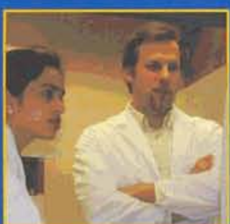
School of Chemical Engineering and Materials Science ■ The University of Oklahoma

OkChE

OklahomaChemicalEngineer

Spring 2003

OU: A leader in carbon nanotube research pg 3



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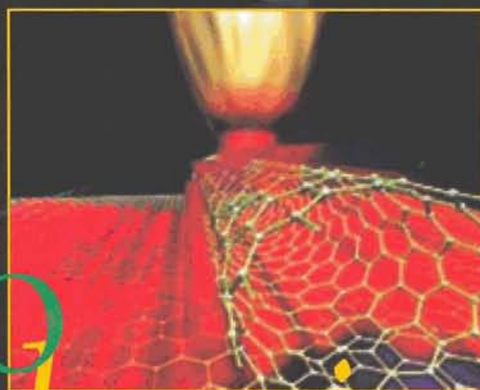

Where can the nano revolution take us?

imagine

imagine

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OkChE Magazine

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A Note from the Director

CEMS activities are generating a lot of excitement these days, and you'll read about some of the reasons in this issue of OkChE Magazine. Despite state budget cuts, this is in many ways the best of times for CEMS: Research on various aspects of nanotechnology involves over half of the CEMS faculty, with spectacular success in the area of nanotube production; research in bioengineering and biomedical engineering is picking up, with six CEMS faculty (including two new faculty added in the last year!) involved heavily in bio research and several others collaborating on bio-related projects. There are continually new developments in traditional CEMS areas of strength such as applied surfactant research, polymer processing and characterization, process engineering, and petroleum and natural gas conversion processes; and total research expenditures are growing.

The undergraduate program is stronger than ever. For example, the average ACT score of chemical engineering students is 27.5. About one in nine chemical engineering undergrads is a National Scholar and more than one in six is in the OU Honors Program. Another indicator of student quality is their accomplishments, which include this year's College of Engineering Outstanding Senior (Andrea Robben), OU Homecoming Queen (Sarah Hodge), second-place winner at the AIChE MidAmerica Regional Student Paper Contest (Holly Krutka, who also finished third last year; OU chemE students have taken nearly half of the awards over the past four years at the five-state competition). Further, the last three CoE Engineers' Club presidents have been chemical engineering undergrads (Shane Steagall, Aron Deen and Susan Kerr).

Other items related to the undergraduate program: The new BASF Multimedia Room, which occupies the former storage space in the back of the Unit Ops Lab, is heavily used for undergraduate lab classes, student presentations, recording presentations for streaming video, small classes and group meetings. Thanks to BASF, this facility meets a longtime need of the School and provides an outstanding setting for developing undergraduate communication and group skills. This spring semester, thanks to a gift from the Chevron Phillips Chemical Co., CEMS launched the Chevron Phillips Scholar-Mentor Program, which sponsored six upperclass chemE students to serve as mentors and tutors for the sophomores. We expect this program to grow (There will be eight mentors in the fall) and to contribute greatly to the success of our undergrads. This year we awarded for the first time the Al Clark Chemical Engineering Prize, which went to Holly Krutka. The Al Clark Prize, which is intended to promote undergraduate research activities, is awarded to a CEMS student who places at the MidAmerica Regional Contest. The prize was endowed by a gift from Al Clark Jr., whose father taught chemical engineering classes at OU after his retirement from Phillips. Next year we will award for the first time the Freda Meyer Guild Award to the outstanding female in chemical engineering. The Guild Award honors the first female chemical engineering graduate, Freda Meyer (Class of 1943) and was endowed by a gift from her family. This fall the student AIChE chapter will kick off a chemical engineering car competition to involve all CEMS sophomores, juniors and seniors in a team activity. We'll report on the results of that activity in the next *OkChE* magazine.

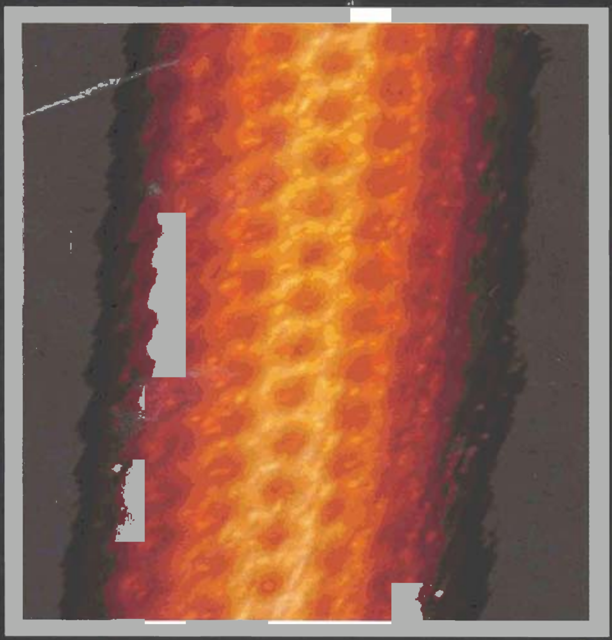
The growth in CEMS of new areas of research reflects the rapid changes taking place in the chemical engineering discipline. Although none of the traditional areas of chemical engineering

are disappearing, new areas in which chemical engineers can apply their skills are rapidly emerging. In addition to giving students technical expertise, chemical engineering education develops students' lifelong learning skills, leadership skills, communication skills, business acumen, and awareness of the global marketplace. These changes in demands on today's engineers were the basis for the evolution of the ABET accreditation process described in the last *OkChE* magazine, and I'm happy to report that CEMS completed its ABET evaluation with flying colors. Building on that positive evaluation, we continue to work with students, alumni and industry to improve our curriculum and the education our students receive. The College of Engineering is in the midst of a $100 million Campaign for Engineering, which I'm sure you've read about in the CoE's *Evolve* magazine, and which will provide resources for further growth and development in CEMS, OU and the state. We are happy to have all of you as our partners in this process – it's an exciting time! ■

Lance

Where can the nano revolution take us?

Imagine pulling your computer out of your pocket for a quick virtual tour of ancient Rome. Hopefully you remembered to download its latest version before you left home. The video and 3D capabilities on yesterday's hardware upgrade were fabulous. Experiencing a bit of time warp vertigo? What century will bring the technology to download hardware that will fit in your pocket? According to experts around the globe, the nanotechnology revolution, which will make such things routine, may have as profound an impact as the combustible engine. At OU, chemical engineering professors and students are at the forefront of this new frontier.



Atomic Force Microscopy image of a single-walled carbon nanotube. Note C_6 rings forming the wall.

"This is the most exciting time in history to be an engineer."

Nanotechnology combines the disciplines of physics, chemistry, engineering and biology to produce materials from the ground up.

"The fundamental concept of nanotechnology is to build things atom by atom - it's one atom at a time construction," explained OU's Conoco/ Dupont Professor of Chemical Engineering Jeff Harwell.

Sounds like science fiction, but today Oklahoma is home to a nanotechnology company planning to use nanomaterials in conventional manufacturing. Almost one-half of OU's chemical engineering faculty are conducting research in various areas of nanotechnology, and of the 21 leading ideas in the 21st century, *Business Week* has rated nanotechnology number four. The U.S. government has dedicated billions of dollars to nano research. Private and public nanotech institutes, businesses and research labs are springing up across the globe.

"This is the most exciting time in history to be an engineer. Every day there are new discoveries that open up whole new futures. It's a fantastic time," Harwell said.

It's definitely a time when less is more. Nanotechnology harnesses a microscopic reality that can grow so big that your mind cannot fathom the boundaries. According to Harwell, the basic blueprints for this reality exist throughout the universe in the natural world. Billions upon trillions of efficient, strong, lightweight biological "nanomachines" work together to make our world.

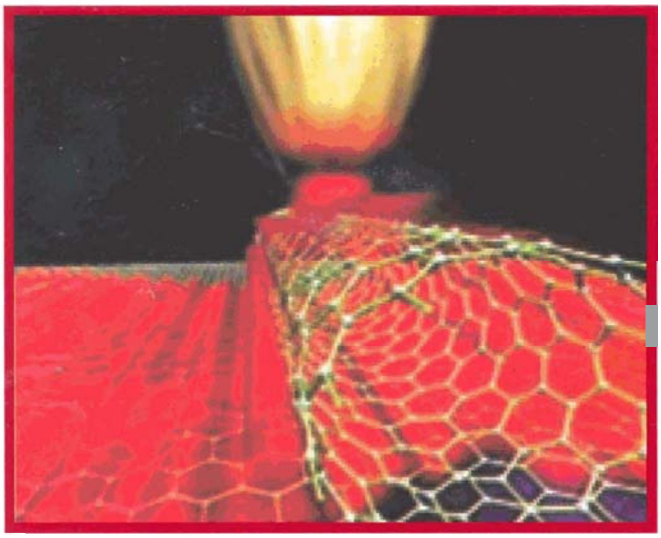
Graduate student Joel Daniel preparing nanotube-collagen composites.

"A baby is conceived when all you have is one cell with a set of instructions. When it combines with another cell it builds an entire baby with trillions of cells, all differentiated. And this comes from a set of instructions stored inside DNA," Harwell said. "All we want to do is build something a billion times smaller and it doesn't have to be nearly as complicated as a baby."

Harwell, who also is associate dean of the College of Engineering, predicts that manmade nanomachines will contain "programming" instructions completely different from today's computers.

"Microchips probably wouldn't work because of the problem of quantum uncertainty. They also consume too much power," he explained. "We need a manmade version of DNA. One of our challenges is to identify a storage medium for the programming and come up with a way to code those programs with the efficiency found in the natural world."

These synthetic models will be in compliance with known natural laws.



Cross-section of a carbon nanotube.

Nanotechnology may use microscopic molecular machines that have gears, shafts and bearings similar to, but more efficient than, today's versions.

"The cells in our bodies and throughout the universe contain billions of nanomachines. By observing these natural nanomachines, such as proteins and enzymes, we can see proof that this is feasible. We're not altering nature's system, we're trying to learn how to design systems that are as efficient as those found in nature," Harwell said.

Why is smaller better? Today's bulky industrial manufacturing methods have been compared to building Legos with boxing gloves on. Pioneers in the nano-revolution such as Foresight Institute founder K. Eric Drexler believe nano-industry will be more effective than conventional manufacturing. "The cutting, stripping, baking, spraying, etching, grinding of large chunks of natural resources not only consumes great amounts of energy, but also produces tremendous toxic byproducts," Drexler said. "In today's world it's an either/or scenario: Better quality competes with lower costs, which in turn competes with greater safety and a cleaner environment." Drexler and others envision nanoindustry where everyone wins: improved quality and lowered costs increase safety and improve the environment.

The theory is that by placing every single atom in the correct place, almost any structure can be perfect, according to the laws of physics and chemistry. Manufacturing costs involved in the development and reproduction of universal assemblers may barely exceed required raw materials and energy. Nanotechnology may produce stronger, lighter, more precise materials where toxic byproducts may be the size of a molecule. Nanomachines could possibly be designed to clean up the microscopic mess.

The concept of nanotechnology was introduced in 1959 by Nobel Prize-winning physicist Richard Feynman, who proposed that "the principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom."

Even though the concept was introduced over three decades ago, technology is just now at a stage where it can actually use existing manufacturing tools to research and create nanomaterials.

"Until now we just didn't have sufficiently sophisticated tools to manufacture atom by atom. Today's tools are so much better in terms of scanning microscopes and the like. Even lithography in the microelectronics industry can build circuits that are approaching nanodimensions," Harwell explained.

But researchers still do not know how to construct nanomachines or microscopic robots that would make nanomaterials, although models and simulations are being developed worldwide. "Right now we're like a 19th-century mechanical engineer trying to build an automobile," Harwell said. "Researchers in all fields are working on various parts, just like you have one part of the automobile factory that makes steering wheels, another makes carburetors. We have to bring these pieces together. We have the vision and the biological analog and we don't have to violate any fundamental physics or chemistry to get there. We know how to make nano-materials, now we have to figure out how to make nanomachines and nanofactories."

Nano robotic arms can perform 1 million functions in one second. Nanoindustries should require less space, less money, less natural resources and less toxic byproducts. Is this the long-heralded phase-out of the human worker?

"There is so much untapped potential still in the world. We have a long way to go before we have to worry about running out of economic opportunities," Harwell predicts, disagreeing with naysayers who fear nanomachines will one day rule the world.

"We used to worry that computers would take over. But you'd have to program them to do that. These [nanomachines] are just tools.

"Every day you hear about companies downsizing and decentralizing," he added. "The larger companies are decreasing while there's a dramatic increase in smaller industries. Nanotechnology puts manufacturing tools into the hands of the individual."

Harwell also celebrates the possibility of decreasing the gap between the "haves" and the "have-nots."

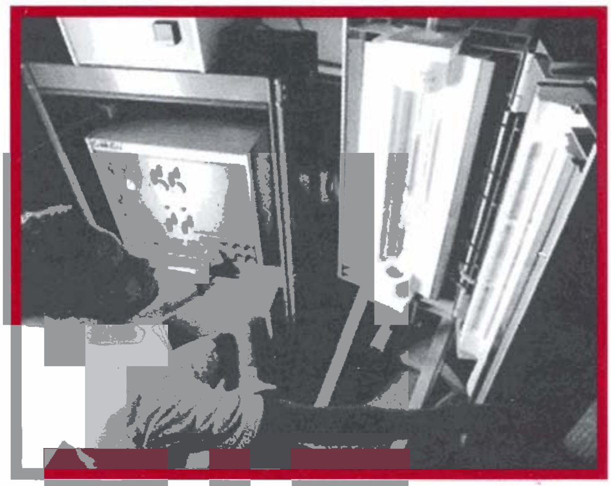
"This gap will shrink a lot faster when you have technology that uses nanomachines in place of pharmaceuticals," he said. "We won't have to worry about not being able to afford AIDS cocktails in Africa. It will take a lot less to produce items that are inexpensive and much more efficient."

This edition of *OkChE* magazine highlights the work of such experts as Daniel Resasco, Sam Wilson Professor of Chemical Engineering, who has developed and patented one of the first cost-effective methods of mass-producing carbon nanotubes. You also will read about three professors engaged in bionanotechnology — David Schmidtke, Vassilios Sikavitsas and Peter McFetridge. Schmidtke's research may result in a better understanding of how wounds heal and how drugs can be delivered more efficiently; Sikavitsas's work may help prevent breast and prostate cancer cells from metastasizing to the bone; and McFetridge's efforts may improve survival rates in heart bypass surgery.

Taken together, the nanotechnology research now being conducted at OU stands to dramatically improve the environment, health and economy of tomorrow's world. ■

"Right now we're like a 19th-century mechanical engineer trying to build an automobile."

Jeff Harwell



Leandro Balzano works on a large-scale reactor for the production of nanotubes.

Resasco Pioneers Cost-Effective Nanotube Production

The concept of nanotechnology hit the scientific community in the late 1940s. Sixty years later revolutions in technology have increased the likelihood that nanotechnology will materialize. Yet, major hurdles still exist. Foremost has been the cost of producing nanotubes — the building blocks of many nanomaterials.

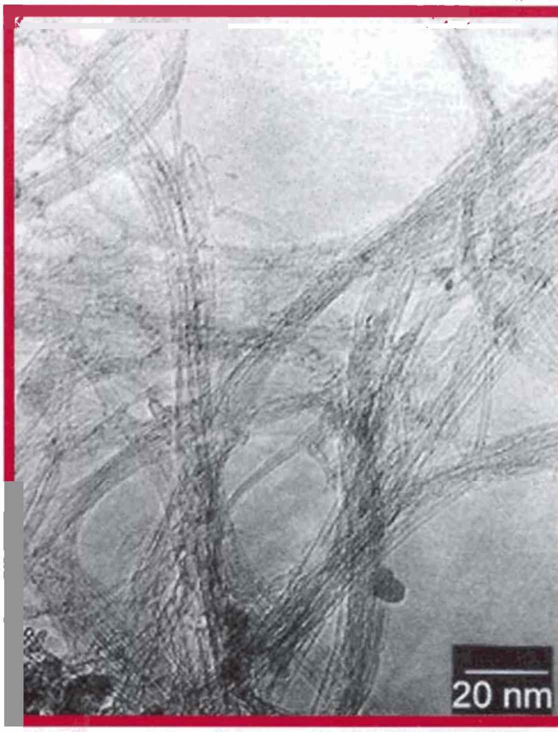
"Most carbon nanotubes produced by the catalytic method are multi-walled, contain lots of defects and are not uniform. It is very difficult to produce perfect nanotubes," Daniel Resasco, Sam Wilson Professor of Chemical Engineering, explains. "Culling a few perfect nanotubes out of millions of defects is not cost-effective. Using conventional manufacturing methods, one gram of nanotubes is about $1,000."

Resasco has pioneered a process to create fullerene nanotubes, using cobalt and molybdenum catalysts. His novel catalytic method, the CoMoCAT™ process, currently has two U.S. patents and a third pending.

"This process provides high selectivity of single-wall nanotubes," Resasco says. "The mechanism of formation is governed by nucleation of metallic atoms until they reach a given size. After this first step, the carbon atoms from the gas phase start to self-assemble in the form of nanotubes. The diameter of the nanotube is controlled by the size of the metal particle or catalyst. My catalyst allows you to control the particle size, resulting in a more perfect product."

The catalytic nature of the process is expected to lower the price of nanotubes dramatically, which could lead to the inexpensive mass production of the tubes. Increased access to cost-efficient nanotubes may directly impact evolution of technology.

"One nanometer is 10^{-9} meters, or 100,000 times thinner than human hair," says Resasco. In a carbon nanotube, the strength to weight ratio is 400 times that of steel. From an electronics standpoint, these nanotubes could be used to make electrical circuits at nanodimensions. Nanotube-based flat panel displays are expected to hit the market this year. These early models may be expensive, though future displays made with Resasco's fullerene nanotubes could be as inexpensive as plastic and require one-tenth the power of conventional displays. They also could be small enough to fold up and put in your pocket.



TEM (transmission electron microscopy) image of bundles of single-walled nanotube produced at OU.

> "One nanometer is 10^{-9} meters or 100,000 times thinner than human hair."

"The length to diameter aspect ratio is 10,000, allowing for lower voltage and lower spacing to produce high intensity and resolution in a television screen," Resasco says.

Research into the creation of materials reinforced with carbon nanotubes has been limited because of the cost of the nanotubes. Today, OU chemical engineering faculty and students are able to use Resasco's cost-effective fullerene nanotubes, thereby increasing the marketability of resulting nanomaterials.

Resasco envisions a method of continuous production that "will occur catalytically and continuously much like polyethylene or plastics are produced today." This breakthrough technology provides a process that can be tailored to meet widescale manufacturing demands.

"With this kind of catalyst and process you can scale up easily," Resasco says. "If it's this easy to produce one gram of nanotubes, it can certainly be used to produce a ton." ■

SWeNT

The first spin-off company of OU's Office of Technology Development Office, SouthWest Nano Technologies, has been formed to bring the CoMoCAT™ process to market. With a recent capital and property rights investment by ConocoPhillips, the third largest integrated U.S. energy company, SWeNT is well on its way.

Convinced of the value of Professor Daniel Resasco's idea, the Technology Development Office, the product licensing arm for the university, recruited a management team that includes Board of Visitor member Bill Nasser, former CEO and president of Petrolite Corp., as CEO of SWeNT, and adjunct professor of engineering Mike Moradi, a co-founder of NanoSources, a DuPont acquisition, as executive vice president of marketing. Resasco serves as chief scientist.

Since its incorporation in April 2001, SWeNT has focused on producing nanotubes for use in three major areas: composite materials, which can be used by NASA in structural, electronic and thermal applications; electromagnetic materials, like the shielding material currently being developed for use in stealth combat aircraft; and thermal materials, which can be used in aerospace applications because carbon nanotubes transfer heat so well.

The company's intent is to provide more than just raw materials. Because the technology is so new that no firm demand exists, SWeNT plans to assist certain targeted companies in application development as well. According to Moradi, "We're in uncharted territory with carbon nanotubes. On one hand, we have the first mover advantage and can lock down high-value applications. On the other hand, we have to build markets for those applications, one customer at a time."

Students Jose Herrera and Olga Rueda work with an X-ray photoelectron spectrometer.

SOUTHWEST NANOTECHNOLOGIES

CoMoCAT™

U.S. Patent Nos. 6,333,016; 6,413,487

SWeNT offices in eTec, Norman's business accelerator, and is building its first pilot plant on the new OU Research Campus North. From there, it can begin working with companies to capture a part of the emerging market.

Moradi points out that the voters' approval of State Questions 680 and 681 made SWeNT, and Oklahoma companies like it, possible. "Although the Office of Technology Development has only been in existence since 1998, in the year 2000 it ranked 10th in licensing revenues, tied with Carnegie-Mellon. It has created 15-20 startup companies and brought in millions in licensing revenues," he says.

Moradi is particularly interested in speaking with ChemE alums who have experience in application development. "One of SWeNT's most valuable assets has been the College of Engineering's formidable alumni network. On several occasions, SWeNT has leveraged that network to grow the company," he says. "In fact, we encourage any and all alumni to contact SWeNT if they feel we can add value to their organization or are interested in an investment." Moradi can be contacted at Mmoradi@swnano.com. ■

"One of SWeNT's most valuable assets has been the College of Engineering's formidable alumni network."

Schmidtke Explores Cell Adhesion and Biosensors

Assistant Professor David Schmidtke came to the University of Oklahoma via a bachelor of science degree at the University of Wisconsin at Madison, master of science and doctoral degrees at the University of Texas in Austin, and postdoctoral work at the University of Pennsylvania, studying platelets and leukocytes under flow. "I like it here. It reminds me of Wisconsin, though the people seem to be friendlier," he says.

Schmidtke has two main areas of research interest: cell adhesion and biosensors. His cell research deals with how cells roll and bind to cell walls and to surfaces under flow. Cell adhesion has applications in such processes as wound healing, thrombosis and inflammation. Understanding its molecular mechanisms can be used to improve drug delivery systems and further tissue engineering research.

Schmidtke and graduate student Pratixa Joshi review the cyclic voltammetry of enzyme electrodes.

His biosensor research is focused on using redox polymers to electrically "wire" enzymes or cells, which has applications in the fields of healthcare, environmental monitoring and chemical warfare agent detection. He plans to partner with chemists at the OU Health Sciences Center to conduct animal, then human, testing, and recently received an American Heart Association grant to further his research.

> Schmidtke helped develop an implantable glucosensor for diabetics, now being brought to market by his advisor.

Biosensors have long been an area of interest for Schmidtke. As a graduate student at UT, he helped develop an implantable glucosensor for diabeticsthat is now being brought to market by his adviser. His post-doctoral work involved consulting for Therasense Glucosensor, a device that is implanted subcutaneously in the forearm or abdomen.

Last year he co-taught a lab class that went beyond mere classroom work to teaching ethics and teamwork. "I had the students do group reports so they would learn how to work as a team. Once they get in the real world they'll work in teams for the rest of their lives," he says.

Schmidtke and his wife, Renette, have a son, Joshua. ■

Bioengineering Center Attracts New Professor

New Assistant Professor Vassilios Sikavitsas was drawn to OU by its new Bioengineering Center. "This is a place where growing opportunities exist. The Health Sciences Center has very important scientists in biology and medicine, and Chemical Engineering is very strong in teaching and research. At the Bioengineering Center, they can all come together to collaborate and create projects together," he says. "We need to learn the language of our partners, and learn how to talk to and respect the opinions coming from disciplines other than ours. Here at OU there is a new culture developing in that direction."

Sikavitsas uses a multidisciplinary approach in his own work, which combines molecular and cell biology approaches with engineering principles. His work concentrates on three areas, one of which is research on taking bone marrow from a patient, isolating the multipotent adult stem cells, and forcing them to become bone cells. The cells are next placed on a biomaterial, and the cell/biomaterial construct is placed in bioreactors to create bone graft alternatives for regeneration and repair. Part of this research, continuation of his post-doctoral work, includes studying the way embryos grow tissues, so that those mechanisms can be mimicked to regenerate tissue in adults. He knows the answers won't come quickly. "Conducting research in the area of tissue engineering requires a lot of money," he says. "I am encouraged by the attention federal agencies like the National Institutes of Health and the National Science Foundation are paying to the field. One thing that we must understand very well is that tissue engineering is, as a research area, still in its infancy. I am expecting the fruits of this research to be enjoyed by the next generation."

Another area of interest for Sikavitsas is biosensors and their use to detect agents of biowarfare. Many environmental toxins are not easily discernable by traditional methods because their elements can be changed to be undetectable but equally dangerous. He seeks to generate cells so that they send an alert when exposed to toxins, thus creating a real-time way to monitor the safety of the environment.

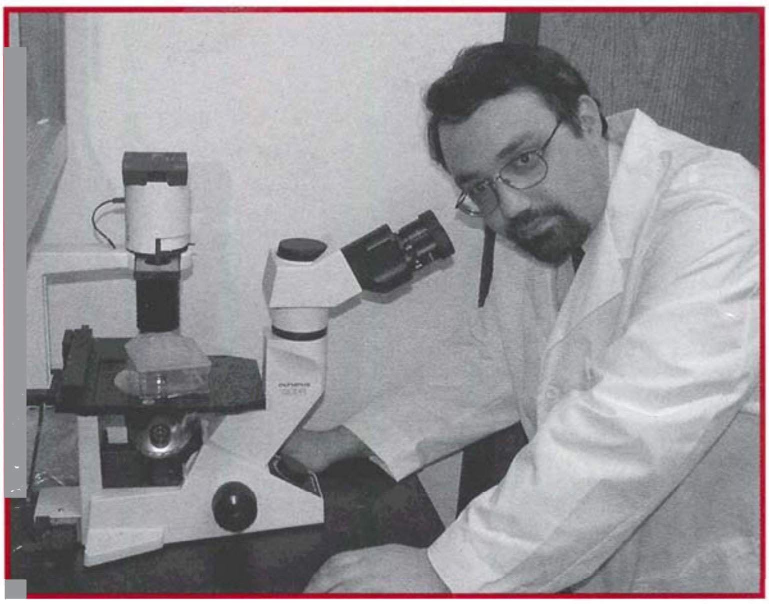
Vassilios is exploring ways to prevent breast and prostate cancer cells from metastasizing to the bone.

Finally, he is exploring ways to prevent breast and prostate cancer cells from metastasizing to the bone. "This is very painful and causes a lot of suffering. If we can identify where the cells attach to migrate into the bone, we may be able to develop drugs to eliminate this possibility and prevent metastasis from happening," he says.

Sikavitsas was born in Thessaloniki, Greece, and did his undergraduate studies in his home country. His graduate work was done at the University of Buffalo in gas separations, with a doctorate in biosensors. His post-doctoral work was done at Rice University. The newest member of the Chemical Engineering faculty teaches an undergraduate class in separation process, and a graduate class in cellular aspects in tissue regeneration.

He enjoys the slower pace he finds in Norman. "This . . . is a great balance, not too small so you can enjoy a mid-sized town, but without the hassles and traffic of a major city. You can go from work to your place or the market in a short time, and that makes the quality of life here very high. In my opinion, there is a good balance between the seasons," he says.

"One thing that moves my research is the OU Bioengineering Center. There is such diversity—there are biologists, medical doctors, zoologists, mechanical engineers, electrical engineers, and chemical engineers. There is a new culture developing today, and without it, we cannot be successful. There is a great collaborative effort here."



Sikavitsas observes adult stem cells for transplantation.

McFetridge Puts Heart in Research

With a family history of heart disease, Peter McFetridge, new research assistant professor, knows the odds. The success rate in cardiac bypass surgery, if a patient's own thoracic arteries are used, is 95 percent. Many patients, however, do not have useable arteries, requiring the use of synthetic materials with success rates as low as 35 percent to 40 percent. McFetridge has a personal interest in using tissue engineering to grow living arteries with a patient's own cells, preventing a negative immune system response and increasing survival rates.

One of McFetridge's graduate professors in Bath, U.K., who also was the head vascular surgeon at the Royal United Hospital in Bath, stated the problem succinctly: "We need arteries now!" To that end, McFetridge has set up a lab in which he hopes to construct small-diameter arteries for cardiac and peripheral bypass surgeries.

His work covers the three phases of tissue engineering: developing a composite matrix composed of different combinations of biological and synthetic materials on which the cells can grow; designing improved bioreactors to better mimic the haemodynamic conditions and processes that human cells experience *in vivo*; and seeding the matrices within the bioreactor with human cell lineages to grow replacement arteries.

"We know that the theory is sound," McFetridge says. "They have already produced simple organs such as skin. Because my background is in biology, the predominant advantages of natural polymers are clear, like employing the basic elements and structure of porcine arteries for use as a 'scaffolding' for the blood vessels."

He explains that because cell growth slows down as people age, a biodegradable matrix may not be the best solution, as the material may degrade and fail before it is remodeled into a neo-artery by a patient's own cells. In this application, McFetridge believes a permanent, biologically active implant that would remain intact during the remodeling process would allow for the slower cell growth of aged patients' cells, to fully integrate them into the recipients' bodies.

Peter McFetridge studies the biological applications of carbon nanotubes.

McFetridge came to OU in May 2002, after earning a bachelor of science degree in applied biological sciences at the University of Bath, U.K., and a doctorate in chemical engineering there. He says he works most effectively if the people around him are enthusiastic and motivated, and he found lots of dedication and enthusiasm here. "By combining the skills of vascular surgeons, biologists, biochemists and engineers in a multidisciplinary approach we are much more likely to succeed."

McFetridge, his wife, Ruth, and two children, Jack and Calum, have adapted well to the United States, but he admits there are drawbacks. "I already had family in New Zealand and England, and that was bad enough, but now we have family on three continents!" he jokes.

McFetridge is realistic about the success of his work. "People have been working on developing conduit materials since the early '50s; this is a very old problem, and the reasons for failure are very complex.

"I guess the long and short of it is that when patients are about to lose a limb, or worse, die from heart disease, and they know there is nothing more that can be done for them, it is a helpless and frightening position. This is particularly poignant when families are dispersed, as is mine, between Australia, Europe and here in Oklahoma. Saying goodbye has, at times, really been a final goodbye. I don't know for sure that I'll make a difference in people's lives, but I'm lucky enough to be in a position that a very real possibility exists," he says.

"By combining the skills of vascular surgeons, biologists, biochemists and engineers in a multidisciplinary approach we are much more likely to succeed."

College Launches fund raising campaign

With $32 million in gifts and pledges already in place, the College of Engineering recently launched a $100 million fund-raising campaign. Goals of the campaign include:

- To support recruitment and retention of top students and faculty by increasing the college's endowment
- To modernize existing facilities and build new facilities to accommodate the college's growth
- To revise the curriculum to better prepare the college's students for today's industry needs
- To help diversify Oklahoma's economy through support of increased technology development and commercialization.

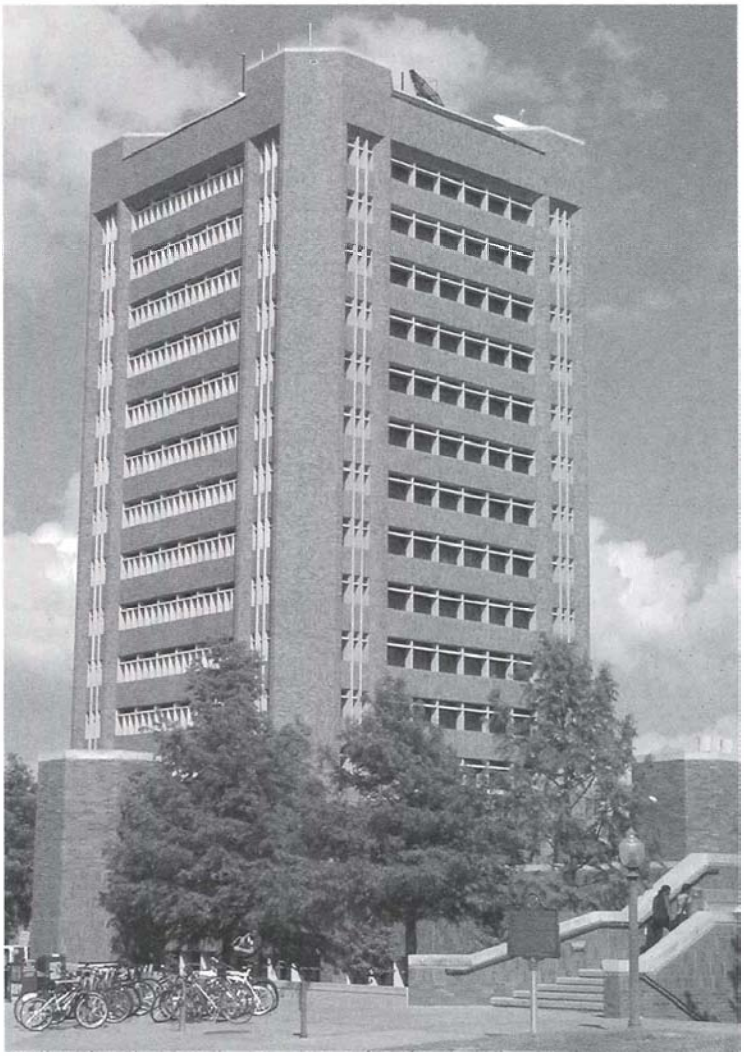
With an enrollment of more than 2,800 undergraduate and graduate students, the College of Engineering is ranked nationally in the top five among publicly supported engineering colleges in the enrollment of National Scholars. The college also conducts ground-breaking research in many areas, including such critical areas as bioengineering, software engineering and nanotechnology.

To continue to produce world-class engineering students, the college is asking alumni and supporters to give back through the campaign. For our students, the campaign will mean learning in state-of-the-art facilities under the instruction of professors who are nationally recognized leaders in their respective fields. For our faculty, the campaign will mean having the ability to conduct critical, groundbreaking research that will change our lives while adding value to the economy through scientific discovery and applied research. For our state, the campaign will mean that world-class engineers will have the opportunity to remain in Oklahoma, where their research can benefit our town, our state and future generations.

If you wish to be a part of this exciting opportunity, please contact Laura Kurz with the College of Engineering at (405) 474-6991 or Lkurz@ou.edu. ■

college of e

university of oklahoma college of engineering



One phase of the engineering college's fund raising campaign will go toward updating facilities, such as the Sarkeys Energy Center, shown.

Alum Establishes Successful Online Consulting Service

As a medical student who came to his field via chemical engineering, David Kendrick maintains that he was able to become a doctor and start his own successful company courtesy of the lessons he learned as a ChemE. "Engineering school, not medical school, taught me problem-solving," he says.

It was correcting an inadequacy in patient care that led him to establish Medsynergy, an online consulting model currently used by 115 specialists and the University of Oklahoma.

Kendrick, a 1995 graduate of OU in chemical engineering, graduated from medical school in 1999 and began a residency in internal medicine and pediatrics at the OU Health Sciences Center "While working on rotations, I saw that the current system of communication between doctors was inefficient. At that time, the Internet had been around five years, and Web sites like Amazon and Travelocity were new. I used the Internet to create a handheld tool for clinical data gathering. It began as a communication tool for doctors . . . a system for them to talk among themselves."

The young student took his idea to the dean, Dr. Jerry B. Vannatta, who encouraged him to create a prototype of the system. It was finished by the time he graduated, and with Vannatta's encouragement, he found himself juggling his internship with presentations and business plans. "It was a time squeeze," says Kendrick in an understatement.

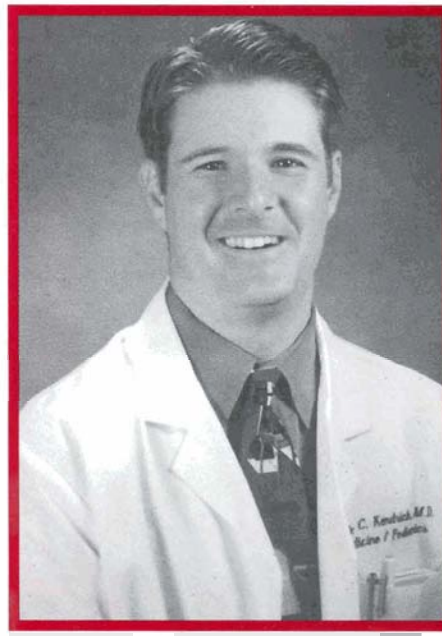
Kendrick found that his unique perspective as a chemical engineer allowed him to apply pure science to solve problems. He says he was able to pinpoint inefficiencies in patient coordination and discover ways to move them through the system in an orderly manner.

Kendrick had not considered founding his own company, but funding for the prototype was taking too long, so he took a month off in January 2000, wrote a business plan and shopped around for investors.

He found them the following March, formed Medsynergy in April 2000, and hit the ground running. Medsynergy allows primary care physicians to access specialists online for consultation. Rural and remote access is free to the physicians, requiring only a computer and digital camera or scanner. The online specialists fund the service.

Kendrick saw the impact of his brainstorm when physicians recently took the system to Russia on a medical mission trip. One of the doctors there took a digital photo of a puzzling dermatological problem and submitted it to a dermatologist online through Medsynergy. He had his diagnosis within seven hours.

The system also is being used to save money for Oklahoma taxpayers and the Department of Corrections. Until recently, the DoC spent about $500 per visit to take a prisoner to the doctor. Beyond the cost, the process also put the public in contact with prison inmates, a dangerous proposition. The DoC recently contracted with Kendrick's Docsynergy, an offshoot of Medsynergy, to handle all the doctor's visits for Oklahoma's 22,000 inmates online between the prison physician and a specialist. "This saves the state money and ensures the safety of the public," says Kendrick.



David Kendrick

MedSynergy

Other recent developments within Medsynergy and Docsynergy include their installation in Peru. "Now physicians in even the poorest sections of Lima can connect directly with specialists in the United States, particularly those at OU," says Kendrick. He also is completing a distance education program for Tulane University Health Sciences Center in New Orleans, which involves putting an entire master's degree program online as part of a National Institute of Health project.

Kendrick, who is practicing in Louisiana, says, "The business world is very different. It's all about the bottom line, and things aren't always about what's best for the patient. I credit engineering school with teaching me how to make the systems better for the people I treat."

"I credit engineering school with teaching me how to make the systems better for the people I treat."

Research Grants Awarded

Miguel Bagajewicz, CEMS
Unconstrained Methods for Optimal Sensor Location
National Science Foundation
Feb. 1, 2002 - Dec. 31, 2002
$9,150

John Scamehorn, CEMS
David Sabatini, CEES
Support for the Institute for Surfactant Research
Various
July 1, 2001 - June 30, 2002
$22,500

Brian Grady, CEMS
CAREER: X-ray Absorption Spectroscopy of Thermal Behavior in Polymers
National Science Foundation
Jan. 7, 2002 - March 31, 2003
$45,000

Dimitrios Papavassiliou, CEMS and the Rock Mechanics Institute Consortium
Instituto Mexicano del Petroleo
Jan. 1, 2001 - Dec. 31, 2002
$40,000.

Robert Shambaugh, CEMS
Center for Polymer and Fiber Research 3M Co.
July 1, 2001 - June 30, 2002
$15,000
Center for Polymer and Fiber Research
Procter and Gamble Co.
July 1, 2001 - June 30, 2002
$15,000

Dimitrios Papavassiliou, CEMS and the Rock Mechanics Institute
Rock Mechanics Institute Consortium
ConocoPhillips
Jan. 1, 2002 - Dec. 31, 2002
$40,000

Dimitrios Papavassiliou, CEMS and the Rock Mechanics Institute
Rock Mechanics Institute Consortium
Halliburton Services
Jan. 1, 2002 - Dec. 31, 2002
$40,000

Dimitrios Papavassiliou, CEMS and the Rockn Mechanics Institute
TotalFinaElf E&P USA Inc.
Jan. 1, 2001 - Dec. 31, 2002
Modifications - March, 2002
$80,000

John Scamehorn, CEMS/IASR
Surfactant Associates
Studies of Detergency
April 1, 2002 - April 30, 2005
$27,441

Matthew Johnson, Physics and Astronomy
Daniel Resasco, CEMS
Kieran Mullen, Physics and Astronomy
Patrick Mc Cann, Electrical and Computer Eng.
NSF-EPSCOR: Co-operative Agreement
Oklahoma State University (NSF- =EPSCoR)
Feb. 1, 2002 - Jan. 31, 2003
Prime Agency is NSF
$468,020

John Scamehorn, CEMS
David Sabatini, CEES
Support for the Institute for Surfactant Research
Various
July 1, 2001 - June 30, 2002
$7,500

Richard Mallinson, CEMS
Lance Lobban, CEMS
Cold Plasma Conversion of Methane
ChevronTexaco Corp.
May 1, 2002 - April 30, 2003
$84,000

John Scamehorn, CEMS/IASR
David Sabatini, CEES/IASR
Formulating DOWFAX8390 Aqueous Systems Using the Supersolubilization Phenomena to Remove Typical Soils in Detergency Applications
Dow Chemical Co.
May 28, 2002 - June 1, 2004
$7,500

Brian Grady, CEMS
Investigations of Polyelectrolyte Composites
Halliburton Services
July 1, 2002 - June 30, 2003
$117,605

Matthias Nollert, CEMS
Insulin Modulation of Platelet Mural Thrimbus Formation
State of Oklahoma, Center for the Advancement of Science and Technology
July 1, 2002 - June 30, 2003
$45,000

Brian Grady, CEMS
Edgar O'Rear, CEMS
NER: Polymeric Nanowires Synthesized on a Flat Surface Via a Surfactant Template
National Science Foundation
Aug. 1, 2002 - July 31, 2003
$99,987

Daniel Resasco, CEMS
Phillips Scholarship for Heterogeneous Catalysis
Phillips Petroleum Foundation Inc.
Sept. 1, 2002 - Aug. 31, 2003
$12,000

Lloyd Lee, CEMS
Henry Neeman, Information Technology
Jerry Newman, CEMS
Combined Research-Curriculum Development (CRCD): Integration of High Performance Computing in Nanotechnology
National Science Foundation
Aug. 15, 2002 - July 31, 2003
$200,000

Dimitrios Papavassiliou, CEMS
Turbulent Transport in Wall Turbulence
National Science Foundation
Aug. 1, 2002 - July 31, 2005
$164,551

Matthias Nollert, CEMS
Graduate Stipend for Keith Cockrum
Oklahoma Medical Research Foundation
Aug. 1, 2002 - July 31, 2003
$18,180

Edgar O'Rear, CEMS
Encapsulated Agents for Thrombolytic Therapy
State of Oklahoma, Center for the Advancement of Science and Technology
Sept. 1, 2002 - Aug. 31, 2003
$44,513

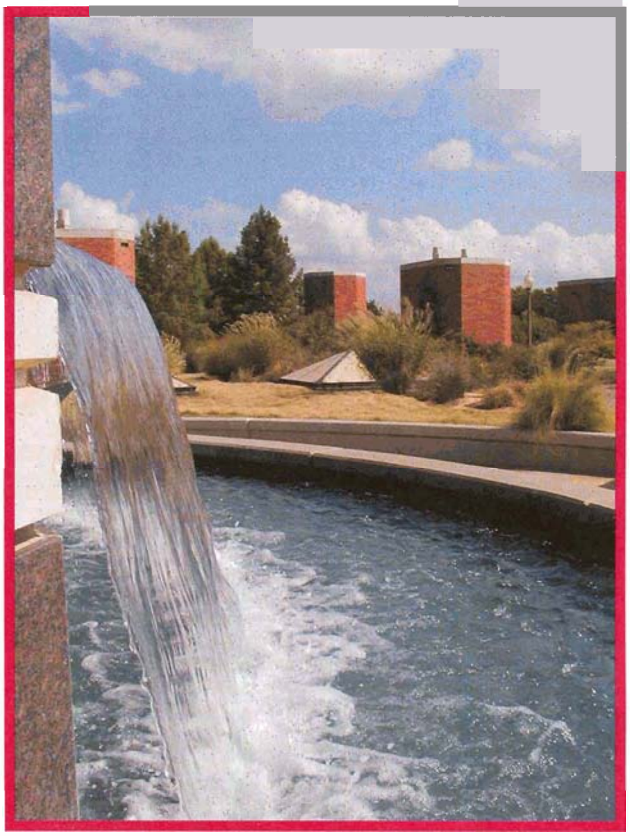
Daniel Resasco, CEMS
Hydrogenation of Polyaromatics Over S-Tolerant Catalysts
State of Oklahoma, Center for the Advancement of Science and Technology
Sept. 1, 2002 - Aug. 30, 2003
$99,986

Daniel Resasco, CEMS
Phillips Cost Share on OCAST
ConocoPhillips Petroleum Co.
Sept. 1, 2002 - Aug. 31, 2003
$20,000

Daniel Resasco, CEMS
Controlling Structural Characteristics of Single-Walled Carbon Nanotubes (SWNT)
U.S. Department of Energy
Sept. 1, 2002 - Aug. 31, 2005
$435,000

John Scamehorn, CEMS
Measurement of Surfactant Properties
Surfactant Associates
Sept. 10, 1997 - June 30, 2003
$6,000

M. Altan, AME
Brian Grady, CEMS
Composite Materials State Management
Altech Services Inc.
Oct. 1, 2002 - July 31, 2003
Prime agency is DOD-AF
$10,076



Melissa Rieger, CEMS
Edgar O'Rear, CEMS
The Prevention of Aluminum Corrosion at the Steel Fastener Interface on the C/KC-135 Tanker
State of Oklahoma, Regents for Higher Education
April 1, 2002 - March 31, 2003
$24,790

John Scamehorn, CEMS
David Sabatini, CEES
Support for the Institute for Surfactant Research
Various
July 1, 2002 - June 30, 2003
22,500

John Scamehorn, CEMS
David Sabatini, CEES
Support for the Institute for Surfactant Research
Various
July 1, 2002 - June 30, 2003
$15,000

Program of Excellence Scholars and Sponsors

Kevin H. Adams
Kansas City, MO
CEMS Associates Scholar

Ore-Ofe Adesina
Norman, OK
CEMS Faculty Scholar

Adam S. Adler
Oklahoma City
Phillips Scholar

Ross P. Allen
Jenks, OK
Sam Wilson Scholar

Joseph T. Azzarello
Yukon, OK
EXXON Scholar

Brant Q. Bennett
Bartlesville, OK
Sam Wilson Scholar

Shawna B. Bolene
McKinney, TX
Sam Wilson Scholar

Susan K. Boyer
Granbury, Texas
CEMS-Engineering Scholar

Dale H. Bradley
Yukon, OK
Shell Scholar

Justin L. Brown
Fort Worth, TX
EXXON Scholar

Adam S. Bymaster
Cache, OK
Sam Wilson Scholar

Sarah Clawson
Idabel, OK
Knapp Scholar

Jeremy I. Constantino
Euless, TX
Ray and Libby Daniels Scholar

Arpana S. Dalaya
Del City, OK
Billy and Mary Crynes Scholar

Frederick Deeg
Duncan, OK
CEMS Associates Scholar

Mariana Dionisio
Bartlesville, OK
EXXON Scholar

Phuong Do
Hanoi, Vietnam
WD Owsley Scholar

Dustin Duke
Norman, OK
Sam Wilson Scholar

Jaime A. Erazo
Tulsa, OK
Shell Scholar

Patrick D. Figaro
Norman, OK
Sam Wilson Scholar

Kimberly L. Fink
Nowata, OK
Sam Wilson Scholar

Zach Finley
Grove, OK
Sam Wilson Scholar

Kristin Fraser
Farmington, NM
Ray G. Collins Scholar

Lisa L. Gourley-Cox
Moore, OK
Sam Wilson Scholar

Mitchell J. Hargis
Oklahoma City
Ray and Libby Daniels Scholar

Jacob B. Hedden
Midwest City, OK
EXXON Scholar

Katherine Hergenrether
Lawton, OK
Kathleen Lorengo-Sultan Memorial Scholar

Jeremy L. Jones
Oklahoma City
Omer and Marjorie Pipkin Scholar

Holly M. Krutka
Tulsa, OK
CEMS Associates Scholar

Melissa A. Lambert
Norman, OK
Shell Scholar

Chelsea M. Lane
Midwest City, OK
Shell Scholar

Bryce D. Lawson
Norman, OK
Phillips Scholar

Phuong Mai Le
Norman, OK
Kendall Carrol Purgason Scholar

Melissa L. Martin
Tulsa, OK
Huntington Memorial Scholar

John Z. McGill
Maud, OK
Sam Wilson Scholar

Anh Hai Nguyen
Norman, OK
Shell Scholar

Thu Nguyen
Norman, OK
Sam Wilson Scholar

Nga Anh Nguyen
Oklahoma City
Sam Wilson Scholar

Brian Pack
Gore, OK
Shell Scholar

Kristy Petty
Oklahoma City
Keys Undergraduate Scholar

Ryan B. Posey
Chickasha, OK
EXXON Scholar

Amanda Robben
Clinton, OK
Keys Undergraduate Scholar

Amy Robertson
Norman, OK
Pipkin Family Scholar

Monica Sanders
Moore, OK
EXXON Scholar

Mark C. Shreve
Edmond, OK
Pipkin Family Scholar

Daniel Silvarajod
Norman, OK
Henry B. Wilson Scholar

David G. Splinter
Oklahoma City
Holbird/Askew Scholar

Roman Voronov
Oklahoma City
Sam Wilson Memorial Scholar

Faculty Awards

Daniel Resasco, Sam Wilson Professor of Chemical Engineering, has received the George Lynn Cross Research Professorship. To qualify for this honor, a faculty member must demonstrate outstanding leadership and creativity in his field over a period of years. Leading scholars worldwide help choose the awardee, who must be considered a top professional in his field. Resasco is the fifth chemical engineering professor to receive this prestigious honor since its inception.

Miguel Bagajewicz was awarded the Presidential Professorship in 2001, and this spring has recently received the Regents Award for Superior Research.

Ken Starling, professor emeritus. has received the Gas Processors Association's Don Katz Award, which recognizes outstanding accomplishments in gas processing research and excellence in engineering education. The award is not annual, but is conferred as deemed appropriate by GPA research leaders and the awards committee.

Chemical Engineering Students in the News

These students were recognized recently for outstanding performance or abilities.

Sarah Hodge, CEMS Jr., 2002 OU Homecoming Queen
Andrea Robben, CEMS Sr., 2002 College of Engineering Outstanding Senior
Collin H. Martin, CEMS Jr., 2003 Goldwater Scholarship
Holly Krutka, CEMS Sr., Al Clark Prize for Undergraduate Research
Scott Wilson – CEMS Award for Outstanding Teaching Assistant
Huy Le – CEMS Award for Outstanding Teaching Assistant
Kyleen Black – CEMS Outstanding Senior Leadership Award – Campus Award
Ore-Ofe Adesina – F. Mark Townsend Scholarship
Collin H. Martin – CEMS Outstanding Sophomore Award
Phuong Thi Mai Do – CEMS Outstanding Junior Award
Phuong Mai Le – Robert Vaughan Award for Excellence in Undergraduate Research
Andrea L. Robben – Pamela Pesek Johnson Award for an Outstanding Senior in Process Design
Lisa M. Rogers – CEMS Outstanding Senior Award

Senior Design Awards:
FIRST TWO GROUPS TIED FOR FIRST PLACE

BTEX
Kylene Michelle Black
James Robert Gourley
Andrea Louise Robben
Maria Mirna Sari
Kelly Lynn Wrich

SEA WATER DESALINATION
Susan Kay Boyer
Michael James McAllister
Lisa Michelle Rogers
Keleigh Katharine Tepel
Kameelah Emika Wesley

3rd Place
DNA ANALYSIS ON A CHIP
Alissa Nicole Hinman
Mathew Thomas Makel
Rachel Gabrielle Mesis
Elizabeth Thao Phan
Tushar R. Sathe