applications of nanotechnology. Companies which adopt nano processes to improve their current products or create new products will lead the way in building the economy of Oklahoma.

If nanotechnology will change everything man-made during this century, why shouldn’t Oklahoma companies lead the way?
Customers must feel a personal level of commitment to a retailer before making recommendations to others.

Successful Retailers Tied to Satisfied Customers

Retailers who want to maximize success need to do more than satisfy their customers, they need to get their customers to actively recommend them to others. But how do you get customers to do that? Answering such practical questions is one of the key reasons Tom Brown, a marketing professor in the Spears School of Business at Oklahoma State University, is getting some special attention.

Brown, Ardmore Professor of Business Administration, and his research colleagues have become “regulars” in major academic research publications such as the Journal of the Academy of Marketing Science. In fact, because their research findings offered a “clear and testable perspective” that is likely to be cited by other researchers for years to come, a panel at the journal has chosen Brown and company for the publication’s highest honor, the Sheth Foundation Award for the best article published during 2005.

“It is certainly reward enough to get your research published in a strong journal in the first place, but to receive the Sheth Award really validates the many hours of work that went into the project,” said Brown, who has been receiving some “validation” from the Spears School as well, which has awarded him its Richard W. Poole research award for two years in a row.

Both the Sheth and the Poole awards include cash rewards and Spears School Dean Sara M. Freedman supports as “extremely important” the monetary aspects of such honors. “You really cannot put a dollar value on the national exposure and recognition the publication of solid research projects like Tom’s attracts to the Spears School and OSU as a whole. It’s enormous, so we need to reward this kind of achievement anyway we can,” said Freedman.

As for Brown, projects like the one he conducted with past and current customers of a car dealership in Dallas, is exciting work and he’s glad to partner with research colleagues Thomas E. Barry and Richard Gunst at Southern Methodist University and Peter Dacin at Queens University to make it happen.

Like most research, the responses from customers at the car dealership not only answered some questions for Brown, they also prompted additional reasons for further research.

In this case, he found there are several variables for prompting customers to spread positive word-of-mouth about a retailer including satisfaction with the retailer, commitment to an ongoing relationship, and even whether or not the customer thinks of himself in the same terms he thinks of the retailer.

“What we learned was that, without a committed relationship between the dealer and the consumer, it was a customer’s level of satisfaction with the service that decided whether or not they were willing to promote the dealership by word-of-mouth,” said Brown. “When customers begin to feel a sense of commitment to the dealership, we believe that positive word-of-mouth will continue, even when satisfaction with the retailer dips, at least for the short run.”

Still open to further research are questions about consumers and how they may use word-of-mouth recommendations about the dealership as a means of expressing themselves or telling others about themselves.

“For example,” said Brown, “While an individual might not want to come right out and tell someone ‘I’m wealthy enough to drive expensive sport cars,’ they may find it perfectly acceptable to comment ‘If you’re looking for a new car, I’ve had good luck with the ABC dealership.’”

How closely do you identify yourself with particular retailers? What are the benefits of that relationship for you and for the retailer? Brown and his colleagues just may have a direct answer for these questions and more someday soon.

Jim Mitchell

Brown’s research was published in the Journal of the Academy of Marketing Science, Spring 2005. The article title is “Spreading the Word: Investigating Antecedents of Consumers’ Positive Word-of-Mouth Intentions and Behaviors in a Retailing Context.”
Elizabeth Catlos, assistant professor in the Department of Geology at Oklahoma State University, reached a major milestone in her career this past year when she was named the Geological Society of America’s “Top Young Scientist” in 2006. Catlos was recognized by her peers for research related to crusts colliding in the Himalayas and extreme crustal extension in western Turkey. The GSA gives the Donath Medal, as the award is known, to deserving young scientists who contribute to the advancement of earth sciences. Catlos is proud of her accomplishments, yet she is focused on her current research in western Turkey funded by the National Science Foundation.

Understanding what caused extreme extension of the earth’s crust will help scientists predict future events.

Catlos Advances Profession Through Research
Catlos spent two weeks in western Turkey last summer collecting some 300 rocks near Turkish villages. Accompanying her on the trip were Ibrahim Cemen, professor in the OSU Geology Department, two graduate students, a geologist from the University of South Carolina, and two Turkish geologists. Catlos says she won’t go back to Turkey for awhile, but will spend time generating data from the rocks collected in western Turkey by analyzing the rocks, dating them and determining how deep they were in the earth. She and her graduate student, Courteney Baker, generated some data this past summer at UCLA. They presented the results at the American Geophysical Union Meeting in San Francisco in early December.

At the meeting in San Francisco, Catlos co-chaired a session with Cemen, dedicated to understanding extension in the lithosphere—areas where the earth’s crust is pulled apart by an extreme amount. She says other researchers want to understand why and how this happens, and many are working to answer this question in the U.S. Basin and Ranges province, the Himalayas and in western Turkey. So, she organized two sessions—one with speakers and one with posters—on the topic. Cemen and Catlos hope to combine the presentations from the sessions into a volume of manuscripts published by well-known publisher Elsevier.

Besides her research, the San Francisco meeting, and the possible development of a special issue in a major journal, Catlos has applied for the Harrington Fellowship at the University of Texas at Austin, where if accepted she will work for nine months. UT has state-of-the-art equipment, including a High Resolution Computed Tomography Facility that shoots X-rays through large samples of rocks so you can see the minerals and the relationship of those minerals without destroying or cutting the rock itself. The UT program would allow her to further her research, then share it with others at a symposium that she would organize in Turkey where attendees could take field trips in the region and meet Turkish geologists.

Catlos says the symposium would involve researchers from a variety of fields concerned with understanding the basic geology of the Aegean region, as well as the area’s geological-archeological history and natural hazards. The Aegean has been a locus for devastating natural disasters, including recent earthquakes as well as enormous historical volcanic eruptions. Two massive earthquakes shook the region in 1999. A recently dated supervolcano that changed civilization in the Aegean is shaking up the archaeology world. Scientists want to learn more about these events. Understanding why the volcano erupted or why a fault moved requires understanding the geology of the region. Catlos says it’s all about timing. “Once you know when something happened, you can tie it to other events occurring in the same general area. Then the goal is to try to predict the future based on what you know about the past,” she says.

At OSU, Catlos teaches a class on using the electron microprobe—equipment used to analyze minerals in rocks. Her class is project oriented, so students understand why learning to analyze rocks is necessary. Students from a previous class gave presentations on their projects at the 2006 GSA annual meeting in Philadelphia. Two undergraduate students studied arsenic in groundwater in the Norman area. Two others helped a graduate student analyze minerals in rocks for a master’s thesis. Catlos wants all student projects in the course to link to faculty or master’s level research. After looking at how professors at other universities teach the same class, she believes the “project oriented” approach is best.

“Geology is changing,” says Catlos. More women and minorities are entering the profession. At the 2006 meeting, the president of the GSA indicated that full members are 80% male, but student membership is equally divided. Many women appear to drop out after they receive their bachelor’s degree and leave the profession. At OSU, women geology faculty are gaining ground. Currently, three of the 10 geology professors at OSU are women. And, according to Catlos, she and the other women faculty receive a great deal of support from OSU’s administration.

Jana Smith
When the Atlantis space shuttle took off from Kennedy Space Center for the International Space Station (ISS) on Sept. 9, 2006, it carried on board a solar cell education experiment panel designed and manufactured by Oklahoma State University students.

The STS-115 shuttle mission delivered and installed two large solar arrays, the energy source used by the ISS in its daily operations and which doubled its ability to generate power from sunlight.

Atlantis pilot Chris Ferguson and Education Specialist Jonathan Neubauer of the Teaching from Space Project conceived an educational component to the mission and turned to the Aerospace Education Services Project at OSU for collaboration.

The NASA program, headquartered in the OSU College of Education for nearly 40 years, provides support to the Astronaut Corps, NASA Explorer Schools, and maintains the Teaching From Space Office at NASA’s Johnson Space Center, which has a goal to target underserved populations in diverse geographic locations.

When Neubauer approached Steve Marks, OSU professor of aviation and space education and director of the Aerospace Education Services Program (AESP), for assistance in developing their concept for an educational component to mission STS-115, Marks turned to the OSU Department of Mechanical Engineering Technology (MET) for assistance.

Its Manufacturing Development Lab had the necessary CNC milling machine and accompanying design software and the staff to design and streamline the implementation of the two different solar cell education experiment units and to machine the transparent plastic for the solar cells. This gave MET students the opportunity to learn about the manufacturing process from conceptualization to prototype development to production.

“MET’s experience in design software and manufacturing processes was instrumental to the project,” said Dan Hern, Wakita graduate student in aviation and space education, who expects that AESP and MET will work together again in the future. Hern conducted all the assembly and testing of the panel before delivery to the Johnson Space Center.

The OSU AESP completed the development and assembly of two different solar cell education experiments, one to be launched on STS-115 and used by astronaut Ferguson on the ISS, and another to be used in the NASA Explorer Schools’ classrooms across the U.S. Both designs have four solar cells that are wired together in a series circuit. The wire is attached to the correct points on the solar cells by soldering the wire to the joint. The four cells also have dielectric tape, or Kapton tape, underneath the wire.

The dielectric tape acts as an insulator so the wire only makes contact with the intended joint on the solar cell. After the solar cells were taped and soldered, they were mounted on the transparent plastic that had been CNC machined to accommodate the extruding wire and solder joints; this assembly forms the solar panel. In full sunlight, both configurations will produce approximately 2.4 volts, about the same as two AA batteries.

The project began in May 2006 and involved producing more than 200 solar cell education experiment panels for NASA Explorer Schools, including four built to space travel specifications that Ferguson carried in his pack on the STS-115 mission.

While orbiting in space, Ferguson used the OSU-designed solar cell education experiments to conduct demonstrations and videotape solar panel experiments for NASA Explorer School students throughout the nation, including the NASA Explorer School in Sasakwa, Okla. Students at 172 NASA Explorer Schools will be able to duplicate Ferguson’s experiments using the solar cell education experiment panel.

AESP has also assembled 42 kits that include the solar cell education experiment panels. Aerospace Education Specialists who conduct education programs for AESP will use the solar cell education panels to demonstrate to students the possibilities of solar energy.

Demonstrations that AESP expect to conduct in the schools with the solar cell education experiment kits include using color filters to study the effects of color on light energy and how an electric motor can be utilized when properly wired to the solar panels.

A NASA-developed video of the experiments and the published results will be made available to the public. Ferguson and Teaching from Space personnel have reported to the AESP that the solar cell education experiment met and exceeded the established flight criteria.

Dottie Witter with Dan Hern
Guangping Chen, associate professor of toxicology in the Department of Physiological Sciences at Oklahoma State University, teaches graduate students biochemical and molecular toxicology and has recently been awarded three new grants.

All three of these research projects will have a significant impact on cancer prevention, toxicology, drug biotransformation, drug design and development, drug to drug interaction, drug resistance, food safety and general human health.

His research projects focus on one type of drug metabolizing enzyme—sulfotransferases. According to Chen, sulfotransferases have two functions: 1) drug detoxification and 2) hormone regulation.

“Sulfotransferases are important in the regulation of different biological signaling molecules including hormones, neurotransmitters, heparin, etc.,” he explains. “They also play an important role in the detoxification of hydroxyl containing xenobiotics and bioactivation of procarcinogens. Xenobiotic induction of sulfotransferases enhances xenobiotic detoxification. At the same time, it can potentially cause improper regulation of biological signaling molecules, bioactivate procarcinogens and lead to drug resistance.”

The United States Department of Agriculture awarded Chen a two-year grant totaling $100,000 for “Nutritionally Related Phenolic Acids Induction of Human Sulfotransferases.” Phenolics are important bioactive food components for good health. Long term goals of this investigation focus on the relationships between phenolics and human sulfotransferases, including how sulfotransferases metabolize phenolics and how phenolics inhibit, activate and induce sulfotransferases.

“Results from this project will allow us a better understanding of the biological roles of phenolic acids,” says Chen. “Studies may explain some beneficial or toxic effects of these compounds on human health. Research results will also lead to a better understanding of sulfotransferases’ biological functions and their potential roles in nutrition and optimal human health.”

One R01 grant from the National Institutes of Health was funded for four years in excess of $1 million. This research project, “Mechanisms and Functions of Human Sulfotransferases,” focuses on catalytic mechanisms and biological functions of human sulfotransferases and investigation of their relevance to human health under physiological and pathological conditions.

A grant from the American Cancer Society with funding totaling $530,000 was funded for three years. This project, “Cancer Drug Induction of Human Sulfotransferases,” will investigate nuclear receptor mediated sulfotransferase gene regulation by cancer drugs and mechanisms of sulfotransferase induction.

All three research projects will have a significant impact on general human health.

Guangping Chen received three separate grants valued at over $1.5M for his research on one drug metabolizing enzyme—sulfotransferases.
Microbial Forensics and Ag Biosecurity: A National Priority
**Fletcher recognized Oklahoma’s capabilities in an area of research that was not being addressed anywhere in the nation.**

**terrorist attacks of September 11, 2001,** elevated national security to an all time high at the federal, state and local levels. Efforts emerged in the scientific community to address U.S. preparedness and capabilities in response to intentional events related to agricultural biosecurity. Jacque Fletcher, Sarkeys Distinguished Professor in the Department of Entomology & Plant Pathology, at Oklahoma State University, was engaged by the president of the American Phytopathological Society (APS) to take the lead in determining that organization’s response to Washington’s needs in agricultural biosecurity.

The area was completely new to Fletcher and not one that she knew much about at the time. But in that role, she spent a lot of time working in Washington, meeting with agency administrators from the U.S. Department of Agriculture (USDA) and the Department of Homeland Security (DHS). She prepared a Congressional briefing and gave a number of informational presentations to various stakeholder groups, including commodity groups. The following year when Fletcher took over as president of the APS and had to design a plenary session for an upcoming meeting, she invited some experts to speak about biosecurity and agriculture.

One of those experts was Randall Murch, a retired Federal Bureau of Investigation (FBI) agent, who had started the field of microbial forensics. At the time, he was working for the

Fletcher will direct the Institute that will establish the university as a nationally-recognized leader in the area of microbial forensics and agriculture biosecurity.
tremendously impact the economy of a country or region.

The team realized that the discipline of plant pathology already had much information, technology and expertise that could be applied to the discipline of plant pathogen forensics. But, this had rarely been done before and most plant pathology methods had not been developed with the rigor and validation necessary for forensic purposes. New research and technology will be necessary for defending a position in a court of law. “We have to understand the limits of our tests,” says Fletcher. “We have to know how likely it is that we will have a false positive because a witness in court is going to be aggressively challenged by the other side.”

The group put together a report of capabilities, identified the gaps and determined the need to increase U.S. capabilities to trace back, for purpose of attribution, something that was done to products or crops. The group began a prioritization effort. “As this happened,” says Fletcher, “I began to understand this was a niche—an area of research that was not being addressed in this country. Oklahoma—a state rooted in agriculture—where agriculture is a major component of our economy, has all the right elements to support such an initiative.

We have the Advanced Center for Genome Technology in Norman, the OSU Oklahoma Food and Agriculture Product Center, the Oklahoma City Memorial Institute for the Prevention of Terrorism and the MesoNet system, among other strengths.”

“We ... are in a position to make a real contribution to the nation.” — Fletcher

The MesoNet system, for example, plays into the epidemiology side of forensics. Plant pathologists usually use epidemiology to predict where a plant disease is going in the future. In forensics, you see where the disease is and try to trace it back to the source. “The MesoNet allows us to do that,” says Fletcher. “We have all these capabilities, so we are in a position to make a real contribution to the nation. And, it’s not being done anywhere else in the country.” Fletcher proposed a new initiative that has resulted in the creation of the National Institute for Microbial Forensics and Food & Agricultural BioSecurity (NIMFFAB) within the OSU system.

Clarence E. Watson, associate director, Oklahoma Agriculture Experiment Station (OAES), supports the formation of the Institute as proposed by Fletcher. “Recent events in our country, such as ‘mad cow’ disease, the E. coli outbreaks in the spinach and lettuce crops, and the anthrax contamination of federal mail in our nation’s capital clearly indicate the relevance of this topic. These incidents all had marked effects upon our agricultural economy and food security, and it is critical that we be able to quickly and accurately identify the source and/or perpetrators of these outbreaks.”

Watson went on to say there are few institutions with the expertise to deal with this growing problem. Fletcher has a wealth of experience in the field and is widely recognized by her peers as a leader in the area of biosecurity. “The research of the Institute is of critical importance to the mission of the OAES, and we strongly endorse the establishment of the Institute,” said Watson. The Division of Agriculture Sciences and Natural Resources (DASNR) provided some funding for the initiative.

Stephen W.S. McKeever, vice president for research and technology transfer, says the effort is in direct support of OSU’s research efforts in sensing and homeland security, and is also in support of the university’s strategic planning objectives. Fletcher was the only ‘plant person’ on the national level FBI’s Scientific Working Group on Microbial Genomics and Forensics. One outcome is that the director of the National Biosecurity Forensics and Countermesures Center, a subset of DHS, wrote a letter of support for the USDA National Needs Fellowship grant that Fletcher and her colleagues Robert Allen and Ulrich Melcher received for student support in this area of research.

John Fernandez, president, OSU Center for Health Sciences (CHS), and dean, College of Osteopathic Medicine, congratulated Fletcher on securing
fellowship support for graduate students working in the emerging area of forensic science. He went on to say, “The Center for Health Sciences fully supports Fletcher and Robert W. Allen’s efforts in the creation of NIMFFAB. Through this, Oklahoma can take the lead in agricultural forensics.”

Allen, who is chair of the Department of Forensic Sciences at OSU’s CHS, also endorsed the concept. “As collaborators we have already experienced the success that synergy between two different areas, plant pathology and forensic science, can have on funding requests in this newly emerging area of forensic science. Creating the proposed Institute will only further enhance the potential for future funding and, more importantly, ensure that our university establishes itself as a nationally recognized leader in the agricultural biosecurity initiative.”

News of the Institute based in Stillwater was well received within the Oklahoma City FBI office, where the responsibility to protect Oklahoma’s vital agricultural infrastructure is taken very seriously. “I feel the creation of NIMFFAB will allow OSU to be a leader in the nation’s efforts to prevent an agroterrorism event. Such a role is very much supported by the Oklahoma City office of the FBI,” said Samuel Macaluso, acting special agent in charge.

The OKC Division of the FBI helped form the Oklahoma Agroterrorism Working Group (AWG), which now includes 41 organizations representing industry, law enforcement, government and academia. OSU has a strong presence on the Oklahoma AWG, with active members and personnel in leadership roles on the AWG Steering Committee. As a public-private alliance, the AWG focuses on establishing pre-crisis liaison and two-way communication flow while training and preparing to deal with the potential threat of agroterrorism.

A workshop on microbial forensics and agricultural biosecurity, funded by DASNR, was held in Oklahoma City, Oklahoma in January 2007 to look at possible scenarios, something that could be a real situation, leading to the development of a decision tree for law enforcement individuals assigned to investigate an agricultural crime scene. These may be FBI agents or other security personnel who are not experienced in agricultural or crop-related issues. They need to understand what kind of questions to ask, what information they would look for or what would be useful to them, such as patterns of disease in the field or particular symptoms they see.

The workshop discussions may be expanded in the future into a full-fledged field exercise in which security personnel would go through the steps as if in a ‘real’ scenario. “You can do this approach with plant pathogens, but not with humans or animals,” Fletcher explained. “Plant pathologists must be able to inoculate plants in the field as long as the pathogen is already common in the state every year. Thus, we have the ability to create a man-made event that can be compared with a natural situation. Then you create a decision tree for someone coming on to the scene, test it against a real situation, modify the tree and test it again. This way, you get a sense of the real issues that you are faced with.”

Fletcher says she will work to establish the Institute and to attract funding for research projects that support development of capability in this area. Research will include projects that would help identify more rigorous methodology, more portable methodology and quicker methods to enhance the capability to respond before evidence is destroyed or the disease gets out of hand or to identify perpetrators and bring them to attribution.

This could be research in disease diagnosis, pathogen identification and best ways to collect evidence, store it and test it. Or, it could be research in epidemiology or food safety.

Fletcher, who will direct the Institute says she hopes as time goes on the Institute will expand to include new faculty positions, but existing OSU faculty can work in affiliation with the Institute or take on a partial appointment. In addition to research, Fletcher also envisions the Institute playing a role in the other elements of the land grant university—education, training and extension.

Fletcher also envisions the Institute playing a role in education, training and extension.
Electrolyzed water’s antimicrobial properties remain effective considerably longer than other natural sanitation methods.

Making a Splash in Sanitation: Electrolyzed Water as an Antimicrobial

Electrolyzed water is making a splash in the sanitation industry. Produced by applying electricity to a solution of salt and water, electrolyzed water has antimicrobial properties strong enough to kill a variety of bacteria, molds, fungi and viruses.

SanAquel LLC, a new venture company in Bristow, Okla., is taking this not-so-new technology and applying it in an innovative way, said Peter Muriana, food microbiologist at the Food & Agricultural Products Center on the campus of Oklahoma State University in Stillwater.

“Although it’s not a new process, few companies are demonstrating SanAquel’s vision to implement electrolyzed water throughout a processing environment using automated generators, PVC plumbing and spray nozzles to mist and fog the liquid as a sanitizing solution into bacteria-sensitive areas in processing facilities,” Muriana said.

Now clients of the FAPC can reap the benefits of this sanitizing agent. Unitherm Food Systems, a sister company of SanAquel also located in Bristow, Okla., donated two electrolyzed water generators to the FAPC.

SanAquel LLC
From a combination of Latin words meaning “health” and “water,” SanAquel is dedicated to developing and marketing food industry sanitizing applications based on electrolyzed water technology, said Douglass Phillips, executive vice president of sales and marketing for SanAquel.

“SanAquel’s inspiration comes from over 20 years in the thermal/heat processing of food products in order to pasteurize them and kill pathogens,” Phillips said. “Many foods do not lend themselves to heat-based sanitizing applications, so it was natural to look for ‘cold pasteurization’ technologies such as electrolyzed water.”

The search led to an innovative way to employ an existing technology.

“Electrolyzed water has been around for a long time, but its use in the food industry has just recently become feasible due to improvements in the technology required to generate the electrolyzed water solution,” Phillips said.

How it’s produced
SanAquel technology produces an electrochemically created biocide, or antimicrobial agent, by applying an electrical charge to a brine solution, which consists of water and a small amount salt, Muriana said.

“The electrolytic process results in the formation of water with an antimicrobial effect,” Muriana said. “This electrolyzed water is similar to the weak bleach solutions placed in swimming pools, but is more effective against harmful foodborne bacteria.”

The system uses water straight from the tap. If tap water is hard, the process begins with passing the water through a water softener. A brine solution, table salt and water, is automatically added to the soft water in the proper proportion. An electrical charge is applied to the saline solution as it passes through an electrolytic cell, according to SanAquel.

“Generators apply an electrical current to a drinkable water solution,” Muriana said. “The small amount of salt in the water serves to conduct the current.”

The anode, or positively charged area of the electrolytic cell, produces an anolyte solution with strong antimicrobial properties. Catholyte solution is the secondary solution that is formed by the negatively charged area of the electrolytic cell. It comprises about 15 percent of the total solution volume, and its anti-oxidant properties make it applicable as a surfactant in food processing applications, according to SanAquel.

How it’s used
Electrolyzed water can be used in place of harsh chemicals to disinfect all surface areas in any type of food processing or harvest facility. In addition to disinfecting the outer surfaces of fruits and vegetables, electrolyzed water can be used to kill harmful bacteria on the surfaces of meat carcasses, according to SanAquel.

The solution is non-toxic and eliminates bacteria, yeast, molds and viruses on food, food processing equipment or any other hard surface, said Jake Nelson, FAPC value-added meats processing specialist.

In fresh meat and poultry processing areas, electrolyzed water is approved for use by the U.S. Department of Agriculture as an antimicrobial for direct product contact or as part of an environmental sanitation program, Nelson said. It is effective against many pathogens, including Escherichia coli, Salmonella, Campylobacter and Listeria monocytogenes, according to SanAquel.

“At the FAPC, the electrolyzed water generators have been installed in-line with our steam pasteurization unit and will be used for researching electrolyzed water’s effects on pathogens that may be found on freshly slaughtered carcasses, including beef, pork and lamb,” Nelson said.

The use of electrolyzed water does not stop with meat and poultry. FAPC researchers are currently examining its uses in other processing areas, including sanitary washes for fresh
produce, vegetables, fresh-cut melons and shell egg processing. Researchers are even addressing the use of electrolyzed water in animal production quarters, as well as in animal drinking water, Nelson said.

“Scientists in the department of animal science at OSU are investigating ways in which electrolyzed water solutions can be used in poultry and swine production facilities to improve animal health and reduce the risks of harmful bacteria getting into the food supply,” Nelson said.

FAPC researchers are beginning to test the safety and effectiveness of electrolyzed water as an anti-microbial intervention for use on ready-to-eat meat items.

“Results show this state-of-the-art process could give food processors in Oklahoma a way to continue to improve their methods to make food safe for Oklahoma consumers,” said J. Roy Escobas, FAPC director.

Benefits

Using electrolyzed water is cost effective because it eliminates chemical shipping and storage costs, Phillips said.

“While it is cost effective in large scale food production facilities, its primary benefits are its efficacy, safety in handling and environmental friendliness,” Phillips said. “These latter three items are ‘soft costs’ that are more difficult to quantify than the ‘hard costs’ associated with the purchase of chemical sanitizers.”

Muriana also recognizes the safety benefits of using electrolyzed water as a sanitizing medium.

“A big advantage of electrolyzed water over other types of antimicrobials is electrolyzed water is safe to spray even in the presence of humans, which can hardly be said for other sanitizing solutions that may cause respiratory problems and must only be used after a production shift,” Muriana said.

The window of time in which electrolyzed water’s antimicrobial properties remain effective is considerably long when compared to other natural sanitation methods, Phillips said.

“Electrolyzed water remains effective for over 30 days,” Phillips said. “So it’s our microbe-killing electrolyzed water, not money wasted on ineffective sanitizers, that ultimately goes down the drain.”

Lacie Stockstill
When Donna Branson received the 2006 Homeland Security Award in Washington D.C., she had two things on her mind: the soldiers in Iraq and the folks at home making sacrifices for them. She listed them as the reasons she is most proud of receiving the award, which honors her collaborative research and development work on QuadGard®, a lightweight, flexible limb body armor for the troops, as well as an earlier project, a personal portable cooling system for first responders.

The award from the Christopher Columbus Fellowship Foundation and AgustaWestland North America recognizes individual citizens or companies who have made “measurable and constructive contributions” to homeland security through cutting-edge innovation. Branson, who heads the new Institute for Protective Apparel Research and Technology at OSU, has led a team working to develop new body armor to protect soldiers against the loss of limbs from roadside explosives and small arms.

The OSU team worked in collaboration with industrial production partner FSTechnology LLC, ballistics and human factors partners at Army Research Laboratory, and Naval Research Laboratory partners who assessed combat casualty trends, protection strategies and warfighter requirements and were the program’s managers. Funding was provided by the Office of Naval Research and the Marine Corps Systems Command.

“Close collaboration between military, business and academic partners resulted in development, testing, redesign and retesting of the innovative body armor with technology transfer to Covercraft Industries in less than two years. That short timeline was achieved because many individuals from OSU and all of our partners, worked long hours and dedicated their time and expertise to offer our soldiers a higher degree of protection,” said Branson.

“We are extremely proud of Donna and the life-saving work she and her team have done,” said OSU System CEO and President David J. Schmidly. “They have toiled many long hours to make QuadGard® a reality for American soldiers. Donna and her team epitomize the dedicated, selfless work OSU researchers are doing in a variety of important areas.”

Since 2004, when the body armor project began at OSU, Branson insists she and her colleagues have been driven by the thought that they can actually help bring some soldiers back home alive with QuadGard®. It is specifically designed to protect a soldier’s arms, legs and back from shrapnel thrown by explosives as well as small arms fire.

“We’re certainly not alone in our desire to protect the soldiers, I receive emails all the time from concerned family members who want to know if the body armor will be available soon for their loved one in the military,” said Branson.

QuadGard® has now been in operational use for several months and has provided protection from blasts in actual combat situations. Such reports are gratifying to the team who has recently expanded their body armor design efforts to create a load-bearing ballistic vest that is undergoing a first stage military wear testing evaluation.

Branson’s work on QuadGard® has already been career-altering. When she started the project, she was head of the Design, Housing and Merchandising Department in the College of Human Environmental Sciences at OSU. Now, she heads the new institute inside the college, which is dedicated to the design, performance testing and technology transfer of protective clothing.

“It was a natural transition since we had been conducting various protective clothing research projects for some time. However, the time-sensitive nature of the body armor research and the comprehensiveness of the project illustrated the need for a way to facilitate such projects.”

“I couldn’t have begun to get this job done without a group of dedicated, talented OSU colleagues including Semra Peksoz, Diane Ricord and Cheryl Farr, graduate students and undergraduates. We’ve worked side by side and together we will chart a future for the institute, which already includes a growing number of faculty and students.”

That vision includes placing an emphasis on product development with testing and redesign as components in the inte-
Grative design process, and taking the institute into additional areas of “functional” apparel. “For instance, QuadGard® has the potential for civilian applications, such as police in SWAT and bomb scare situations,” said Branson.

“We expect continued development of high-tech materials that should make it possible to live more comfortable lives while offering all of us a higher degree of personal protection,” she added.

Jim Mitchell
The National Institutes of Health (NIH) recently awarded William Barrow and team an additional $2.99 million for two more years under a seven-year NIH/National Institute of Allergy and Infectious Diseases (NIAID) Drug Screening Contract. Shortly after the initial announcement, the NIH announced an additional increase of $2.86 million in connection with the current NIH/NIAID contract. This will provide the means for the Center for Veterinary Health Sciences (CVHS) to continue drug screening of various compounds for a total of four more years.

The primary objective of the NIAID In Vitro and Animal Models for Emerging Infectious Diseases and Biodefense Program is to provide targeted screening and evaluation of potential therapeutic and prevention modalities for emerging infectious agents and bioterrorism pathogens.

The initial contract was awarded to the CVHS team in late September 2003. The first task orders were awarded in September 2004 and the team has been moving forward ever since.

In the early stages of the program, Barrow’s team focused on developing and evaluating in vitro screening for four select agents. This last year, they expanded their capabilities and the team is now able to screen drug compounds using robotics and perform synergism assays, which allows the team to serve as an additional resource to NIH researchers.

Under Barrow’s direction, the CVHS evaluates potential bioterrorism and emerging infectious disease pathogens to determine which compounds are effective against these agents. According to Barrow, the additional funding will allow for a more expanded effort to include various drug resistant strains of bacteria.

An expanded program allows Barrow and his team to screen drug compounds using robotics and perform synergism assays—an important resource for NIH researchers.

Drug Screening Program Moves Forward

“Known antimicrobics that are effective against certain bacteria are combined with another compound and screened,” explains Barrow. “The results are one of three possible scenarios: 1) you experience no improvement; 2) you experience a synergistic response which has a better effect or 3) you experience an antagonistic response which is worse than the original scenario.”

According to Barrow, the team will add ten bacterial drug resistant strains to the screening of emerging infectious agents during the next year. Studies for these additional organisms have not been done. Drug combination studies, such as this one, may provide information that shows we should start treating these agents with a combination of drugs to get a better result.

Barrow’s research will also add the MyriaScreen Diversity Collection of 10,000 drug-like screening compounds to the project. His team will then screen select agents against these 10,000 compounds.

“We will build a database of our results so that other investigators can use the information to search their chemical libraries. It is our hope that investigators will be encouraged by this and submit their compounds to NIH for screening in the NIAID Biodefense Research program,” adds Barrow.

This new award brings the CVHS’ total NIH/NIAID contract to $7.9 million.

Research at Oklahoma State University • www.vpr.okstate.edu
Scientists at NASA are working to solve a problem with driving robotic rovers on the planet Mars and an Oklahoma State University-Tulsa professor may have the answer.

Jay Hanan, assistant professor of mechanical and aerospace engineering, is working with scientists at NASA’s Jet Propulsion Laboratory (JPL) to create new technology that would make self-directed driving for rovers possible on the surface of Mars.

“Visual landmark tracking enables a vehicle to more precisely determine its position, heading and velocity and to hone in on desired targets or waypoints,” Hanan said. “Basically, we’re putting artificial intelligence into a robot so that it can drive itself on Mars. With our technology, the robot can recognize rocks in its field of view and change course.”

Hanan said current systems are heavily dependent on “dead reckoning,” which is the process of estimating navigation using speed, time and distance of travel based on counting wheel rotation. This method leads to navigation errors including problems such as driving into rocks and other obstacles.

Due to Mars’ sandy surface, slipping and speed are also major concerns for current rovers. Obstacles in the path of rovers must be detected and avoided as much as 20 minutes in advance.

“The rovers move slowly to compensate for uncertainty in the environment and the dead reckoning system. Small errors can be catastrophic,” Hanan said.

Providing intelligent vision to the rover could vastly improve the missions. With Hanan’s technology, the machines could cover much more ground, saving time and efficiently gathering additional data in a given day.
Scientists Developing **New Dental Materials**

Oklahoma State University doesn’t have a material science department, but it does have world-class material scientists collaborating on research leading to the development of new materials for high-tech applications. Jim Smay, assistant professor in the Chemical Engineering Department at OSU-Stillwater, one of the nation’s most promising young scientists and engineers, teamed with expert materials scientist, Jay Hanan, an assistant professor in the Mechanical Engineering Department at OSU-Tulsa working on strain related to ceramics, to develop new materials for dental crowns.

Smay was first exposed to the “robocasting technique” he uses in his research today while completing his graduate degree as an intern at Sandia National Laboratories. The printing process he has perfected is much like writing with a pen only automated. Smay designs a structure using a CAD program and prints it with a robocasting technique. The ink he has developed is a ceramic material much

![Smay uses one of his CAD drawings that he then prints with inks he has perfected with his robocasting technique.](image)

Photo by Erika Contreras

A new approach for fabricating dental crowns may transform the dental industry.

**Scientists Developing New Dental Materials**
like toothpaste with the ability to hold its shape. So half the technology he is working on is making the ink. The difference in the ink in the printer he uses and an inkjet printer is the density. An inkjet printer uses ink that is 3 to 5% solids, and Smay uses ink that is 45 to 47% solids.

Smay has refined the ink formulation and processing steps to yield inks that can produce a wide range of geometries, including space filling solids, high-aspect ratio walls and self-supporting spanning structures. He uses advanced materials like aluminum and zirconium oxides blended with water and polymers to make the ink with the right flow properties. The details of the ink formulation depend intimately on the surface chemistry and concentration of the ceramic particles, pH of the water and chemistry of the polymers. The ink is extruded through a tip that is seven thousandths of an inch in diameter. The tip is immersed in oil during printing so that the printed ink won’t dry until the entire part is finished. Finally, the part is removed from the oil, dried and baked in a kiln to produce a dense, high-strength dental crown.

Different ceramic materials are used for different applications based on such properties as strength and electrical behavior. Smay uses aluminum oxide for dental crowns because of their high strength and wide acceptance in the dental community. He used barium titanate and lead zirconate titanate for photonic band gap structures and sensors. A biocompatible ceramic, hydroxy appetite, is being used to develop bone scaffolds that can be implanted in the body so bone cells will grow into pore space and make new bones.

The complete ‘rapid prototyping’ process Smay calls ‘art to part’ takes only 24 hours. He received a $400,000 National Science Foundation grant to advance the science and conduct an outreach program targeted at high school students. In July 2006, he received the Presidential Early Career Award for Scientists and Engineers for his research accomplishment and contributions in education.

With a National Institutes of Health subcontract, Smay is working with the New York University (NYU) Department of Dentistry to develop the new approach for fabricating dental crowns. He is collaborating with Hanan who works with X-ray micro-tomography and micro-diffraction. Smay is utilizing the capability of the printing process to print inks of different ceramics to build composite crowns and improve their fracture properties. The premise of the design is that by strategically placing the right ceramics in the right locations in the dental crown, residual stress may be controlled to arrest cracks that would normally destroy the crown. Hanan takes these samples to Argonne National Laboratory (ANL) where they are tested using the synchrotron.

Hanan and two of his graduate students recently came back from testing samples at Argonne’s Advanced Photon Source—the synchrotron which gives researchers access to X-rays. Researchers apply for beam time on the synchrotron by submitting a proposal. Hanan’s proposal for beam time was accepted which allowed him to focus on this concept of ceramic materials and how they deform. Hanan is looking at aluminum and zirconium composites which are what Smay makes with his robocasting technique.

Some things you can see with the beam line can’t be seen with any other tool. There are also advanced third generation beam lines in Japan and Europe, but there are no others offering the same capabilities as the one at ANL. Hanan looks at strain and damage in these materials which is how a material responds to stress and contact fatigue. Hanan says the ability to look deep within the material using synchrotron X-rays can’t be done in any other lab without cutting through the material which then destroys it. This falls into the non-destructive evaluation area—a graduate course taught by Hanan at OSU. The 3-D images created using a synchrotron are high resolution. “You can see atoms in motion with the beam line,” says Hanan.

According to Hanan, this research is exploratory, but it could grow into a four-year program. NYU doesn’t know the residual stress of the crowns Hanan is testing. “But if we can determine the stress, we can use it in a way to make better crowns,” says Hanan.

Jana Smith
An outstanding team of Oklahoma State University researchers has collaborated to develop ways to capture information from biomedical signals such as electrocardiograms that could change medical diagnosis and treatment.

Bruce Benjamin, OSU-Center for Health Sciences associate professor of physiology, and Ranga Komanduri, OSU-Stillwater Regents Professor and A. H. Nelson, Jr. Endowed Chair in Engineering, worked with researchers from both campuses to find a way to interpret and apply routinely collected but vastly unused, and often discarded, complex biomedical signals.

The result is the OSU Center for Biomedical Signal Analysis and Integrative Diagnostics (SAID), and it promises to advance diagnosis and treatment of cardiovascular disease. “The availability of powerful, inexpensive computers makes it possible,” Benjamin says. “The process will help OSU biomedical scientists, engineers/scientists and clinicians to analyze this often discarded information, which can be very useful for improved diagnostics,” he adds.

The OSU partners crafted computerized diagnostic systems that work together to harness the signals and pinpoint problems. It could lead to new or better ways to predict, detect, diagnose and treat diseases such as heart disease, diabetes and neurological disorders.

Biomedical signal analysis and integrative diagnostics promise to advance diagnosis and treatment of cardiovascular disease.

Team Works to Harness Biomedical Signals
Right now, Benjamin says, 21st Century biomedical signals are analyzed with 20th Century tools. Clinicians often use only a small fraction of the available information, discarding the remainder because it is an array of complex signals not easily translated into a usable form.

“The signals that can aid patients are available,” Benjamin says. “Processing the signals in a new way with SAID technology promises to provide a wealth of important information.”

SAID looks at the big picture of heart, vascular and respiratory systems, using the SAID model to analyze complex biomedical signals (EKG, continuous blood pressure and respiration). It also uses multiple techniques that are non-linear in frequency and time, including Fast Fourier Transform, wavelet analysis, statistical analysis, feature extraction methods and neural networks.

“We can analyze the whole signal, not just a fraction of it, using several approaches,” Benjamin says.

“As a challenge, the researchers undertook the task of classification of different atrial fibrillations states from the 2004 PhysioNet Challenge competition,” Komanduri says. “Atrial fibrillation is a common form of arrhythmia, affecting some 2.2 million Americans annually. The risk of sustained atrial fibrillations includes strokes and myocardial infarctions caused by the formation of blood clots with stagnant volumes in the atria. Within a short period, the research group was close to 90 percent successful in differentiating different states,” Komanduri adds.

Komanduri lauds the team approach. “I am a strong believer in an interdisciplinary approach to research, as most problems are too complex to analyze with any one discipline or by any one researcher. At OSU, we have been successful in building several such teams to address many challenging problems in the past 15 years. The present collaboration of engineers and scientists from OSU-Stillwater and OSU-CHS is like a marriage made in heaven,” he says.

Komanduri says that such collaborations can be difficult because of different backgrounds and experiences. “Remarkably, this collaboration was two-sided and both sides are more than eager to participate. We now have six researchers from OSU-Stillwater and three from OSU-CHS, along with our graduate students, meeting regularly on this exciting problem. This is not a group put together to respond to a request for proposals but an interdisciplinary research group, genuinely interested in making significant contributions to this all important and challenging problem,” he adds.

Phase one, proof of concept, is under way. Engineers are developing a computer neural net that uses artificial intelligence to analyze data sets. CHS biomedical scientists and clinicians have completed heart rate variability and autonomic balance studies. Phase one also calls for gathering data from normal and sick individuals to be collected and coded.

Benjamin says normal data is needed to enhance the training of the neural net, the “brain” of the signal analysis process.

The remaining three phases are development and expansion of databases; development of prototype analysis software and equipment and then testing and implementation.

Using the OSU-CHS rural health care network and telemedicine expertise, signal analysis can reach remote rural areas with advanced technology. Both campuses can expect to provide interdisciplinary programs to train students in biomedical-engineering sciences.

Besides advances in medical research, especially in cardiovascular disease and increased medical service to Oklahoma, Benjamin says the project can spark educational initiatives, help establish Northeast Oklahoma as a biotechnology center, and lead to development of patented commercial products.

“We would like to develop a diagnostic tool using our signal processing capability to provide health care from hard-to-reach places, small towns and in the rest of the world where low cost medical service is needed,” Benjamin says. “We also can train students in biomedical-engineering sciences.”

Marla Schaefer

Drs. Benjamin and Komanduri work with the OSU Center for Biomedical Signal Analysis and Integrative Diagnostics to develop ways to capture information from biomedical signals such as electrocardiograms that could advance diagnosis and treatment of cardiovascular disease.
If you ever watch a football game, you may notice when the quarterback passes, he doesn’t throw to where the receiver is, but where the receiver will be. OSU-Okmulgee President Bob Klabenes, who used to coach high school football himself, is doing just that – but on the scientific, rather than athletic field. The future he is aiming at is somewhere around 2010, when the demand for nanotechnology scientists and technicians will become critical.

Klabenes says “The niche that OSU-Okmulgee is positioned to fill is in providing high-performance technicians, for both the manufacturing industry involved with nanotechnology and in assisting the researcher working on nanotechnology development in a university or industrial environment. At the present time, many nanoscientists are doing everything, and to make them more productive, a high-performance technician is needed to do many of the tasks associated with the research.”

Nanotechnology is the science of manipulating materials at the molecular level. (One nanometer is 1/100,000 the diameter of a strand of hair.) The results are amazing. Consumer-oriented products include high-efficiency foot warmers; golf balls that correct their own flight path; customizable skin care creams; rain-proof super coatings for homes; odor-killing clothes that repel dirt and water and car waxes that last a year.

Life-saving creations include nanoparticles that home in on prostate cancer cells and deliver doses of targeted chemotherapy. For third world countries where water quality is a critical need, scientists have developed rust nanoparticles, which bind to arsenic to then be lifted out of water by a simple handheld magnet, leaving behind drinking water pure enough to meet Environmental Protection Agency standards.

OSU-Okmulgee is focusing its efforts on the field of electrical engineering technology. The Nanoscientific Instrumentation Technology program designed by Steve Holley, an instructor who helped create the introductory courses, says the next step is a characterization or metrology course. This involves using atomic force microscopes, which operate at the nano level and can make images of atoms and molecules. The hands-on course will give students experience with the tools of nanoscience with emphasis on instrumentation.

Holley said one of the rationales for the program was to equip students for an industrial environment that is most likely in the microelectronic technology mode but is migrating toward nanotechnology. “These students will be able to help their employers make that transition – perhaps even pioneer a new path for their company.”

Getting prospective students to sprint downfield and catch this opportunity is a challenge because the technology is new and not well understood. To encourage awareness, OSU-Okmulgee applied for a National Science Foundation (NSF) grant to finance more lab equipment, provide more faculty training and – most importantly – fund development of a nanotechnology introductory course within the state’s CareerTech system.

“I’m excited that our NSF grant application is clearly linked to Oklahoma’s CareerTech system,” says Klabenes. “Eleventh and 12th grade CareerTech students can be exposed to nanotechnology and become excellent prospects for the nanoscientific instrumentation technology program on our campus.”

Oklahoma Center for the Advancement of Science and Technology members recently met with an official from the Oak Ridge National Laboratory who praised the state’s progress with the Oklahoma Nanotechnology Initiative. Klabenes agrees that the process is well underway. “There are some private research facilities and half a dozen industries in the Oklahoma City area working in the health and materials fields that are beginning to utilize nanotechnologies. They will need the kind of people that OSU-Okmulgee will produce.”

The nanotechnology labs on campus have been equipped with atomic force and scanning tunneling microscopes – the basic tools that allow students to see and manipulate structures at the nanoscale. Graduates will earn a 75-credit hour Associate in Applied Science degree. Klabenes says OSU-Okmulgee will launch the full program next fall.

Rex Daugherty
Growing the Numbers


Annual Research Funding in Millions of Dollars


Number of Patents Granted

Number of Licenses Yielding Income

Income from Licenses
Artist Liz Roth depicts social concerns in a humorous way with her art installations and public art works dealing with environmental issues. Her most recent project, *America 101*, took her to all 50 states to create oil paintings emphasizing environmental losses resulting from consumerism. Her project pairs small, commodity-sized paintings (two typical landscapes from each state) with a large mural of a typical commodity (blister packed Barbie). By reversing the size of things (making a tiny commodity huge and exquisite vistas tiny), she reminds us of the real scale of things.

Roth shows her concern for the environment by contrasting the natural beauty of the American landscape with the flagrant consumerism that is typically American. *America 101* and a previous work by Roth, *Pink and Green*, which is part of a permanent collection in Japan, reveal the mystery of nature and modern life in her signature style. Roth brilliantly captures Japan’s “culture of space” in “*Pink and Green*” with 36 views of Kamiyama, referring to Hokusai’s 36 Views of Mt. Fuji. A large mural of a toy “Hello Kitty” mobile phone symbolizes modern life.

Americans love their commodities, but seem to have no idea where they come from. *America 101* reminds us that our consumption has a price—environmental degradation. Americans must realize that we sacrifice beauty in the name of consumerism. So, what is the intent? Roth wants her audience to think twice about their choices and make better ones. “If you care about the environment, you will make small changes in your behavior. If the art I make contributes to these small changes, then I am satisfied,” says Roth.

Roth came to Oklahoma State University two years ago from the University of Wisconsin-Madison. An assistant professor in the OSU Department of Art, Roth teaches painting, drawing and a Studio Capstone class on professional practices for artists. The Capstone course teaches students how to slowly and methodically make a living with their art, including how to get an exhibit and how to write a grant. OSU is one of only a few university art programs teaching students the complete process—making money, art and business. Roth says she is excited to be part of this program.

Roth’s works have been acquired by many national and international collections, including the Walker Museum of Art, the Museu del Jocut in Spain, the Museum of Awa Japanese Paper and the KAIR Contemporary Art Collection. She has been an artist in residence at the Jentel Artist Foundation (in Wyoming), the Awagami Paper Factory (in Japan), the Kamiyama (Japan) Artists in Residence program, and the Vermont Studio Center. Most recently, she received the generous national Ludwig Vogelstein Foundation grant for painting.

For more about Liz Roth and to view her collections, visit www.lizroth.com.