Ira A. Fulton School of Engineering

ARIZONA STATE UNIVERSITY

In the News

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Boeing looks to ASU for new technologies

By Andrew Johnson

Arizona State University scientist Henry Sodano is developing and testing ceramic materials invisible to the eye that could make aircraft frames more durable.

Sodano's efforts at a campus lab in Tempe have received a boost from one of the world's biggest aerospace manufacturers, the Boeing Co.

The Chicago-based company, which employs about 4,500 workers at its manufacturing campus in Mesa, is looking to ASU and a cadre of other universities and economic-development organizations it calls the Boeing Technology Alliance to identify cutting-edge technology outside its own walls.

Boeing formed the alliance in 2006 and has grown it to about 30 members since then, manager Summer Locke said.

"Our job is . . . to go out and work with these (members), find the best technology that can benefit our current products and maybe even lead to future products," said Locke, who also is manager of technology sourcing, evaluation and testing for Boeing's research and development unit.

The alliance is a matchmaker of sorts for Boeing's various business units spanning the defense, space and commercial-aviation markets, and outside technology experts, she said.

Alliance members are not guaranteed money for their involvement. If their technology piques Boeing's interest, it could result in licensing deals.

Sodano's lab has received about $15,000 from Boeing in the past year to fund ongoing research of a nanomaterial that can strengthen carbon-fiber composites used to make panels for some aircraft, golf clubs, satellites, rockets, high-performance automobiles and other products.

Boeing is using composites to build the frame of the 787 Dreamliner, its newest commercial plane that currently is undergoing testing.

Sodano said his lab created ceramic nanowires that could help improve the performance of those composites.

Sodano's lab also has received funding from several government agencies to study how the nanomaterial works on a microscopic level, he said.

Boeing's support has moved the research into a broader realm.

"We're taking a technology that's on a very small scale and trying to ramp up into something that's an immense structure," said Sodano, director of the Multiscale Adaptive Sensors and Structures Lab at ASU.

ASU joined the Boeing alliance in 2007, one of five universities currently part of the alliance, Locke said.

The Arizona Technology Council, a Phoenix-based trade group that represents local tech firms, also became an alliance member in June.

For the council, the idea is to connect Boeing with its member companies that are working on a wide array of technology, said Council President and CEO Steve Zylstra.

"We can be the emissaries or agents on behalf of Boeing for identifying solutions to some of their technical challenges," Zylstra said. "If we are able to connect one of our member companies . . . to Boeing and it leads them to some business with Boeing, we'll have a loyal member forever."

The strategy of combining internal research strengths with experts in research fields outside Boeing's forte could help it find technology it wouldn't have access to otherwise, said Tom Koehler, a company spokesman in Seattle.

"There's a trillion dollars of research-and-development investment every year that goes on throughout the world, and we know we can't do it all," Koehler said. "The idea is we can tap into that research and development and technology in a way that is going to be beneficial for us without us having to do the early-stage or scientific-type research."

ASU's alliance participation is channeled through Arizona Technology Enterprises, its technology-transfer arm that works to commercialize inventions created by faculty and students.

ASU's work in materials science was attractive to Boeing, said Bill Loux, director of business development for physical- science inventions with the technology-enterprises group.

If Boeing decides Sodano's research is promising, the aerospace company would likely contract one of its existing suppliers to work with ASU on developing the technology into a format it can use, Loux said.

"What we're doing right now is trying to find a way to take what he's doing in the lab and determine how we would scale it up to large production," he said.

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300 competing in Lego championship at ASU

By Kerry Fehr-Snyder

Arizona State University is hosting the First Lego League robotics championship this Saturday where 300 students ages 9 to 14 statewide will be vying for a chance to compete in the national finals in Atlanta.

Two groups of students from Basha Elementary School in south Chandler will be among the competition.

Basha School's two teams, working under the direction of teacher Susan Jernigan, compete under the names "Those People" and "Crash Test Dummies."

But winning isn't everything for the 32 teams, said Patty Smith, K-12 outreach coordinator for the Ira A. Fulton Schools of Engineering at ASU.

"It's a program that is exciting and inspiring for this age group," Smith said. "And we know that this is an age group that we have to impact.

"If we show them that science and engineering can be fun, that it's not just a nerd field, that it's a hands-on field in a format that's fun, we can influence their career decisions later on."

The 32 teams made it to the state finals by competing in regional tournaments.

Organizers are trying to establish a streaming video link operated by Carl Hayden High School so the contest can be "broadcast" on the Internet. But the link, like any technology, may not wind up working.

Many parts of the all-day competition, which runs from 9 a.m. to 4:45 p.m. on the second floor of ASU's Memorial Union near Apache Boulevard and College Avenue in Tempe, are free and open to the public. But a few parts of the contest require teams to meet with technical judges who will be evaluating their robotic designs in private.

In order to compete in the Arizona First Lego League, each team bought a robot kit that must be transformed into a working robot. Kits contained as few as 400 pieces and as many as 700 pieces.

The teams also were required to buy a Lego Mind Storms kit that walks them through the process of building and programming a robot step by step by step. It includes a game, a Lego mat and a tournament table on which teams must complete pre-set missions.

The theme this year is transportation.

Judges award each team up to 400 points based on its ability to complete a 2 ½ -minute robot run. The run includes several small, low-point tasks and other larger, big-point tasks.

"Above and beyond, they're learning to strategize and prioritize," Smith said. "They have to decide, 'Do you go after small tasks or a few big tasks?' "

Teams may build attachments that can perform many tasks or specialized Lego devices that are specific to completing one task. They must decide whether to swap out the devices during the match or stick with one do-everything attachment.

They also learn the value of consistency, that sometimes the devices work and sometimes they fail.

"Sometimes it does (work) and it sometimes it doesn't and that's the heartbreak of it," Smith said.

During a recent regional tournament, one team struggled to get its device working during practice runs. When competition time came, it performed perfectly.

"And that's when we saw the girls lift off the ground" with excitement, Smith said.

The 32 teams come from across the state. Besides Chandler, the other Southeast Valley schools in the competition are from Mesa and Tempe.

The tournament details and schedule are listed at azfll.asu.edu.

The winner will compete in April at the national finals but even those teams that don't win the statewide competition will be eligible to compete in open championships in other states and countries.

Last year, the state champion went on to compete in a tournament in Dayton, Ohio. Another team later competed in Copenhagen, Denmark.

Alson on East Valley Tribune

December 21, 2009

Tech News Arizona
Tech News Frontiers, LLC

Pendaphonics powers sight & sound for live action SLAMs to the edge

By Erica Rodriguez

Streb Lab for Action Mechanics [SLAM] collaborates with ASU engineers and physicists to explore the body's capacity for engaging with the machines we make, such as this whirly-gig from "Catapult."

A renowned dance choreographer and an Arizona State University professor fused their skills of dance and technology to create an experience that wowed audience members and made them part of the action.

The infusion of art and science was seen at STREB: BRAVE, choreographed by Elizabeth Streb of Streb Lab for Action Mechanics in Brooklyn. The dance performance took place at the Herberger Theater in early November and was presented by Future Arts Research at ASU.

Elizabeth Streb defies gravity & the probabilities of appearance in her choreography which she calls "PopAction."

Streb said she wants audience members to feel each movement and even feel as if they performed the movement during her shows.

"I wanted the movement to ram into the spectator," Streb said. "When they leave, I want them to feel like they've performed some of the movement. I want them to feel charged and changed when they walk out of those doors."

STREB: BRAVE mixes mechanics, engineering and heavy equipment with dance. For one number, Streb collaborated with ASU Assistant Professor of Human Computer Interaction Win Burleson to create a moonscape on a 23 ft. X 23 ft. wall for dancers to scale while pirouetting in harnesses.

The moonscape was possible due to pendaphonics, which was developed by Burleson in collaboration with Aalborg University in Denmark.

Pendaphonics is hardware and software that senses dancers' movements on a wall to create a dance set to music on the moon.

Much of Streb's work interacts with "gizmos" designed with engineers and physicists she collaborates with. Some are as simple as circuiting concrete blocks, swings daring human entry.

The dancers on the wall were connected to a line that is connected to a computer on stage. The computer reads the dancers' movements and changes the picture on the screen projected onto the wall.

"It started with a commercial game controller called Gametrak," Burleson said. "It spurred an inventive process."

Burleson compared the technology of pendaphonics to the videogame Guitar Hero.

"It's like in Guitar Hero when players respond to new events on the screen," Burleson said. "It's a real-time interaction between choreographers and dancers."

Pendaphonics made its debut in a public art gallery, acting as a tetherball to show the interaction between user and technology.

"There was a wiffle ball-like molecule," Burleson said. "Users would push it and it scratched like a record and it would play a soundtrack. It was an exploration of mixed reality in physical space."

Streb said she worked with Burleson and other ASU scientists because of their reputation for innovation.

"ASU definitely has a reputation of motion capture," Streb said. "I really like all of the science emersion with the arts. They also were so approachable. They allow themselves time to come visit. Other universities seem to have their own agenda, but ASU was very willing to make time to meet with us."

Streb and Burleson first met in 2008, brought together by Future Arts Research.

"FAR fully commissioned the project," Streb said. "It gave us a platform to meet all the directors and scientists. It allowed us access to the knowledge, time and place."

Burleson said of ASU, "In the collaboration, we're only contributing 2 percent. We're just doing something they can't."

The name for STREB: BRAVE comes from the intense action performed by the dancers, Streb said.

"'BRAVE was a genesis of trying to add force to construction and extreme action," Streb said. "The ante was upped. We're using motors and things move and everything is way more exaggerated."

In addition to the mechanics of pendaphonics, the stage is motorized, constantly moving under the dancers feet, and a massive metal contraption called the Whizzing Gizmo is used.

Dancers are referred to as "actioneers" and as actioneer Jackie Carlson said, every performance with the machines is a "challenge."

"It's all very dangerous and we are taking huge risks, but we have to have a 100 percent trust in one another," Carlson said.

Future performances will take place spring, 2010 in Pennsylvania, New York and North Carolina.

December 21, 2009

AZoNanotechnology The A to Z of Nanotechnology

An elegant method for significantly improving the memory capacity of electronic chips

Scientists at Arizona State University have developed an elegant method for significantly improving the memory capacity of electronic chips.

Led by Michael Kozicki, an ASU electrical engineering professor and director of the Center for Applied Nanoionics, the researchers have shown that they can build stackable memory based on “ionic memory technology,” which could make them ideal candidates for storage cells in high-density memory. Best of all, the new method uses well-known electronics materials.

“This opens the door to inexpensive, high-density data storage by ‘stacking’ memory layers on top one another inside a single chip,” Kozicki said. “This could lead to hard drive data storage capacity on a chip, which enables portable systems that are smaller, more rugged and able to go longer between battery charges.”

“This is a significant improvement on the technology we developed two years ago where we made a new type of memory that could replace Flash, using materials common to the semiconductor industry (copper-doped silicon dioxide). What we have done now is add some critical functionality to the memory cell merely by involving another common material – silicon.”

Kozicki outlined the new memory device in a technical presentation he made in November at the 2009 International Electron Devices and Materials Symposia in Taiwan. He worked with Sarath C. Puthen Thermadam, an ASU electrical engineering graduate student.

Kozicki said that given current technology, electronics researchers are fast reaching the physical limits of device memory. This fact has spurred research into new types of memory that can store more information into less and less physical space. One way of doing this is to stack memory cells.

The concept of stackable memory is akin to one’s ability to store boxes in a small room. You can store more boxes (each representing a memory cell) if you stack them and take advantage of three dimensions of the room, rather than only putting each box on the floor.

Kozicki said stacking memory cells has not been achieved before because the cells could not be isolated. Each memory cell has a storage element and an access device; the latter allowing you to read, write or erase each storage cell individually.

“Before, if you joined several memory cells together you wouldn’t be able to access one without accessing all of the others because they were all wired together,” Kozicki said. “What we did was put in an access, or isolation device, that electrically splits all of them into individual cells.”

Up until now, people built these access elements into the silicon substrate.

“But if you do that for one layer of memory and then you build another layer, where will you put the access device,” Kozicki asked. “You already used up the silicon on the first layer and it’s a single crystal, it is very difficult to have multiple layers of single crystal material.”

The new approach does use silicon, but not single crystal silicon, which can be deposited in layers as part of the three-dimensional memory fabrication process. Kozicki said his team was wrestling with how to find a way to build an electrical element, called a diode, into the memory cell. The diode would isolate the cells.

Kozicki said this idea usually involves several additional layers and processing steps when making the circuit, but his team found an elegant way of achieving diode capability by substituting one known material for another, in this case replacing a layer of metal with doped silicon.

“We can actually use a number of different types of silicon that can be layered,” he said. “We get away from using the substrate altogether for controlling the memory cells and put these access devices in the layers of memory above the silicon substrate.”

“Rather than having one transistor in the substrate controlling each memory cell, we have a memory cell with a built-in diode (access device) and since it is built into the cell, it will allow us to put in as many layers as we can squeeze in there,” Kozicki said. “We’ve shown that by replacing the bottom electrode with silicon it is feasible to go any number of layers above it.

With each layer applied, memory capacity significantly expands.

“Stackable memory is thought to be the only way of reaching the densities necessary for the type of solid state memory that can compete with hard drives on cost as well as information storage capacity,” Kozicki said. “If you had eight layers of memory in a single chip, this would give you almost eight times the density without increasing the area.”

Kozicki said the advance mimics an idea employed in early radios.

“We created a modern analog to the ‘cat’s whisker,’ where we are growing a nanowire, a copper nanowire, right onto the silicon to create a diode,” he said.

Cat's whisker radios, a product of the 1930s, were simple devices that employed a small wire to scratch the surface of a semiconductor material. The connection between the semiconductor and the wire created a diode that they could use as part of a radio.

"It turns out to be a ridiculously simple idea, but it works," Kozicki said of his stackable memory advance. "It works better than the complicated ideas work."

"The key was the diodes, and making a diode that was simple and essentially integrated in with the memory cell. Once you do that, the rest is pretty straightforward."

Also on: DNAindia.com, EFY Times, Element-14 ,Examiner.com, First Science.com, Nanotechnology Now, Nanowerk, Physorg.com, ScienceNews Daily, Softpedia, Thaindian News

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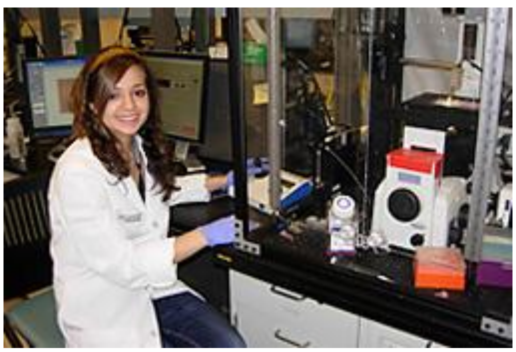
U.S. Department of Health & Human Services

National Institutes of Health
The Nation's Medical Research Agency

Stimulus funds support student's summer job, future dreams



Aida Mohammadreza, at Arizona State University, studies throat cancer using a cell manipulation system at her summer research position being supported by the American Recovery and Reinvestment Act.

In the current economic climate, it's a challenge for young people to find any sort of summer job, let alone a job that both expands their minds and helps society.

But, thanks to the American Recovery and Reinvestment Act (ARRA), 19 -year-old Aida Mohammadreza and thousands of other science-minded students across the nation are hard at work in jobs that yield far more than a paycheck.

A sophomore majoring in biochemistry at Arizona State University (ASU) in Tempe, Ms. Mohammadreza was thrilled to learn that she had secured an ARRA-supported summer research position at an ASU laboratory that uses genome-based tools to study throat cancer. Besides helping to pay college bills, the student's job meshes well with her dream of a career in biomedicine and her desire to help people with cancer.

Ms. Mohammadreza's great-grandfather passed away from throat cancer, an inspiration and motivation for her interest in this research. "I've been told he was very strong throughout his entire life and being diagnosed with cancer was no exception," said Ms. Mohammadreza, who grew up in Salt Lake City, and is the daughter of Iranian immigrants. "Such family history has really influenced me to pursue research that would save lives."

For the past year, Ms. Mohammadreza has worked at the ASU Biodesign Institute's Center for Ecogenomics under the guidance of her mentor Laimonas Kelbauskas, Ph.D. She is able to continue her research there this summer because of an ARRA-funded administrative supplement that was awarded by the National Human Genome Research Institute (NHGRI) to Deirdre Meldrum, Ph.D., the center's director and the dean of ASU's Ira A. Fulton School of Engineering.

"We were delighted to receive the added boost to our research made possible by the ARRA stimulus funding from NHGRI," said Dr. Meldrum. "It is impossible to overemphasize the value of the contributions that highly-motivated, talented undergraduates like Aida bring to our efforts."

Nationwide, ARRA funding will support approximately 5,100 research and training positions this summer for high school and college students, as well as science educators.

"If I didn't have this summer research position, I would definitely look for another opportunity in genome research," said Ms. Mohammadreza. "The ARRA funding will allow me to turn my ideas and dreams into a reality."

Ms. Mohammadreza will study Barrett's esophagus, a condition that affects about 1 percent of adults in the United States. In Barrett's esophagus, the cells lining the lower part of the throat, or esophagus, are replaced with cells that appear similar to those that line the intestines. Barrett's esophagus is often found in people who suffer from gastroesophageal reflux disease, which occurs when acidic contents from the stomach rise into the esophagus. A small number of people with Barrett's esophagus develop a rare, but particularly deadly, type of throat cancer.

Ms. Mohammadreza's work involves analyzing individual cells to understand the genetic differences between healthy esophageal cells and the cells seen in Barrett's esophagus. Such information is important for understanding the fundamental mechanisms involved in the disease process, which in turn may lead to new or better ways to treat or prevent the condition.

Scientific inquiry seems to come naturally to Ms. Mohammadreza. Back in elementary school, she would play veterinarian with her best friend's dog. Ms. Mohammadreza explained that she would create odd concoctions of anything she deemed healthy, such as eggs, milk, carrots, grape juice, bananas and herbs. But did she feed it to the always-hungry canine? That was too obvious – and too easy, she said. Instead, she'd soak bandages in the murky mixture and cover the unlucky dog from head to tail.

Ms. Mohammadreza balances her love of science with an equally strong love of helping others. Beside her paid work in the lab, she's volunteering this summer at Scottsdale Healthcare Hospital and Chandler Regional Medical Center. She also belongs to several student-run charitable groups, including Habitat for Humanity and Global Medical Brigade.

"One of the aims of genome research is to develop drugs that improve people's quality of life, a goal similar to my own," said Ms. Mohammadreza. "There are many people that are vulnerable to life-threatening diseases and I want to be part of a team that could help them."

December 31, 2009

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Arizona may get sky-high solar towers

Australian company envisions a giant energy plant in desert

by Ryan Randazzo

In the 1980s, Spain built a giant solar-tower project. EnviroMission purchased the technology and plans to build two much larger towers in Arizona.

There are few ideal ways to make electricity that don't come with at least one drawback.

Solar power doesn't work at night, nuclear plants are expensive to build, wind turbines operate best far from where people live, and cheap coal power produces the most global-warming emissions.

But an Australian company hopes to build what sounds like an ideal energy source in western Arizona - a power plant that uses no fuel or water, causes no pollution and runs all day.

The concept could promise a cost-effective way to meet the increasing demand for clean energy without the expense and drawbacks of other alternative-power sources.

But first EnviroMission Inc. has to raise the money to build one of the tallest manmade structures on Earth on top of a sprawling greenhouse.

Officials said they want to actually go one better and build two of their $750 million power plants on barren stretches of public and state land in La Paz County.

The company owns the rights to solar-tower technology, which is unlike the more traditional black panels often used to convert sunlight to electricity, or solar-thermal power that uses sunlight and mirrors to heat water and make steam.

A solar-tower plant would use a massive, 4-square-mile greenhouse to heat the desert air.

The hot air would rise to the top of the greenhouse, which would peak in the middle like a giant circus tent.

The hot air in the center would rush up a chimney 2,400 feet tall, nearly half a mile high, or 1,000 feet taller than the Chicago building formerly called the Sears Tower.

The warm air from the greenhouse would swoosh through turbines on its way through the tower, spinning them to make electricity, much like turbines in dams that spin when water rushes over them.

"It's basically an upside-down hydroelectric dam," said Christopher Davey, president of Australia-based EnviroMission Ltd.

The vision

Davey has a small executive team working from offices on 44th Street in Phoenix to develop the company's ambitious plan.

The towers would be just shorter than a project called Burj Dubai scheduled to open in January as the world's tallest building at more than 2,600 feet.

Davey acknowledges the idea is bold. Not only would it require huge amounts of land, but the technology has only been tested once, and that pilot project in Spain was toppled in 1989 after running for eight years.

But that test plant showed the technology is viable, Davey said.

"It is an incredibly benign technology," Davey said.

"This will enable Arizona to become a powerhouse. We would like La Paz County to become a new solar county."

One solar tower could produce 200 megawatts of electricity at once, or enough to run appliances in about 50,000 homes. And because the technology uses heat rather than sunlight like photovoltaic-solar panels, the electricity production wouldn't drop off with passing clouds, Davey said. "Greenhouses stay warm even after the sun goes down," he said.

With heat trapped in the greenhouse, the towers could produce electricity well into the night, and by storing the heat in black rocks or other material they could make electricity all day, he said.

Although the towers would be massive, Davey said that their height-to-width ratio and lack of windows and doors would make them sturdy.

"Like any other solar facilities, earthquakes, hurricanes and tornadoes are not ideal," he said.

"We can deal with some seismic activity, but I'm not going to build on the San Andreas Fault."

Innovation

EnviroMission's solar towers are trying to break into a growing renewable-energy market that for now is focused on solar-thermal power plants.

Solar-thermal power plants use mirrors to focus sunlight and make steam and can store heat in molten salt to make some electricity past sundown. But they use huge amounts of water, which is usually scarce in deserts where the plants burn hottest.

EnviroMission's towers don't face that obstacle.

"Where we are at, there is no water," Davey said. "There are no water rights. We'll be able to get it for construction, and that's it."

He said the towers represent an economic opportunity for the area.

"It is a former gunnery range," Davey said. "There are .50-caliber artillery shells on both parcels."

Financing

Davey founded the company with his father, who works from Australia. EnviroMission is traded on the Australian exchange and recently was added to the over-the-counter stock market in the U.S.

The company has tried to develop solar towers in Australia, Texas and now Arizona.

Without a plant in operation and no other source of revenue, EnviroMission is a money-losing company, and now is not the best time to try to raise money for big projects.

Arizona Public Service Co. serves as an example.

APS announced in early 2008 that it would buy power from a solar-thermal plant planned near Gila Bend, but the builder still hasn't found adequate financing for that plant. Another deal for APS to buy power from a plant to be built by Lockheed Martin Corp. fell apart recently when concerns arose over costs.

Davey said he is optimistic his projects will find financing.

"We're in the same boat as everyone else with financing," Davey said.

But regulators have shown concern. EnviroMission got a letter from the Australian Securities Exchange in November asking if the company had sufficient funds to continue operations.

"Is it reasonable to conclude . . . the company may not have sufficient cash to fund its activities?" the regulators wrote.

EnviroMission responded that it recently received $413,000 from U.S. investors and intends to meet its financial obligations through further fundraising.

EnviroMission has a formal agreement with financial firm Raymond James and Associates Inc. to help attract U.S. investment.

Raymond James released a report in October on the solar-tower technology, and listed, among its highlights, the cheaper price tag compared with solar-thermal power plants.

cording to Raymond James, which Davey said relied on EnviroMission for its figures, a 200-megawatt solar tower would cost about $750 million.

That's comparable to recent price tags announced for solar-thermal plants, but the towers would bring in more revenue than solar plants that shut down at sundown and would cost less to maintain because they have fewer moving parts, the report said.

Utility support

EnviroMission also has won the confidence of the Southern California Public Power Authority, which represents 10 municipal utilities including the Los Angeles Department of Water and Power.

SCPPA has agreed to negotiate a power-purchase agreement with EnviroMission for electricity from its Arizona power plants, should they get built.

"We are excited about it," SCPPA Executive Director Bill Carnahan said. "We want to see it go. The key element for us, it is not a viable project until you have all the permits."

EnviroMission has applied to the Arizona Land Department for one plant site and has an option on private land for the other, Davey said. In a recent shareholder report, EnviroMission said it has completed preliminary cultural, archeological and environmental surveys on both sites.

EnviroMission also could try to sell power to Arizona utilities, but APS has recently required that any alternative-energy project selling it power have at least a small operating plant, which would preclude EnviroMission.

EnviroMission's plans have caught the attention of energy experts, but few know what to make of the proposal in the current economic environment when all projects are difficult to finance.

"It is a very big tower, and obviously it has a lot of skeptics," said Stephen Goodnick, an Arizona State University engineering professor and director of the Arizona Institute for Renewable Energy. "It would be nice if this works."

EnviroMission has asked for student interns from ASU, and ASU has requested engineering data from the company, Goodnick said.

The National Renewable Energy Laboratory in Colorado has conducted proprietary research on solar-tower technology for a South African utility that was considering a plant but can't share the data, said Mark Mehos, a NREL program manager.

"The thing to be aware of is it is very inefficient from sun in to electricity out," Mehos said.

But new data indicates that solar-thermal plants can use dry-cooling designs that use 90 percent less water, he said. He added, "If (solar towers) were incredibly cheap to make up for the lower efficiency, they'll finance it."

December 31, 2009

Carbon nanotubes show promise for high-speed genetic sequencing

In the current issue of Science, Stuart Lindsay, director of Arizona State University's Center for Single Molecule Biophysics at the Biodesign Institute, along with his colleagues, demonstrates the potential of a new DNA sequencing method in which a single-stranded ribbon of DNA is threaded through a carbon nanotube.

Faster sequencing of DNA holds enormous potential for biology and medicine, particularly for personalized diagnosis and customized treatment based on each individual's genomic makeup. At present however, sequencing technology remains cumbersome and cost prohibitive for most clinical applications, though this may be changing, thanks to a range of innovative new techniques.

In the current issue of *Science*, Stuart Lindsay, director of Arizona State University's Center for Single Molecule Biophysics at the Biodesign Institute, along with his colleagues, demonstrates the potential of one such method in which a single-stranded ribbon of DNA is threaded through a carbon nanotube, producing voltage spikes that provide information about the passage of DNA bases as they pass through the tube—a process known as translocation.

Carbon nanotubes are versatile, cylindrical structures used in nanotechnology, electronics, optics and other fields of materials science. They are composed of carbon allotropes—varied arrangements of carbon atoms, exhibiting unique properties of strength and electrical conductivity.

Traditional methods for reading the genetic script, made up of four nucleotide bases, adenine, thymine, cytosine and guanine (labeled A,T,C,&G), typically rely on shredding the DNA molecule into hundreds of thousands of pieces, reading these abbreviated sections and finally, reconstructing the full genetic sequence with the aid of massive computing power. A decade ago, the first human genome—a sequence of over 3 billion chemical base pairs—was successfully decoded, in a biological tour de force. The undertaking required around 11 years of painstaking effort at a cost of $1 billion dollars. In addition to the laboriousness of existing techniques, accuracy is compromised, with errors accumulating in proportion to the number of fragments to be read.

A new strategy involves the use of nanopores—orifices of molecular diameter that connect two fluid reservoirs. A constant voltage can be applied between two electrodes located at either end of the nanopore , inducing an ionic current to flow through the length of the nanopore's enclosed channel. At this scale, the passage of even a single molecule generates a detectable change in the flow of ionic current through the pore. This current is then electronically amplified and measured. Only fairly recently have state of the art micro-manufacturing techniques enabled researchers to construct nanopores at the scale of individual molecules, opening up many new possibilities for single-molecule manipulation and research.

In the current study, single walled carbon nanotubes, 1-2 nm in diameter, were used for the conducting channels. When a current was induced through the nanotube, segments of single-stranded DNA (known as oligomeres) made up of either 60 or 120 nucleotides, were drawn into the opening of the nanotube and translocated from the anode side of the nanotube to the output cathode side, due to the negative charge carried by the DNA molecule. The velocity of DNA translocation is dependent on both the nucleotide structure and molecular weight of the DNA sample.

The carbon nanotubes were grown on an oxidized silicon wafer. Results indicate that among the successfully formed nanotubes—those fully opened and without leakage along their length—a sharp spike in electrical activity is detected during the process of DNA translocation. Further, reversing the bias of the electrodes causes the current spikes to disappear; restoring the original bias caused the spikes to reappear.

Lindsay stresses that the transient current pulses, each containing roughly 10x7charges, represent an enormous amplification of the translocated charge. A technique known as quantitative polymerase chain reaction (qPCR) was used to verify that the particular carbon nanotubes displaying these anomalously sharp current spikes—around 20 percent of the total sample, were indeed those through which DNA translocation had occurred.

The team carried out molecular simulations to try to determine the mechanism for the anomalously large ionic currents detected in the nanotubes. Observation of current-voltage curves registered at varying ionic concentrations showed that ion movement through some of the tubes is very unusual, though understanding the precise mechanism by which DNA translocation gives rise to the observed current spikes will require further modeling. Nevertheless, the characteristic electrical signal of DNA translocation through tubes with high ionic conductance may provide a further refinement in ongoing efforts to apply nanopore technology for rapid DNA sequencing.

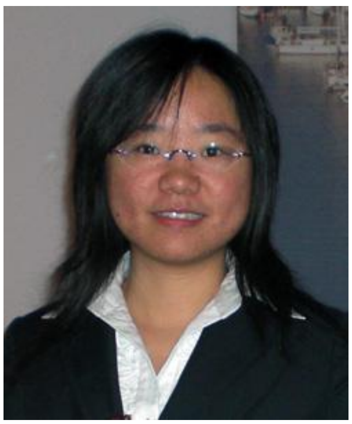
Critical to successful rapid sequencing through nanopores is the precise control of DNA translocation. The hope is that genetic reading can be significantly accelerated, while still allowing enough time for DNA bases to be identified by electrical current traces. Carbon nanotubes provide an attractive alternative, making the control of nanopore characteristics easier and more reliable.

If the process can be perfected, Lindsay emphasizes, DNA sequencing could be carried out thousands of times faster than through existing methods, at a fraction of the cost. Realizing the one-patient-one-genome goal of personalized medicine would provide essential diagnostic information and help pioneer individualized treatments for a wide range of diseases.

December 2, 2009

asu news [now]

Student's research draws industry interest



Ting Pang, an Arizona State University senior chemical engineering student, has drawn international attention for her research after her recent project presentation at a major chemicals industry conference.

Only well-established researchers typically are invited to make presentations at the annual Sulfur International Conference, but an exception was made for Pang, said Jerry Lin, a professor in the School of Mechanical, Aerospace, Chemical and Materials Engineering, a part of ASU's Ira A. Fulton Schools of Engineering.

The conference is the main annual event for the sulphur industry, hosted by leaders in the metals and mining, power and cables, fertilizer and chemicals industries.

Pang's project, "A New Process for Sulphuric Acid Production," is attracting interest because of its potentially major significance for those industries, Lin said. Sulphuric acid is one of the most important inorganic chemicals, and is widely used in phosphate processing, petrochemicals production, mining and many other industries.

Pang's project involves a new sulphuric acid production process using pure oxygen as the oxidant. Conventional processes emit significant amounts of sulphur oxides and nitrogen oxides into the atmosphere, resulting in pollution that poses environmental problems and legal risks for companies.

Pang is proposing a new process that recycles the gases that result from sulphuric acid production process and reduces the pollution effects.
The Bayer Corporation and MECS Company are among those showing particular interest in her work, Pang said.

She has applied for a patent on the new production process and also is applying for awards for technology advancement and new inventions from the government of her homeland in China's Sichuan Province.

Pang began her undergraduate studies at Sichaun University before transferring to ASU.

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Initiative targets better battlefield communications networks

By Chelsea Brown

Junshan Zhang is working to improve wireless communications technology with support from a Multidisciplinary University Research Initiative (MURI) grant from the U.S. Department of Defense.

Zhang is an associate professor in the School of Electrical, Computer and Energy Engineering, a part of Arizona State University's Ira A. Fulton Schools of Engineering. He also works in the engineering schools' Sensor, Signal and Information Processing Center (SenSIP).

The grant of more than $600,000 will fund Zhang's efforts to improve the reliability of communications networks under battlefield conditions.

"Battlefield wireless networks often operate under hostile conditions that include adverse radio frequency environments, interference, bursts of traffic and changing network topology," Zhang said. "As a result, network management of information flows in such a hostile environment often faces a number of challenges, such as network failure and compromise and intermittent connectivity."

There is an "urgent need to develop fundamental network science for identifying, representing and controlling information dynamics" in Department of Defense networks, Zhang said.

Advances in this area of research also promise to provide more reliability for various types of airborne and ground-based communications networks.

Zhang's work is ASU's part of a larger project, titled "Information Dynamics as a Foundation for Network Management," led by Princeton University, with other research partners at the California Institute of Technology, Stanford University, University of California-Irvine, the University of Pennsylvania and the University of Wisconsin-Madison.

Zhang's grant is part of a $7 million MURI award for the overall project. It is one of three grants ASU researchers are part of in the most recent round of MURI awards. The other two projects include Nancy

Cooke, a professor of applied psychology in the College of Technology and Innovation at ASU's Polytechnic campus, who is part of a project on computer-aided human centric cyber situation awareness led by Peng Liu of Penn State; and Patrick Langley, a professor in the School of Computing, Informatics and Decision Systems Engineering, who is part of a project on unified theories of language and cognition that is headed by Nicholas Cassimatis of Rensselaer Polytechnic Institute.

The MURI program is designed to accelerate research and technology development that supports specific science and engineering efforts considered vital to national defense.

In BRIEF

Professor honored for achievement

Dean Kashiwagi, an ASU professor, has won the International Facility Management (IFMA) Association 2009 Distinguished Educator Award, recognizing numerous accomplishments in research as well as in teaching.

Kashiwagi is a professor in the Del E. Webb School of Construction, a part of the School of Sustainable Engineering and the Built Environment in ASU's Ira A. Fulton Schools of Engineering.

The IFMA is the world's largest international association for professional facility managers, supporting more than 19,500 members in 60 countries. The organization particularly cited Kashiwagi's use of resources provided by a prestigious Fulbright Scholar grant he was awarded in 2008 to develop a project to bring state-of the- art facility and project management research and practices to Botswana, Africa in the past year.

For details on the Botswana project, visit the Web site http://engineering.asu.edu/news/2869.

The award also honors Kashiwagi's work to establish a "groundbreaking" Facilities Management Model of the Future graduate program at ASU.

Kashiwagi is the director of ASU's Performance Based Studies Research Group. It focuses on applying concepts for improving efficiency and performance, and minimizing risk, in project management, as well as for organizations and businesses.

Winners of the IFMA's Awards of Excellence were presented in October at the organization's annual banquet, part of IFMA's World Workplace 2009 Conference & Expo at the Orange County Convention Center in Orlando, Fla.

December 7, 2009

asu news [science & tech]

Report on cancer detection research lauded

ASU engineering professor Seungchan Kim is the lead author on a cancer detection study research paper that has earned the top prize at an international science and engineering conference.

An Arizona State University engineering professor's contributions to a research team making promising strides in cancer detection has been recognized by a major international organization.

Seungchan Kim is the senior author of a report on the work that earned the prize for the best scientific paper at the recent International Conference on Bioinformatics & Biomedicine in Washington, D.C. The conference was organized by the Institute of Electrical and Electronics Engineers (IEEE), the world's leading professional association for the advancement of technology.

Kim is an assistant professor in the School of Computing, Informatics, and Decision Systems Engineering, a part of ASU's Ira A. Fulton Schools of Engineering. As a joint hire of the university and the Translational Genomics Research Institute (TGen) in Phoenix, Kim also leads the institute's Biocomputing Unit in Computational Biology Division.

Kim has been working with the TGen-based team in a study of lung cancer, in which researchers are using molecular imaging as well as microRNAs – small molecules that regulate gene expression in cells – to help understand and predict how malignant lung cancer often spreads to the brain. The results promise to provide knowledge that will enable physicians to provide more effective care for lung cancer patients.

The research paper on the project was chosen for the conference's top prize from among more than 230 scientific papers submitted.

The study is being funded in part by the IBIS Foundation of Arizona, Science Foundation Arizona and the National Institutes of Health.

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Professor's role in civil engineering leadership expands

Edward Kavazanjian has been elected a Fellow of the American Society of Civil Engineers (ASCE) and became president of the organization's Geo-Institute, which represents more than 10,000 geotechnical engineers among ASCE's membership.

Kavazanjian is an associate professor in the School of Sustainable Engineering and the Built Environment, a part of the Ira A. Fulton Schools of Engineering at Arizona State University.

The ASCE is the oldest engineering society in the nation and represents almost 150,000 members in the civil engineering profession. Fellow status recognizes members who have made significant contributions to civil engineering and become recognized leaders in their areas of specialty.

As Geo-Institute president, Kavazanjian will preside over the group of scientists, engineers and technologists concerned with employing their expertise to improve the environment, help protect communities from threats posed by natural disasters, and construct engineered facilities in economical and sustainable ways.

Earlier this year he won the ASCE's Ralph B. Peck Award, which honors outstanding contributions to the geotechnical engineering profession through the publication of documented case histories.

The award recognized Kavazanjian's work specifically on waste containment systems, including design of landfills to withstand seismic activity and post-closure development of these facilities.

He also is the current chair of the Committee on Geological and Geotechnical Engineering (COGGE) of the National Academies of Engineering and Science National Research Council, and sits on the council's Board of Earth Sciences and Resources (BESR).

Kavazanjian also was named an Outstanding Engineering Educator of the Year by the National Society of Professional Engineers in 2008.

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ASU scientists improve electronic chip memory

By Skip Derra

Scientists at Arizona State University have developed an elegant method for significantly improving the memory capacity of electronic chips.

Led by Michael Kozicki, an ASU electrical engineering professor and director of the Center for Applied Nanoionics, the researchers have shown that they can build stackable memory based on "ionic memory technology," which could make them ideal candidates for storage cells in high-density memory. Best of all, the new method uses well-known electronics materials.

"This opens the door to inexpensive, high-density data storage by 'stacking' memory layers on top one another inside a single chip," Kozicki said. "This could lead to hard drive data storage capacity on a chip, which enables portable systems that are smaller, more rugged and able to go longer between battery charges."

"This is a significant improvement on the technology we developed two years ago where we made a new type of memory that could replace Flash, using materials common to the semiconductor industry (copper-doped silicon dioxide). What we have done now is add some critical functionality to the memory cell merely by involving another common material – silicon."

Kozicki outlined the new memory device in a technical presentation he made last month at the 2009 International Electron Devices and Materials Symposia in Taiwan.

He worked with Sarath C. Puthen Thermadam, an ASU electrical engineering graduate student.

Kozicki said that given current technology, electronics researchers are quickly reaching the physical limits of device memory. This fact has spurred research into new types of memory that can store more information into less and less physical space. One way of doing this is to stack memory cells.

The concept of stackable memory is akin to one's ability to store boxes in a small room. You can store more boxes (each representing a memory cell) if you stack them and take advantage of three dimensions of the room, rather than only putting each box on the floor. Kozicki said stacking memory cells has not been achieved before because the cells could not be isolated. Each memory cell has a storage element and an access device, the latter allowing you to read, write or erase each storage cell individually.

“Before, if you joined several memory cells together you wouldn’t be able to access one without accessing all of the others because they were all wired together,” Kozicki said. “What we did was put in an access, or isolation device, that electrically splits all of them into individual cells.”

Up until now, people built these access elements into the silicon substrate.

“But if you do that for one layer of memory and then you build another layer, where will you put the access device,” Kozicki asked. “You already used up the silicon on the first layer and it’s a single crystal. It is very difficult to have multiple layers of single crystal material.”

The new approach does use silicon, but not single crystal silicon, which can be deposited in layers as part of the three-dimensional memory fabrication process. Kozicki said his team was wrestling with how to find a way to build an electrical element, called a diode, into the memory cell. The diode would isolate the cells.

Kozicki said this idea usually involves several additional layers and processing steps when making the circuit, but his team found an elegant way of achieving diode capability by substituting one known material for another, in this case replacing a layer of metal with doped silicon.

“We can actually use a number of different types of silicon that can be layered,” he said. “We get away from using the substrate altogether for controlling the memory cells and put these access devices in the layers of memory above the silicon substrate.”

“Rather than having one transistor in the substrate controlling each memory cell, we have a memory cell with a built-in diode (access device) and since it is built into the cell, it will allow us to put in as many layers as we can squeeze in there,” Kozicki said. “We’ve shown that by replacing the bottom electrode with silicon it is feasible to go any number of layers above it.”

With each layer applied, memory capacity significantly expands.

“Stackable memory is thought to be the only way of reaching the densities necessary for the type of solid state memory that can compete with hard drives on cost as well as information storage capacity,” Kozicki said. “If you had eight layers of memory in a single chip, this would give you almost eight times the density without increasing the area.”

Kozicki said the advance mimics an idea employed in early radios.

“We created a modern analog to the ‘cat’s whisker,’ where we are growing a nanowire, a copper nanowire, right onto the silicon to create a diode,” he said.

Cat’s whisker radios, a product of the 1930s, were simple devices that employed a small wire to scratch the surface of a semiconductor material. The connection between the semiconductor and the wire created a diode that they could use as part of a radio.

“It turns out to be a ridiculously simple idea, but it works,” Kozicki said of his stackable memory advance. “The key was the diodes, and making a diode that was simple and essentially integrated in with the memory cell. Once you do that, the rest is pretty straightforward.”

December 21, 2009

asu news [now]

Adams is President's Professor Award winner

Engineering professor James Adams has won the Arizona State University President's Professor Award for 2009.

The award bestowed by ASU President Michael Crow recognizes tenured faculty who have made outstanding contributions to undergraduate education at Arizona State University.

Adams is chair of the undergraduate materials program in the School of Mechanical, Aerospace, Chemical and Materials Engineering, a part of ASU's Ira A. Fulton Schools of Engineering.

President's Professor Award winners are selected for their mastery of subject matter, enthusiasm and innovation in the learning and teaching process, the ability to engage students in and outside the classroom, innovation in course and curriculum design, and scholarly contributions, among other criteria.

In a statement announcing the award, President Crow noted Adams' achievements in designing and teaching courses responsible for inspiring students to commit more fervently to careers in engineering and science.

Crow points to Adams' work in developing courses and teaching materials that have had a national impact on engineering education methods. Adams has years of success in recruiting and advising students, and providing them opportunities to get involved in research. He has also helped students with job placement.

The President's Professor Award is one of several major honors for teaching, research and public service that Adams has received during his career.

December 28, 2009

asu news [now]

Lin, Akay earn major engineering honors

Ira A. Fulton Schools of Engineering faculty members Jerry Y.S. Lin and Metin Akay have been selected as Fellows of the American Association for the Advancement of Science (AAAS).

AAAS is the world's largest general scientific society, and publisher of the prominent journal *Science*. Each year, the association recognizes a number of scientists and engineers for significant contributions to their fields and to society.

Lin, a professor in the School of Mechanical, Aerospace, Chemical and Materials Engineering, was chosen for Fellow status for his achievements in inorganic membrane science and technology for chemical separation and membrane reactor applications.

Earlier this year, his leadership in the field also earned Lin a prestigious Award for Excellence from the American Institute of Chemical Engineers.

His work is spurring advancements in chemical engineering technologies used in numerous industrial processes, including processes to produce hydrogen as an alternative fuel for cars, to prevent pollution from industrial systems and to purify water supplies.

Akay, a professor in the School of Biological and Health Systems Engineering, was named an AAAS Fellow for his contributions to biomedical engineering research and education. In particular, his work in neural engineering and informatics was recognized by the organization.

Akay’s accomplishments also recently earned him election to the College of Fellows of the American Institute for Medical and Biological Engineering – one of the highest recognitions in the biological and biomedical sciences.

His research spans a wide range of interests in biomedical informatics and biomedical engineering, including the areas of neural, cardiovascular and rehabilitation engineering, and biomedical informatics.

Contributions to electrical and information technologies – specifically biomedical signal modeling and process –earned him Fellow status in the Institute for Electrical and Electronic Engineers in 2009. He also was honored by the government of Colombia for promoting biomedical engineering research and education in Latin America.

In 2010, Akay will take on the leadership of the Department of Biomedical Engineering at the University of Houston Cullen College of Engineering. He will be the founding chair of the department and John S. Dunn Distinguished Professor.

Akay will continue a working relationship with Arizona State University through his research and as an engineering graduate program faculty member. He will continue as a supervisor to a group of ASU doctoral and master's degree students.

Lin was nominated for AAAS Fellow by colleague Yushan Yan, professor and chair of the Department of Chemical and Environmental Engineering at the University of California, Riverside.

Yan noted Lin's international reputation in the field, for both his research contributions and his efforts to advance education in the field and share knowledge with colleagues.

"I feel privileged to have had the opportunity to nominate Jerry," Yan said. "His selection as an AAAS fellow is a fitting recognition of his tireless commitment and the status he has earned in chemical engineering."

New AAAS Fellows will be presented with an official certificate and a gold (for science) and blue (for engineering) rosette pin at the AAAS Fellows Forum on Feb. 20, during the organization's 2010 annual meeting in San Diego.