interface

California Institute for Telecommunications and Information Technology

Volume 4 | Issue 2 | Spring 2009

University of California, Irvine

Energizing Technologies

Table of Contents

Interface®
Spring 2009

Calit2@UCI
G.P. Li
Director

Shellie Nazarenus
Assistant Director
Marketing and Outreach

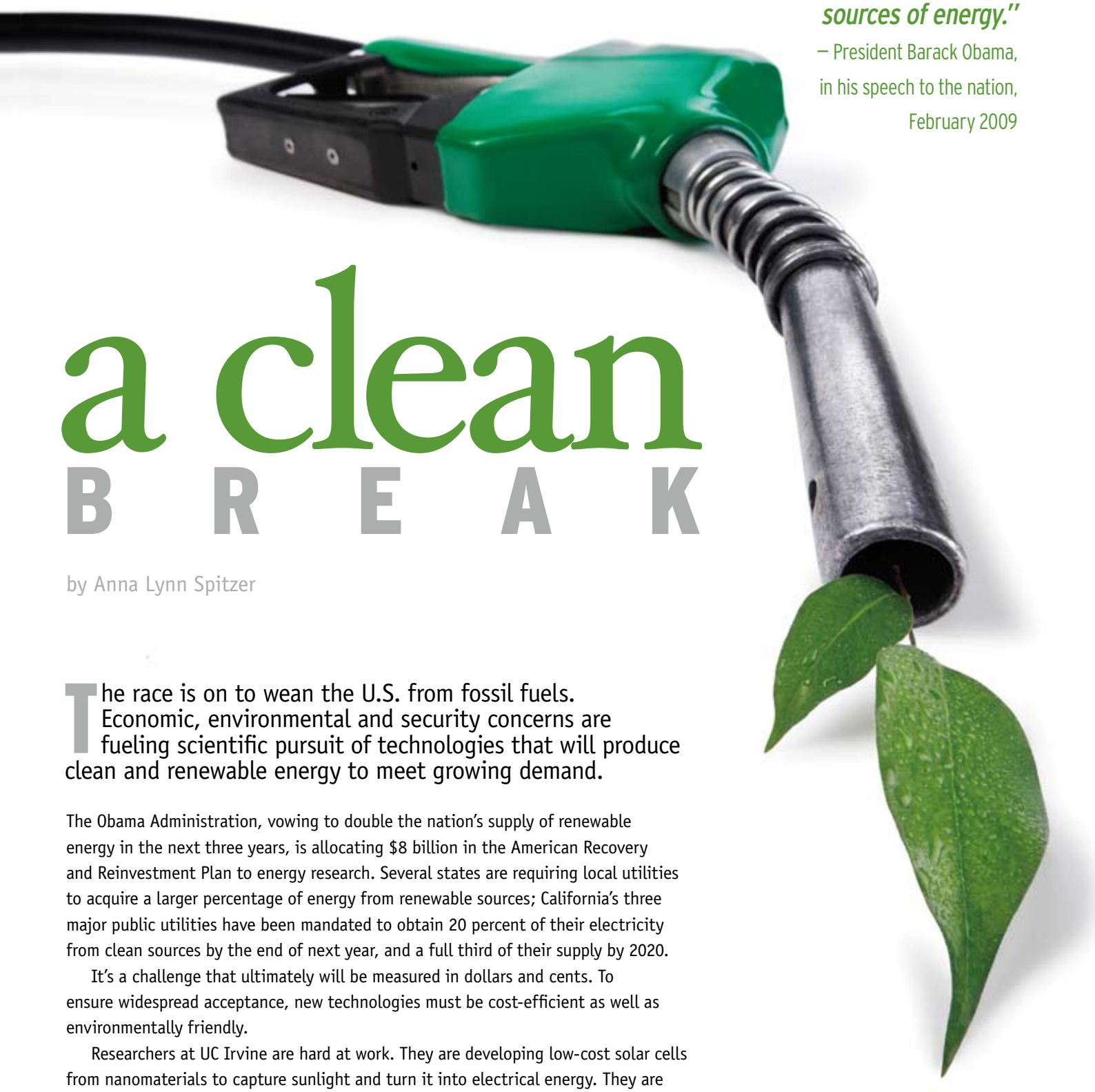
Stuart Ross
Assistant Director
Research Development

Shellie Nazarenus – Executive Editor
Anna Lynn Spitzer – Managing Editor
Michael Marcheschi – m2design group
Paul Kennedy – Photography
Mike Delaney – Meridian Graphics

Calit2
University of California, Irvine
4100 Calit2 Building
Irvine, CA 92697-2800
(949) 824-6900
www.calit2.net
www.calit2.uci.edu
info@calit2.uci.edu

"We have known for decades that our survival depends on finding new sources of energy."

– President Barack Obama, in his speech to the nation, February 2009



a clean BREAK

by Anna Lynn Spitzer

The race is on to wean the U.S. from fossil fuels. Economic, environmental and security concerns are fueling scientific pursuit of technologies that will produce clean and renewable energy to meet growing demand.

The Obama Administration, vowing to double the nation's supply of renewable energy in the next three years, is allocating $8 billion in the American Recovery and Reinvestment Plan to energy research. Several states are requiring local utilities to acquire a larger percentage of energy from renewable sources; California's three major public utilities have been mandated to obtain 20 percent of their electricity from clean sources by the end of next year, and a full third of their supply by 2020.

It's a challenge that ultimately will be measured in dollars and cents. To ensure widespread acceptance, new technologies must be cost-efficient as well as environmentally friendly.

Researchers at UC Irvine are hard at work. They are developing low-cost solar cells from nanomaterials to capture sunlight and turn it into electrical energy. They are re-engineering biofuel production to reduce manufacturing costs, and developing new techniques to burn coal more efficiently. They're maximizing output on fuel cells that produce electricity with zero emissions. And they're finding ways to recycle waste from nuclear power plants.

In addition, researchers at UCI's Advanced Power and Energy Program are investigating several other approaches to generating and distributing power that will lead to a cleaner and more sustainable future.

(continued, page 2)

Let the Sunshine In

Silicon solar cells turn the unlimited energy of the sun into electricity without harming the environment. The technology comes with a steep price tag, however. Current solar cells require extremely pure silicon and costly fabrication techniques, putting solar electricity out of reach for most consumers.

Nanoscale materials, on the other hand, are potentially cheap to manufacture. They can be produced in large quantities by low-temperature-solution methods, processed into inks and deposited onto flexible substrates using roll-to-roll printing.

Calit2-affiliated researchers in UCI's Center for Solar Energy in the School of Physical Sciences are confident they can develop more efficient, less costly alternatives using these novel materials and innovative construction methods.

"Eventually, we hope to lower the cost per watt [of solar power] by about 10 times."

Matt Law measures the electrical conductivity of a nanocrystal film comprised of millions of quantum dot solar cells.

Harnessing Sun Power

Solar cells are made from semiconductor materials that have two "bands" of energy where electrons can exist. The lower-energy valence band and the higher-energy conduction band are separated by a bandgap that is devoid of electrons. When a semiconductor absorbs photons from sunlight, negatively charged electrons in the valence band jump across the bandgap to the conduction band. This leaves empty states in the valence band called "holes" that act like positive charges.

Materials with small bandgaps absorb more sunlight and therefore produce a large current but at a low voltage, while a larger bandgap yields a higher voltage but less current. The challenge for researchers is to maximize voltage and current while minimizing cost.

Nanoscale materials could be the answer, according to Matt Law,

An argon laser lights up a nanowire array so Reg Penner can measure the sample's photoluminescence to determine its electronic properties.

chemistry assistant professor. Nanoscale generally refers to structures that are 100 nanometers (nm) or smaller, the equivalent of 1/500 the diameter of a human hair. Another way of looking at it: the size of a nanometer when compared to a meter is the same ratio as a marble compared to the size of the Earth.

Law is using these materials in different ways. One is "quantum dots," a nanocrystal construction that can greatly increase the device's current without negatively affecting its voltage. Law's lab is studying these nanocrystals made from semiconductors like lead selenide and tin telluride.

Although quantum dot solar cells are still in their infancy, Law sees a bright future. "Eventually, we hope to lower the cost per watt [of solar power] by about 10 times," he says. "That would put it in the same ballpark as making electricity from coal or natural gas."

Law's group also experiments with nanorod solar cells. Nanorods are approximately 10-100 nm wide and can be grown vertically on a substrate, like trees in a forest. Sunlight can be absorbed along the entire length of the rod and electrical charges can be collected much more efficiently than with thin films made from the same material.

(continued, page 4)

"One of the real stories of the biofuel research has been the collaboration of disparate groups across campus and getting the synergism that we really hadn't had before."

Other research in Law's group focuses on synthesizing new semiconductor materials from Earth-abundant elements like zinc, phosphorus and iron. These elements are readily available, non-toxic and cheap, but for various reasons have not been utilized successfully for solar applications. "A number of these have promise and we're just beginning to learn how to control their physical and electrical properties," Law says.

Wired for Efficiency

Reg Penner, center director and chemistry professor, uses another approach to solar energy. His group is investigating ultra-long nanowire arrays that will absorb sunlight on one side and produce electricity through direct thermal-to-electrical energy conversion. These nanowires utilize the longer rays of the spectrum, generating a voltage spontaneously when they're heated at one end.

Although these materials are in use now, they are extremely inefficient, Penner says. Research indicates, however, that if the materials can be formed into wires that are less than 10 nm in diameter, efficiency can be increased enormously, a goal his group is pursuing.

Current testing shows bismuth telluride and lead telluride are the most viable materials. "You have to choose a material that can be efficient at 200 degrees Celsius," says Penner. "Forming it into nanowires should make it orders-of-magnitude more efficient."

Fabrication is tricky. Thousands of the nanowires, each only 10-50 nm in width and millimeters in length, must be fashioned into a device. "The nanowires are very small and fragile, and very, very long," Penner says, "and we don't want them to be in thermal contact with any surface because the thermal gradient needed to generate electricity will leak into the surface if the nanowires touch it."

So his research group developed and patented a process called "lithographically patterned nanowire electrodeposition," which allows the nanowires to be suspended across air gaps as they are deposited on photoresist-covered glass wafers.

The devices could stand alone or be used in combination with photovoltaics, says Penner; both ideas will be evaluated.

Consumer devices could be a number of years down the road, but Law and Penner are taking their research one step at a time. "We're just trying to figure out what works," Penner says.

Engineering a Better Biofuel

Ethanol could be the grand prize in the U.S.'s race for environmentally neutral energy independence. It derives from natural products like corn and sugar cane, and is high-octane, clean-burning and renewable.

But there's a hitch. It is expensive to manufacture and leaves a carbon footprint during processing. In addition, the U.S. produces most of its ethanol from corn, leading to agricultural repercussions that include increased corn prices, higher prices for livestock feed and many foods, and extensive acreage requirements to grow the crop.

UCI scientists, however, are well on the way to solving those problems. They are creating a yeast strain that can produce twice as much ethanol naturally from a wide variety of new biomaterials.

New Gene, New Capability

Using computational biology techniques, they are modifying the genetic structure of a common yeast strain called *Saccharomyces*, which produces ethanol as a byproduct when it ferments plant sugars. One of those sugars is glucose, which *Saccharomyces*

easily breaks down because the yeast produces the necessary enzymes.

But plant material contains other sugars as well, namely xylose and arabinose, which *Saccharomyces* cannot process. Researchers knew that *E. coli* produces the enzymes necessary to break down arabinose, so they isolated the correct protein sequence from the bacteria. Then they re-engineered its gene with their patented gene protein-production technology so that it would successfully express in *Saccharomyces*, inserted it into the yeast's old chromosome, and voila! Now *Saccharomyces* can break down arabinose effectively.

They are doing similar work with genes from other fungi that are growing successfully on xylose.

The new and improved yeast will be able to ferment sugars found in other forms of biomass like switchgrass, hemp, wheat stalks and wood, expanding greatly the stockpile of materials from which ethanol can be gleaned.

It can also circumvent expensive production techniques. The modified yeast strains are being engineered to grow anaerobically, so they don't need air to function. This eliminates the need to pump oxygen in during fermentation, an expensive process that also increases the risk of contamination.

Reducing Production Costs

If all goes according to plan, project leader Wes Hatfield, director of Calit2's Computational Biology Research Laboratory, believes the mutated yeast can double the efficiency of ethanol production without diverting food from humans or animals.

"Right now, the cheapest ethanol is $2.90/gallon to make. If we can get this to work under anaerobic conditions, which will increase the yield, we could double the ethanol production rate," says Hatfield. "That would be like cutting the cost of a gallon of fuel in half."

The project is a multi-pronged effort that encompasses researchers from the CBRL, and the schools of information and computer sciences, engineering and medicine, as well as industry partner Verdezyne, Inc., an Orange County synthetic biology company, which under its former name, CODA Genomics, was created from UCI research. The project is supported by Verdezyne and a two-year UC Discovery Grant that provides matching funds for innovative industry-university research partnerships.

"One of the real stories of the biofuel research has been the collaboration of disparate groups across campus and getting the synergism that we really hadn't had before," says Hatfield, who is also UCI professor emeritus and a co-founder of CODA Genomics.

He says it's a "better than even bet" that the biofuel project will succeed. Next steps include ordering fermenters and putting the new yeast organisms through their paces. "At the end of the grant, we hope to have an organism that we can turn over to industry for pilot plant optimization."

(continued, page 6)

A yeast strain created by Wes Hatfield's research team can produce ethanol efficiently from new types of biomaterial.

Cleaner, Meaner Coal

While scientists continue to make steady progress in the search for alternative energy sources, one immutable fact remains: it takes time to develop and broadly implement revolutionary technologies – 20 to 30 years, most likely. Meanwhile, coal continues to supply the vast majority of our electrical energy needs. Doesn't it make sense in the interim to improve coal-combustion tools to reduce pollutants?

UCI engineering professor Derek Dunn-Rankin thinks so. He is developing new technologies that can be implemented easily in existing power plants to do just that.

"You can make a very small change in the efficiency or utilization of coal, and because so much of it is used, it can make a huge environmental impact," he says.

It's well known that coal combustion releases carbon dioxide, which experts agree has long-term global-warming effects on the environment. But in the shorter term, burning coal releases other pollutants as well, including oxides of nitrogen and mercury, which affect the air we breathe every day.

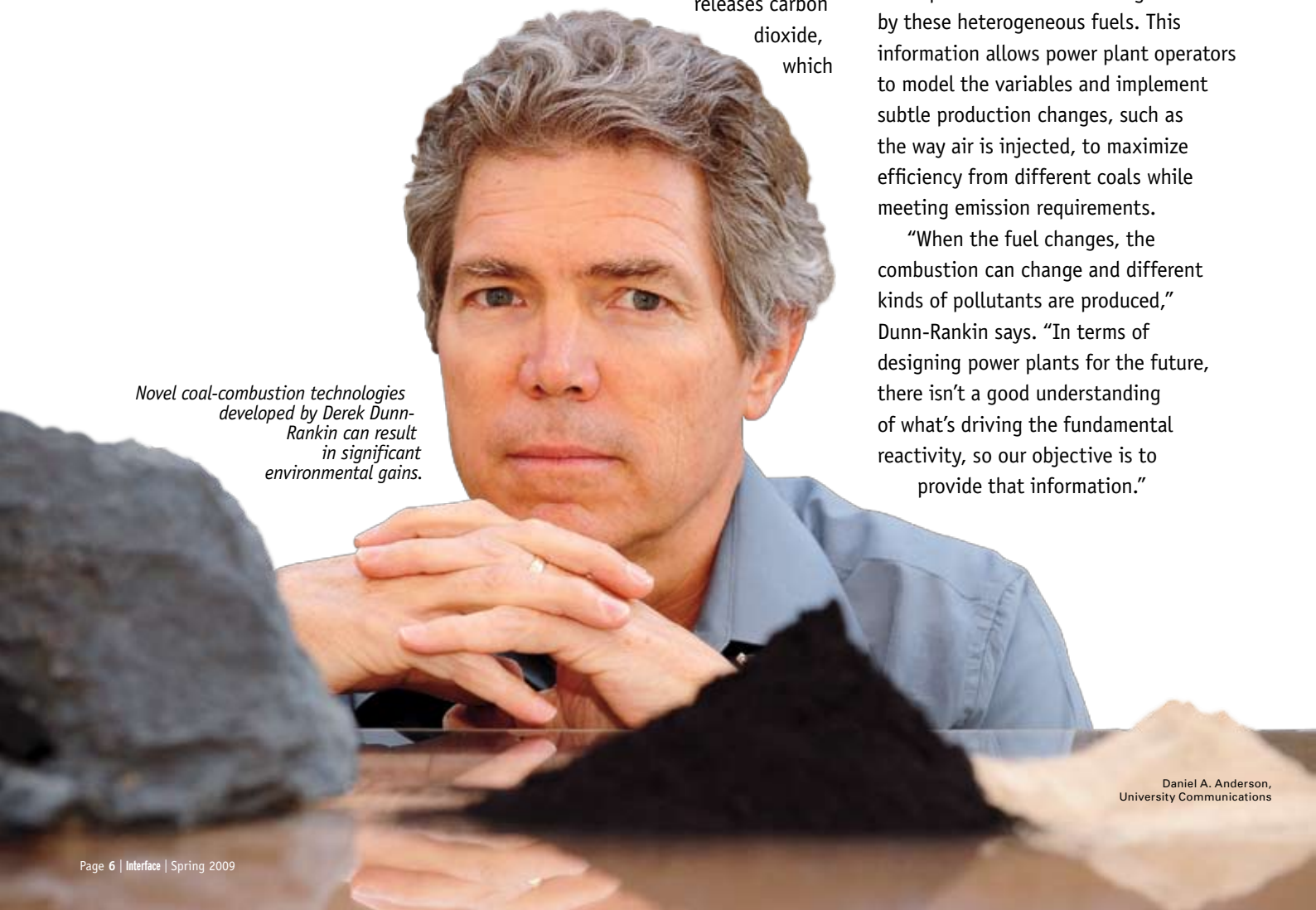
No Two Coals Alike

Dunn-Rankin says output of those pollutants can be reduced with simple fixes based on the heterogeneous fossil fuel's specific properties. "Really, there is no such thing as coal; it's actually many different kinds of coal," he says.

There are five generic categories of coal, each of which reacts differently to combustion due to variables, including: what geographic area and even specifically, what seam it originated in; what minerals it contains; and the amounts of moisture, hydrogen, carbon, oxygen and nitrogen it holds.

The research, which is sponsored by General Electric and the UC Discovery program, employs chemical-kinetic descriptions of the reactions generated by these heterogeneous fuels. This information allows power plant operators to model the variables and implement subtle production changes, such as the way air is injected, to maximize efficiency from different coals while meeting emission requirements.

"When the fuel changes, the combustion can change and different kinds of pollutants are produced," Dunn-Rankin says. "In terms of designing power plants for the future, there isn't a good understanding of what's driving the fundamental reactivity, so our objective is to provide that information."



Novel coal-combustion technologies developed by Derek Dunn-Rankin can result in significant environmental gains.

Daniel A. Anderson, University Communications

Reusing Residuals

Residual ash from coal can be recycled into building materials, primarily as additives to cement and concrete. But if it contains too much carbon, it can be relegated to landfills, certainly a less satisfactory option. Slight changes in the combustion process that may reduce emissions can lead to excess carbon in the ash, making adjustments especially important.

"The byproduct of coal can be sellable or useless and a disposal challenge for very, very small changes in the combustion behavior," Dunn-Rankin says. "The idea is to give manufacturers a very clear handle on exactly what the key triggers are for keeping them safely below the carbon content required for clean ash while also reducing the nitric oxide emissions."

Dunn-Rankin is careful to differentiate between carbon emissions and those from other pollutants. The retrofits suggested by his research do not reduce the release of carbon dioxide during combustion, but maximizing efficiency reduces the overall level of carbon emitted into the atmosphere. "Because so much coal is burned," he says, "the carbon dioxide reduction from a very small change in efficiency has a huge impact on the total carbon emitted.

"If coal power plants could improve their efficiency by one percent, that is equivalent to the entire installed wind energy."

Carbon-Neutral Uses

His research also has applications for burning biomass, which is carbon-neutral and will most likely be used to a greater extent in the future.

"Biomass is even more heterogeneous than coal," says Dunn-Rankin. Biomaterials like wood, sawdust, corn husks and ground rice hulls all have different burning characteristics that require similar adjustments in the combustion process to maximize efficiency and minimize emissions.

"If coal power plants could improve their efficiency by one percent, that is equivalent to the entire installed wind energy."

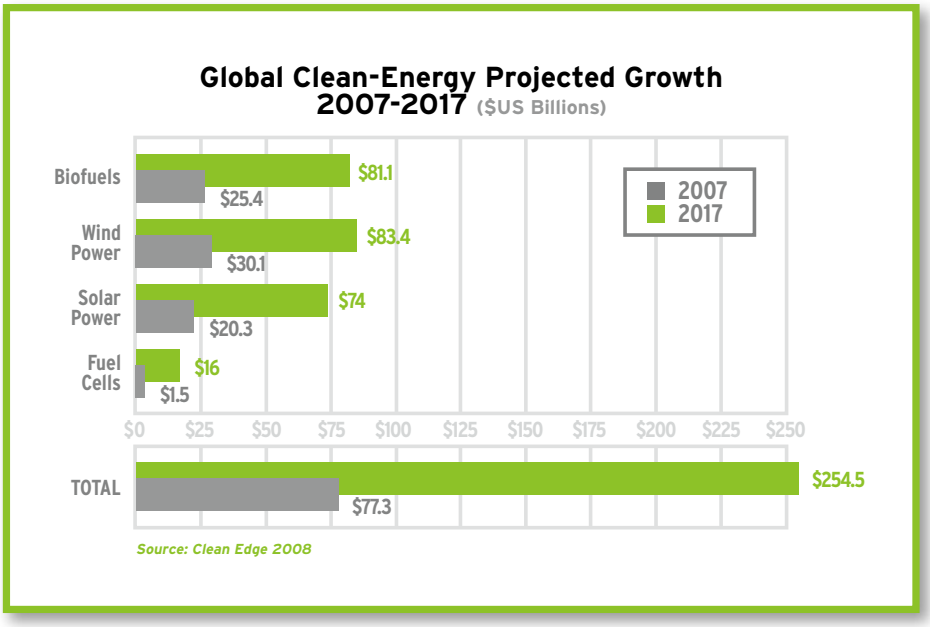
The technologies currently are being tested in co-firing applications with both coal and biomass, but could be adapted for biomass combustion alone. "When we get to the point in the future where we're burning biofuel instead of coal, we won't have the carbon issue at all," he says.

For now, however, Dunn-Rankin admits to some pessimism about the realities of energy production. "My view is that any energy source that can be burned will be burned," he says. "So we want to make it burn slowly and [to the best of our ability] so we don't go through it so quickly.

"And," he adds, "we have to make sure it doesn't kill everyone in the process."

(continued, page 8)

Clean Edge, a clean-tech research and publishing firm, projects explosive market growth for renewable technologies over the next eight years.



Martha Mecartney discusses a fuel-cell test with (from left) Jack Brouwer, Daniel Mumm and Vince McDonell. The high-temperature furnace in the National Fuel Cell Research Center offers dual-environment controls for testing the SOFC and the solid oxide electrolyzer simultaneously.

"If we can bring the temperature of a fuel cell down to 800 degrees, that is a huge move forward."

The Fuel Cell Generation

In 1839, Welsh physics professor Sir William Grove had a bright idea. He knew that water could be split into hydrogen and oxygen by sending an electric current through it, but he wondered: if the process were reversed, could hydrogen and oxygen produce electricity and water?

Grove proved that it could, and from his experiments, the fuel cell was born. Scientists continue to look to the electrochemical conversion devices, which leave only heat and water as byproducts, for quiet, efficient and pollution-free power generation.

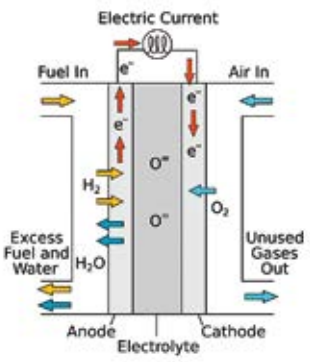
Today, there are at least six different types of fuel cells that power everything from large generating plants and NASA rockets to cars and small portable communication devices.

UCI researchers affiliated with the National Fuel Cell Research Center (NFCRC) and Calit2 are finding ways to improve both the devices' efficiency and their incorporation into other systems – hybrid technologies, distributed-generation operations and the smart grid of the future.

Improving Efficiency

Material scientists Daniel Mumm and Martha Mecartney are making changes in the fundamental materials in one of the most promising technologies, the solid oxide fuel cell (SOFC), to improve its commercial viability.

The SOFC is comprised of four layers, three of which are ceramics. A single cell consisting of these four layers stacked together is typically only a few millimeters thick; from 30 to a couple hundred cells are connected to form a fuel cell stack.



Air is pumped into the device's cathode, where an electrocatalytic reaction changes it from oxygen molecules into negatively charged oxygen ions. These ions then travel through an ion-transport membrane called an electrolyte. The electrolyte, made of a dense ceramic material, passes them to the anode, where they oxidize hydrogen fuel.

This chemical reaction produces water and two additional electrons that pass between the anode and the cathode via an external circuit, creating electricity. As long as there is a constant flow of hydrogen and oxygen into the cell, electricity will flow out.

The ceramic materials used in the cells present researchers with a quandary. Because they are more effective at higher temperatures, solid oxide fuel cells traditionally have been designed to operate at 1,000 degrees Celsius.

"The higher you go in temperature, the faster your reactions occur," Mecartney says. "But when we go to lower and lower temperatures to preserve and stabilize the materials, these reactions get slower."

She focuses on finding ways to change the fuel cell's electrolyte, so ions can be transported more quickly at lower temperatures, while Mumm seeks to develop anode and cathode materials that can maximize reaction speed when the operating temperature is reduced.

The electrolyte is an immensely resistive part of the system, Mecartney says, so she uses several approaches to make it more efficient.

"We do anything we can to move those ions, whether it's creating higher flux (more ions moving per unit of time) or making it easier for them to move by increasing conductivity."

Mumm is working on composites that go far beyond the materials currently in use. He also uses coatings to engineer better surfaces on the interconnect layers, and he studies degradation at the interfaces.

"We're looking for materials that work better or ways to change what we're already using," he says. "If we can bring the temperature of a fuel cell down to 800 degrees, that is a huge move forward."

System Integration Challenges

Their unique properties make fuel cells the perfect complement to other power-generation devices and systems. Jack Brouwer, a thermal systems scientist, is investigating ways to integrate them into distributed-generation systems, hybrid technologies like gas turbine/fuel cell systems, the existing electrical grid and even the smart grid of the future.

Building economical systems around fuel cell materials can be daunting. Ceramics, for example, are used in the stack connectors because they can withstand the high temperatures required to run the cell efficiently. But the system would become less expensive if it incorporated metal connectors, which are cheaper to manufacture but cannot withstand intense heat.

"This technology can be used in any application from the central plants of the future down to the neighborhood level."

Perhaps his biggest challenge, though, is developing technologies for advancing fuel cell systems into "load-following" operations so they are dynamic enough to interact with other systems. Renewable energy sources like wind and solar can be sporadic, Brouwer says, resulting in grid instability. Fuel cell systems potentially could respond to intermittent delivery issues by increasing their own production and sending the power where it's needed.

"This idea of 'dispatchable generation' is very important for complementing renewable power," says Brouwer. "Five years ago, scientists thought solid oxide fuel cells could never follow loads dynamically. Then we started to prove that the physics of the fuel cell can respond very rapidly."

First iterations of the technology will be computer-controlled by people, but Brouwer envisions "smart systems" that can respond autonomously. The systems will have the intelligence to process ongoing information from independent operators and the main grid, decide on the best response and react immediately. "This is going to be very important for the smart grid of the future."

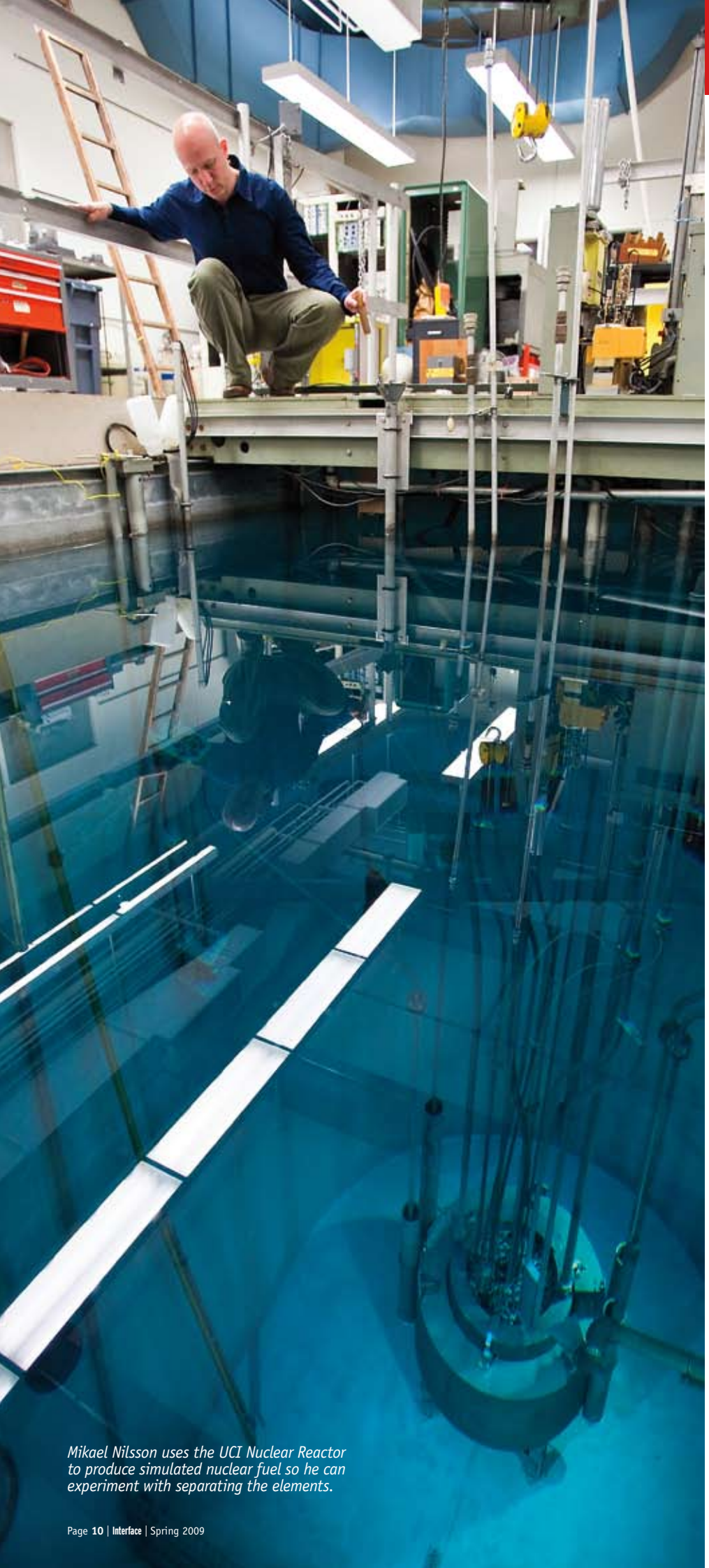
Hybrid technologies, including fuel cell/gas turbine systems, also have lots of potential in sustainable energy systems. Because of the way the two technologies interact, integrating them actually produces higher efficiency in the fuel cell than using it alone.

Other benefits: emissions are reduced because the fuel cell replaces burning fuel between the compressor and the turbine; and the fuel cell's heat loss can be used to produce extra electricity. "Not only do we get more power out of the fuel cell, but it also produces it at higher efficiency," says Brouwer.

The NFCRC, which is part of UCI's Advanced Power and Energy Program, is at the forefront of this innovative technology. In collaboration with Southern California Edison and engineering firm Siemens, they built and tested the first proof-of-concept prototype. The hybrid systems could be available commercially within a couple of years.

"This technology can be used in any application," Brouwer says, "from the central plants of the future down to the neighborhood level."

(continued, page 10)



Mikael Nilsson uses the UCI Nuclear Reactor to produce simulated nuclear fuel so he can experiment with separating the elements.

Atomic Age Appropriate

Splitting a uranium atom produces 10 million times more energy than combusting a carbon atom from coal. It also produces widespread dissent.

Proponents of nuclear energy cite its "clean" footprint, long-term availability and efficiency. One ton of uranium produces more energy than several million tons of coal or several million barrels of oil, without releasing pollutants into the atmosphere.

Critics, though, vociferously condemn the high cost, the threat of terrorism and proliferation, and waste disposal hazards.

UCI chemical engineering assistant professor Mikael Nilsson wants to alleviate one of those concerns; he is researching ways to reduce and recycle nuclear waste. Chemically separating elements in spent nuclear fuel, Nilsson says, allows much of it to be reused and the remainder to be altered so it poses less of a threat.

Reducing the Risk

Nuclear energy is the result of neutrons bombarding the nuclei of uranium or plutonium atoms, which causes the atoms to split in a process called nuclear fission. Splitting the atoms releases tremendous heat, as well as additional neutrons. The heat is used to drive generators that produce electricity, while the neutrons continue to split other atoms, causing a chain reaction.

The problem, however, is that the reaction leaves behind highly radioactive waste material. The toxic detritus is stored: first in cooling tanks and then, when those become full, in lead-lined concrete buildings at the nuclear reactor sites.

Recycling plants in Europe and Japan separate the uranium and plutonium from the spent fuel and reuse it in new fuel, leaving less harmful material to accumulate. The U.S. prohibited this separation process about 25 years ago,

fearing it would lead to proliferation and facilitate terrorism. Because all nuclear waste in this country is stored, stockpiles from 104 nuclear reactors in 35 states continue to grow at the rate of 2,000 tons per year, with no end in sight.

And it's not short-term storage either. The components of spent nuclear fuel can last almost forever; Uranium-235, for example, has a half-life of 704 million years, meaning it takes that long for just half its atoms to decay.

Yucca Mountain, a national waste repository in Nevada, was scheduled for completion next year, but after 20 years of planning and $9 million in expenditures, it was recently eliminated from the federal budget.

There is an upside though. U.S. policy was amended in 2006, so scientists like Nilsson have redoubled their efforts to understand chemical separation of elements in spent fuel.

Recycling Toxic Elements

Nilsson seeks to separate out the most long-lived and toxic of the elements that remain in spent fuel after the uranium and plutonium are removed. Some of these elements then can be reconstituted into new fuel.

Transmutation, as it's called, is not new, but the advanced separation process has never been entirely successful with nuclear fuel. "This hasn't been done because it's hard to find a good process," he says. "The chemicals all suffer from poor stability, or they're too poisonous or they may be too difficult to control in a commercial plant."

Nilsson's approach is to simulate material in spent nuclear fuel by submerging samples of a number of different materials into UCI's nuclear reactor in the basement of Rowland Hall. The nuclear fission process creates neutrons, which in turn can activate the material and create radioisotopes. He adds these radioactive elements to a solution that mimics nuclear fuel, allowing him to experiment with less fear of contamination.

"There are so many elements in spent nuclear fuel – almost half of the periodic table – so in order to be able to separate them, you have to find a way to select just the ones you want to try to recycle," he explains.

By tracking the radioactive elements, he learns how they behave, so he can identify them and ultimately, remove them from the "chemical soup."

"It's easy to follow them once they're radioactive," he says, and adds, laughing, "The beautiful thing about working with radioactivity is that it's so easy to detect."

Decreasing Storage Time

The first step is to identify the materials that have the longest half-lives, because they will be there for the longest time, Nilsson says. When these elements are irradiated, their properties may change and they can become other elements. These altered compounds usually have shorter half-lives, meaning they decay faster.

"Some of it will always have to be stored somewhere," he says. "But if we can decrease storage time from 1 million to a few hundred years, we've come a long way."

> **"The beautiful thing about working with radioactivity is that it's so easy to detect."**

Nilsson examines one component at a time, making the process easier to control and track. "If you tried to analyze it all at once, you would get an indication of what happens but you would have no idea why," he says. "By doing a little at a time you can build a knowledge base, which leads to better methods for processing nuclear waste."

And although research into separation and recycling of nuclear fuel has been around since the 1950s, only recently has it gained public acceptance in the U.S., where nuclear energy currently accounts for nearly 20 percent of electricity generation. "It's much more efficient than coal, and if used correctly it doesn't release anything into the environment," Nilsson says. "Now we have to convince the public and the politicians that we have the know-how to safely take care of the waste in a cost-efficient manner."

INSIDE LOOK

AT THE UCI NUCLEAR REACTOR FACILITY

- TRIGA Mark I nuclear reactor, manufactured by General Atomic in the 1950s; operating on campus since 1969. Approximately 65 of these reactors in use around the world.
- Produces 250 kilowatts of power. San Onofre produces 3,000 megawatts. A hand-held hairdryer or a toaster uses about 1 kilowatt.
- Sole focus: research. The neutrons and gamma rays it produces are used to investigate materials in a wide variety of fields, including archaeology, geology, forensics and chemistry.
- Most 'famous' research: examining bullet fragments supplied by the FBI from the assassination of Pres. John Kennedy. "We were able to fairly convincingly show they all came from one bullet," said facility supervisor George Miller.
- Uses different fuel than commercial nuclear reactors. The zirconium hydride in its fuel gives it a large negative temperature co-efficient; if the reactor's temperature escalates beyond a certain point, the fuel will automatically cause it to shut down.

SUSTAINABLE
POWER TO THE PEOPLE

A fuel cell stack at NFCRC

Developing sustainable energy technologies for the future is the mission at UCI's Advanced Power and Energy Program (APEP).

In addition to its fuel cell research, APEP scientists investigate combustion technologies, distributed generation, co-generation, air-quality impacts and the hydrogen infrastructure.

Generating Solutions

Combustion technologies, distributed generation and combined heat and power (CHP) or combined cooling, heating and power (CCHP) are often pieces of the same puzzle.

In distributed generation (DG), electricity is generated at the site where it will be used, instead of being transmitted from large power plants. It can be produced by a number of small-scale technologies, including microturbines, photovoltaic cells, gas turbines and fuel cells.

The CHP or CCHP systems capture the waste heat from the fuel cells or combustion engines and reuse it. It is channeled into steam turbines to generate more electricity or through heat exchangers to generate hot water; waste heat can be used for heating and cooling buildings as well. This waste heat "recycling" improves the overall efficiency of the system and reduces pollutants released into the atmosphere.

The UCI Power Plant is such a system, using its waste heat for hot water. Vince McDonell, APEP associate director, says that when these systems are powered by the most advanced gas turbine engines, they produce the lowest emissions possible.

APEP has collaborated with the U.S. Department of Defense, installing test CHP units on military bases in Germany and the U.S., including one at a Northern California daycare facility at Ft. Ord. There, the system is powered by a refrigerator-sized 60-kilowatt natural gas-fired microturbine that provides the building's electricity and hot water, and is also set up as an emergency generator.

If the region's grid is up and running, the CHP system displaces both electricity and natural gas used to produce hot water. But if the grid goes down, the system replaces the lost electricity and provides heat to the building. McDonell says the research project exceeded expectations, even becoming a community gathering place during power outages.

While the custom DG systems are proving themselves effective, they also fuel the concept's biggest dilemma. Because each system must be unique, they are expensive to implement. "If you could find a generic application that would allow you to make one device that would work for everything, the price would come down and this technology could make a more substantial market penetration," says McDonell, whose research includes seeking ways to reduce costs.

Search for Alternatives

APEP is also investigating alternative fuels that could power combustion engines. Possibilities include hydrogen, methane from landfills or waste treatment, and biodiesels derived from plant oils. "Combustion as a science is applicable to pretty much any combustion system," McDonell says, but alternative fuels necessitate equipment adjustments. "If we do switch to a hydrogen economy, what would the implications be for all the boilers out there, all the gas turbine engines? I'm trying to figure out what would have to be done to allow them to use this new fuel or combinations of fuels in as clean and reliable a manner as possible."

APEP's fuel cell arm, the National Fuel Cell Research Center, is investigating other implications of a new hydrogen infrastructure, including pipelines, hydrogen generation stations, trucking requirements and impacts on air quality. It works hand-in-hand with vehicle manufacturers like Toyota and GM to test hydrogen-powered fuel cell vehicles, says Jack Brouwer, associate director.

Fuel cell vehicles, electric generation, distributed generation, co-generation and combustion technologies: all impact air quality in different ways. To get a better view of the big picture, APEP relies on computer modeling to predict the effects of various power-generation approaches on surrounding air quality. By modeling potential scenarios with changing variables within the Southern California basin, Brouwer says researchers hope to gain an enhanced understanding of how each will affect the region's air quality in the future.

A sustainable future, they hope.

FRONTIERS
IN ENERGY

www.sc.doe.gov/production/bes/reports/list.html

In February, John Hemminger, dean of UCI's School of Physical Sciences, briefed members of Congress about our country's energy future.

Hemminger, chair of the U.S. Department of Energy's Basic Energy Sciences Advisory Committee, told lawmakers that advances in science and technology are essential if America is going to successfully decrease its dependence on foreign oil and reduce greenhouse gases.

In a comprehensive report, "New Science for a Secure and Sustainable Energy Future," the committee identified three strategic goals that must be accomplished to meet the impending challenge:

- Making fuels from sunlight;
- Generating electricity without carbon dioxide emissions; and
- Revolutionizing energy efficiency and use.

"Development of these advances will require scientific breakthroughs that come only with fundamental understanding of new materials and chemical processes that govern the transfer of energy between light, electricity and chemical fuels," the report says. "Such breakthroughs will require a major national mobilization of basic energy research."

The work taking place on campus has the "potential for major breakthroughs," Hemminger says, citing research on thin film solar cell structures, thermoelectric materials, plasmonics for solar concentration and catalysts for solar-energy-to-chemical-conversion processes, as well as fuel cells. "UCI is working at the forefront of a number of areas of fundamental materials sciences as it applies to renewable energy and global change."

Hemminger, a chemistry professor, conducts research through UCI's Center for Solar Energy on metal/semiconductor hybrid nanowires that can concentrate solar radiation.

He believes replacing fossil fuels with renewable energy requires more than one approach, however. "We need to be working on all areas, including solar, nuclear, wind and biofuels."

He adds that there is a critical need for breakthroughs in the areas of energy storage and energy transmission, specifically superconductors for the new grid.

Register: www.calit2.uci.edu

Join us
Thursday, May 14, 2009
to learn how researchers, policymakers and investors are illuminating the focus on environmentally progressive technologies.

Presenters:
- Jack Brouwer, UCI Advanced Power and Energy Program
- Joseph DiMento, UCI Newkirk Center for Science and Society
- Brian Kremer, ROTH Capital Partners, LLC
- Reg Penner, UCI Center for Solar Energy
- Bill Radany, Verdezyne, Inc.

Igniting Technology is sponsored by Knobbe Martens Olson & Bear LLP in partnership with the University of California, Irvine division of the California Institute for Telecommunications and Information Technology.

Getting Down to Business

by Lori Brandt

Platforms based on gaming technology like those developed by Walt Scacchi's research team can train personnel and improve business performance. Opposite: Semiconductor technicians consult in FabLab screen shot.

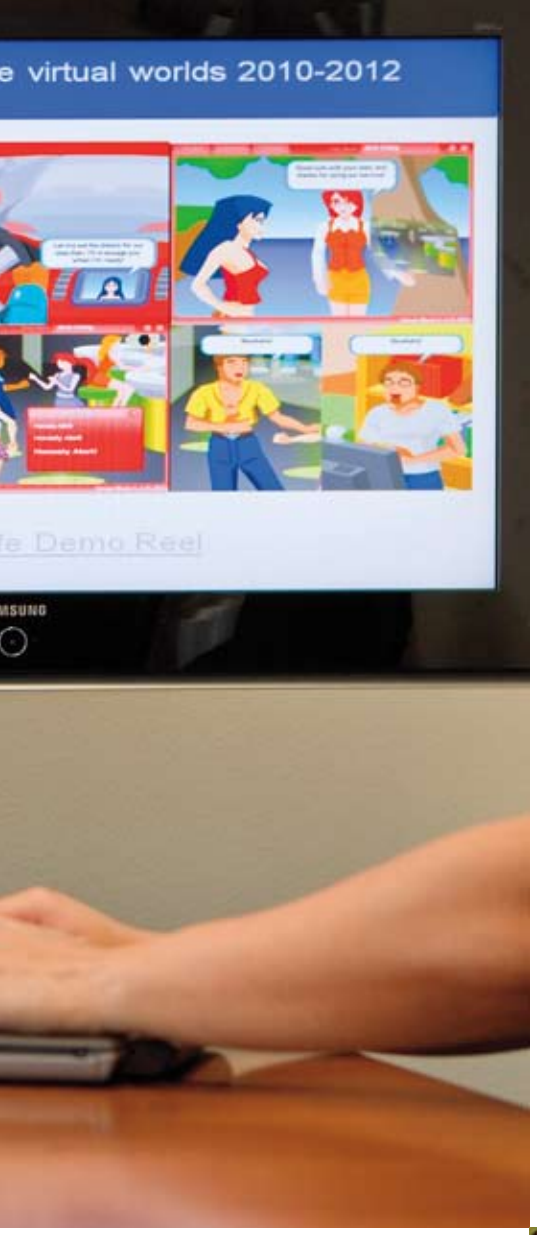
Think playing computer games at work can get you fired? Not necessarily. As more businesses look to computer game and virtual world technology to help them solve problems, improve collaboration, train workers and compete in a global economy, the line between work and play is fading.

"Game software has improved dramatically over the years, and business applications of these technologies have the potential to improve performance," says Vijay Gurbaxani, a UCI professor of information systems and director of the Center for Research on Information Technology and Organizations. "But it is important to understand the conditions under which the use of these technologies is more likely to succeed."

That is the goal of the recent $3 million National Science Foundation grant to UCI's Institute for Software Research: to see how the emerging forms of communication that employ computer-game and virtual-world technology can best help organizations, as well as determine when this technology may not be an effective solution.

Not Just Fun and Games

One such organization working with Calit2 researchers is the technology innovator Intel. For a high-tech company like Intel, which builds microprocessors, one small accident in its manufacturing plant could suspend production for hours or even days. A shutdown costs hundreds of thousands of dollars an



hour. With 3,500 technicians who cover three shifts a day, Intel's $3-billion fabrication facility in Chandler, Ariz., consists of large, sterile clean-room environments. Training employees to deal with spills or service-equipment problems in this environment poses an expensive and difficult challenge. These workers must learn to diagnose and fix problems on the job as they occur.

"This presents the ideal situation for game-based virtual world technology," explains Walt Scacchi, ISR senior research scientist and co-director of the Calit2 Game Lab. As a demonstration of game technology's potential, Scacchi and computer programmer Craig Brown designed what they call the "FabLab" game. In this game, semiconductor manufacturing technicians, fully suited in clean-room attire with hood and facemask, perform their work activities, including diagnosing and resolving material spills that contaminate the clean room. The game shows how such breakdowns in operations can be modeled and collaboratively diagnosed at a distance, as well as how the game could be used to train new technicians.

The Future is Now

Northrop Grumman is another company working with UCI researchers. As a recruitment tool on college campuses, the aerospace company uses a short video game that lets potential employees practice their top-level engineering skills and build a fighter jet. The company is also developing a game for its current workforce to reinforce the notion that every job contributes to the quality and success of the final product.

Mark Conger is a project manager at Northrop Grumman who oversees the application of game technologies in the company's aerospace sector. "At Northrop Grumman, much of our research and development can take 10-plus years to go from concept to war fighter. If you think about that, our future customers and employees are in junior high right now. Rather than building our father's system, we need to figure out, right now, how to inject the technology these kids are used to into our product line, so that it makes sense when they are decision-makers or employees."

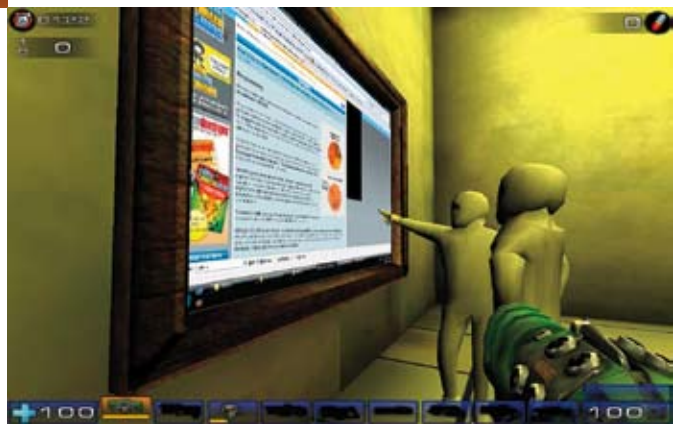
For Northrop Grumman, researchers are developing different virtual worlds and online game concepts to study how people behave – how they make decisions, how they do business, how they relate to one another. "These virtual-world gathering places are like vast social science Petri dishes," says Conger. "It's the first time in history we can capture this many people in one sample to do research."

Productive Play

Scacchi says computer-game and virtual-world technology can improve processes and practices in four areas. Exchanging information: think of a three-dimensional virtual conference or meeting, each person interacting with others through their avatar. Interactive design prototyping will allow engineers in different locations to collaboratively create products in real time. Simulation-based learning can be used to train employees, and virtual product showrooms could help sell products.

Scacchi believes that as the new medium of the 21st century, game technology will affect all modes of work and play, just as radio, television and the Internet did in the 20th century.

"Maybe there is no fundamental difference between work and play," says Scacchi. "Playing a complex, difficult computer game like "World of Warcraft" can be serious work. And people say the more challenging the game is to play, the more fun it is. So rather than thinking computer-game and virtual-world technology only applies to play, we view it as an activity system – an interactive activity system that can be used in many new ways to benefit corporate enterprise."



"These virtual-world gathering places are like vast social science Petri dishes."

Virtually Speaking

by Shellie Nazarenus

Between interviews with National Public Radio and a Dutch documentary film crew, Tom Boellstorff, UCI anthropology professor, sat down with me to discuss his new book, "Coming of Age in Second Life," in which he explores how virtual worlds can change ideas about identity and society. The release has generated a plethora of speaking requests, proving that timing is everything. When he started his research five years ago, there were only 5,000 people exploring a relatively unknown virtual world called Second Life. Now there are often 80,000 people at once and interest is growing.

Why are people attracted to virtual worlds such as Second Life?

People have needs and desires in the physical world that maybe a virtual world could fill. But new things emerge once you're in the virtual world that you couldn't have predicted and might find interesting. That's often what keeps people involved in virtual worlds. For example, people often go into Second Life (SL) to try being a different person, change their gender or race, whatever, but what they really discover is that SL is a great way to stay in touch with their aunt who lives three time zones away. Instead of calling each other in the actual world, they meet in SL and do stuff together. By the way, I say "the actual world" instead of "real life" because it's clear that virtual worlds are real places of human culture.

Why did you choose to study SL?

There have been plenty of people looking at human-computer interaction. I wanted to try something that anthropology had not quite done before – a full-scale ethnographic study of a virtual world. With that in mind, it was important for me to have a really open-ended virtual world where it would be easier for me to be an anthropologist, create an office to conduct interviews and do all the stuff I do as an actual-world researcher.

How did you conduct your research in SL?

The idea was to replicate the fieldwork methods that I use in my actual-world research as much as I could. Participant observation is the main thing you do with an ethnographic approach. So I created Tom Bukowski, an avatar (a graphical representation of a virtual world resident), and spent a lot of time in SL hanging out with people in everyday interactions. By actually participating, you realize what kinds of questions you should ask or what kinds of things you should look at that you wouldn't even know were there. Then I invited groups of avatars to discussion groups at my SL home, Ethnographia, and I also conducted individual interviews.

Were SL people willing to be interviewed?

I couldn't get them to stop talking! Once people understood I was interested in their SL experiences without needing to know details about their physical lives, it was almost like I had people lining up. Sometimes people would ask me to interview them again or their friends would start messaging me. Part of that is because SL is still seen as something very new. Many people are really fascinated by it in various ways, just like me, and they wanted to talk about it.

Does your avatar resemble you?

The default look for him does. But he can also look like a woman or a cat or a dragon. I mean, I have many different avatar embodiments because you can change your look in SL instantaneously. Some people completely change their look, their race, their gender or their species every day, but that's probably not the norm. Most people have a kind of default look, often some kind of fantasy, idealized version of themselves. There aren't a lot of ugly avatars.

(continued, page 18)

Opposite: Anthropologist Tom Boellstorff explores identity and society in virtual world Second Life. Above: Avatar Tom Bukowski began his anthropological research on June 3, 2004.

Tom Bukowski surveys other avatars for their views.

Is there discrimination in virtual worlds based on appearance?
Yes. A big issue in the physical world is discrimination based on aspects like race or gender, something that you can't change or can change only with great difficulty. In theory, you would think that when you could change your appearance in SL at the drop of a hat, the discrimination wouldn't be there because it's not an innate part of who someone is. But – and this is the big "but" – people often sense it's all chosen, so they will still read meaning into it. Why do you look like that? What does that mean about you? And it can in some cases trigger real-life prejudices. There are interesting cases of African-Americans who have white avatars at least some of the time because they just find it easier. But that is not always the case, and then there are all kinds of people who are seeing what it's like to live as someone with a different ethnicity than the one they have in the actual world. There's cross-gender stuff, too, and a lot of debate on why so many female avatars in virtual worlds are controlled by men in the actual world, and to a much lesser degree, the other way around.

What was the biggest surprise?
The kindness and altruism – I continue to be surprised at how generous and giving people are in virtual worlds. They will often give you hours of their time if you need help or companionship. In popular culture, the most common image of virtual worlds is from the Matrix movies, where they enslaved humanity. But realistically, in terms of the percentage of negative social interactions in SL, it's miniscule. The reason these worlds survive and grow is that generosity and kindness are more common than people who've never spent time in them may think.

So your hypothesis is that we're all virtually human?
Right, that's the "double sense" about the phrase in my book "we are virtually human." In one sense, there is something new to virtual worlds and to being human inside of virtual worlds. But there's also something about being human that's always been about being virtual. From the first cave painting to the development of language to the first novel, there's been a kind of virtual-ness that's always been a part of the human experience.

Do you find it ironic that you conducted the study online but the results came out in a hard-copy book?
It's not ironic – that was actually an intentional decision I made for two reasons. One is because I was trying to reproduce traditional ethnographic methods so I wanted to produce a traditional anthropology book. The other thing was that I wanted to reach out to a lot of people who don't know anything about Second Life or virtual worlds, and the reality is, the book form is still the dominant way in which people access information. The publisher does, however, allow the first chapter of the book to be available by PDF. So I actually put an open-able book inside of Second Life on my living room coffee table and people can read the beginning for free.

And where do virtual worlds take us from here?
It's not going to be the Matrix. Just like TV, cell phones or email, it's not going to take over our lives. Virtual worlds are a relatively new technology and the number of people spending time in them is bound to go up since not long ago the amount of time people spent in them was zero! There will be changes that result from improvements in technology, but I actually think [there is] a lot of interesting stuff that no one's even thought of yet that we could even do now. The lag in where we go from here isn't the technology, it's our imagination.

TIPS (Taking IP to Startup) is a service offered by Calit2 to help guide faculty and students through the process of moving their research to the business market. TIPS has open office hours 1 – 5 p.m. every Tuesday in the Calit2 Building, suite 4100.

Ask the TIPSter

by Luis Vasquez,
OCTANe LaunchPad

Financing a startup can be a challenging endeavor in normal economic times. So how should entrepreneurs and researchers with the dream of creating a technology-based company adjust their financing plans in this economic recession?

It's useful to first understand how the current economic situation has affected startup financing. The credit crisis has hit many entrepreneurs, who in recent years seed-financed their startups using home equity or zero-percent credit-card accounts. Those days are over.

Angel investors have also seen their net worth fall as their home values and investment portfolios have taken a dive. This has decreased their risk appetite and sometimes reduced the funds that they have to invest in startups.

Some venture capitalists have found it harder to get commitments from their institutional investors, whose entire portfolios have suffered big losses. Plus, the VCs are getting fewer or depressed liquidity exits due to the lack of IPOs and the decreased valuations of almost all companies.

So what are some creative options? Let's start with **government stimulus money.** In an effort to pump up the economy, the government is spending trillions of dollars. Lots of that will be invested in research. Future entrepreneurs affiliated with universities may want to continue R&D as far as possible before taking the technology outside. Small Business Innovation Research (SBIR) grants and Small Business Technology Transfer (STTR) grants will also increase as research budgets increase for federal agencies.

Another source of revenue and financing for startups is **licensing royalties from larger companies.** Ironically, as companies cut their internal R&D budgets, it may open the door for outside technology through increased in-licensing and open-innovation programs. The caveat is that large companies' licensing departments are usually looking for technology and new products that are very close to commercialization. Further, there are often terms in these licensing deals that may prevent competition in certain markets. So while a licensing deal may prevent a startup company from selling its own products around the world, it can be a great path to revenue and a way to prove a market exists for its technology.

There is also the option of a **structured loan from an angel investor.** Unlike a normal equity investment, where the investor gets his/her money back upon an IPO or company sale, structured loans provide a mechanism to return principle to investors sooner, much like a loan with interest, but with equity warrants. The terms of such deals can vary widely, so it is imperative that entrepreneurs seek legal counsel.

Finally, there is **self-financing or "bootstrapping."** This method should always be considered regardless of economic conditions. In the long run, self-financing is the least expensive alternative, especially compared to taking equity investment. The downside is that it can greatly prolong the time required to build a successful startup, and it puts all the financial risk on the entrepreneur and his/her family.

Despite the challenges, the good news is that there are always wildly successful companies started during tough economic times. Cisco Systems received its first VC investment just weeks after the stock market crash of 1987, and Microsoft was founded during the mid-70s severe economic recession.

Companies started during economic downturns are forced to be more capital-efficient, often pay lower rates for rent and services, and have a bigger pool of talented employees. Consequently, if they survive, they usually thrive and greatly reward founders and investors.

So if you are trying to fund a startup right now, you must be creative, entertain alternatives that you might not have considered, and have hope that if you get off the ground, you will be in a good position to thrive when the economy rebounds.

Good luck!

Autonet researchers James Marca (foreground) and Craig Rindt are fine-tuning the autonomous vehicle-to-vehicle system so it can integrate street and freeway traffic information

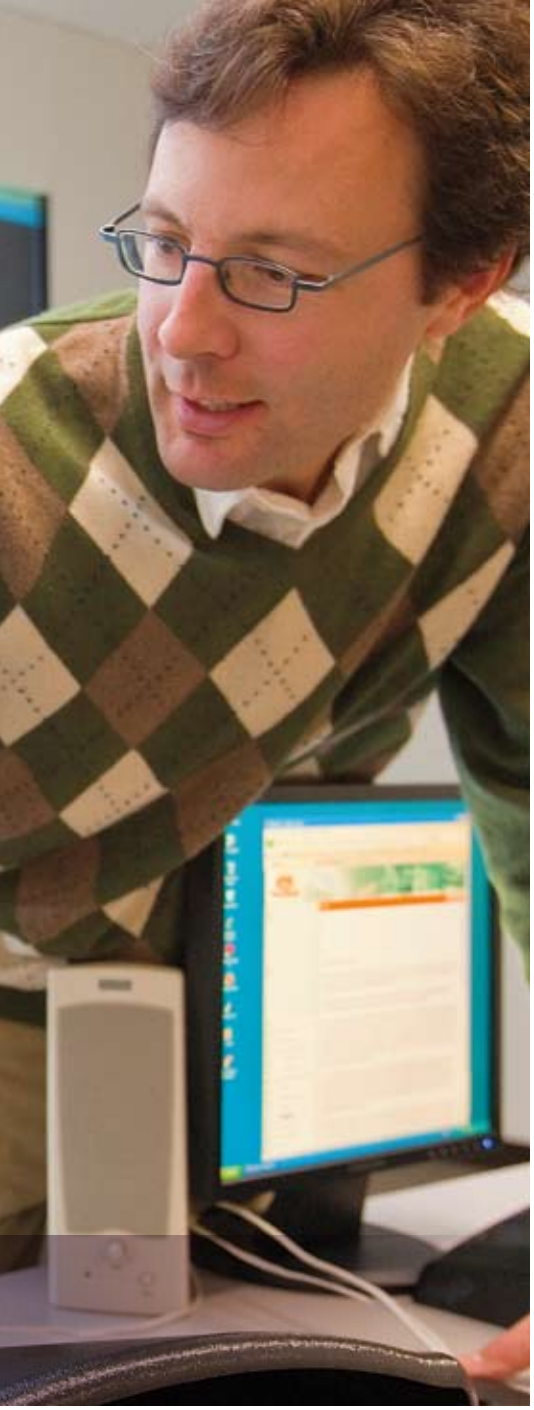
Ready for DRIVETIME

by Anna Lynn Spitzer

Researchers at UC Irvine's Institute of Transportation Studies are ready to go the extra mile with "Autonet," the vehicle-to-vehicle, autonomous traffic-information system they've been developing for 10 years.

Timing is everything, the researchers say. As wireless technology becomes more ubiquitous, the public has suddenly found the Autonet concept more realistic and newly relevant. Widespread interest became apparent when an academic paper on the project –written in 2007 but published this year – caused a recent flurry of media attention.

And now, with billions of dollars available in the Obama Administration's stimulus plan, the time could be right to secure additional funding – and, researchers hope, commercial partners



– for developments that could take the system to the next level.

"It was very good fortune that [the paper] was slow to be published," says James Marca, one of its authors. "Enough people have seen an 'OnStar' system or a live traffic update system to know this can work. That's good but those systems are very limiting."

Vehicle-to-Vehicle Communication

The Autonet system, one of Calit2's first projects, can be installed in cars and roadside monitoring posts. Using ad hoc networks, the system alleviates traffic congestion and increases driver safety by enabling cars to "communicate" with each other via common wireless technology. A car passing an accident or avoiding an obstacle could alert other cars, allowing drivers to avoid the incident.

In its early days, the system was tested in a virtual simulator. Then the team collaborated with electrical engineering, computer science and database colleagues to build the prototype with off-the-shelf components. They road-tested it on freeways and surface streets, using 802.11 b wireless networks. "That generated a lot of excitement," Marca says.

On With the New

Now developers see ways to advance the system even further to help Caltrans and its municipal partners manage street and freeway traffic as an integrated system. "Caltrans has lots of quality, real-time information on the freeway systems, but they know very little about the streets," says Marca. "What we want to do is build the next-generation traffic management center for them."

Researchers also want to adapt the Autonet platform for use on high-end phones like Apple's iPhone and Google's G1, which could upload information and transmit it to the transportation agency. "Caltrans will be able to use the real-time vehicle data, and in turn will provide better information to drivers than just [telling them to] 'expect delays,'" he says.

Researcher Craig Rindt credits advances in technology for next-generation potential. "Transportation research has long studied human behavior in the context of both spatial and social environments," he says. "What's different now is that mobile computers directly measure this behavior via their navigation, calendaring, and social networking applications. This makes it possible to apply well-established methods to analyzing behavior, and provide value-added services to users."

Marca envisions the final product as a "hybrid system" that will incorporate all available communication options, including wireless networks and cell phone-based communication, depending on the situation.

"Some things, like a traffic jam, would be better suited to a local area connection, which is almost instantaneous," he says. On the other hand, since Autonet "knows" a driver's usual daily routes, a cell phone application could send notification before he gets in his car that there is an incident along the way. "In my mind, the end system will be both."

Marriage of Two Technologies

When it was first introduced, the concept was not well understood and was considered quite futuristic, says Wenlong Jin, who in 2006 served as guest editor of a special journal issue focused on inter-vehicle communication and intelligent transportation systems. "When we talked about this before, many people liked the idea but were kind of skeptical. After several years, and with the continued development of wireless communication technologies, people realize it is more probable."

Trevor Harmon, the paper's lead author who earned his doctorate degree last spring, attributes public interest in the project to the innovative way that two familiar technologies have been merged into a new product.

"It takes the principles of peer-to-peer networks – which are now famous thanks to Napster, BitTorrent, and the RIAA – and applies them to the problem of automobile traffic, which just about everyone cares about in one way or another," he says. "Autonet marries these two concepts in a novel way."

Adds Marca, "The time is finally right to get this going."

FUNDING NOTES

by Stuart Ross

Thinking Outside the Stimulus-Recovery Box

Does crowd behavior bother you? Are you tired of reading e-mails to learn for whom the bill tolls? Has it been more than a week since you checked with an important agency official? Don't worry – there are still other funding opportunities available. The chase will be less exciting, but the support will still be useful. The following opportunities look good for Calit2 affiliates.

Medical Technologies that Reduce Health Disparities

National Institutes of Health RFA-EB-09-001
Letters of intent are due Aug. 22, 2009; proposals are due Sept. 22, 2009

This competition is part of the Small Business Innovation Research (SBIR) program. Small businesses are eligible to apply, and they can subcontract part of the work to universities. Technologies are sought that minimize barriers of distance, cost or knowledge that keep some populations from getting adequate healthcare. Examples might include devices for in-home monitoring or integrating diagnosis and treatment, or cheaper and simpler sensors. Awards are available for initial technology development, up to $200,000 per year for up to two years.

Environmental Decision-Making Under Uncertainty

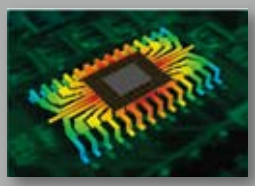
National Science Foundation 09-544
Proposals are due July 14, 2009

This competition offers awards to support collaborative research teams that will generate useful information and tools to help decision-makers

incorporate climate change and its related long-term environmental risks. In addition to generating new knowledge and technologies, the collaborative groups should enhance basic understanding across the social and behavioral sciences as well as related science and engineering disciplines. NSF will make four to five awards of $900,000 to $1.5 million per year, for up to five years.

Microsystems Technology: Office-Wide Broad Agency Announcement

Defense Advanced Research Projects Agency BAA-09-25
Proposals will be reviewed as they are received, until February 2010



Research areas of current interest include low power-high performance data processing, novel electronic and photonic device demonstrations, novel semiconductor materials enabling new capabilities, nanophotonics and nanoelectronic device and circuit demonstrations, power electronics, biological and chemical sensors, chip-scale navigation and control, and 3D digital imaging technologies. Proposals are also sought for micro-scale power generation and conversion, terahertz technology, optical communication, trusted design and hardware, anti-tamper technology, non-destructive examination of integrated circuits, novel/integrated antennas and microwave photonics.

Advanced Neural Prosthetics Research and Development

National Institute of Neurological Disorders and Stroke/NIH/DHHS PA-09-063
Proposals are due June 5, 2009 or Oct. 5, 2009

This program includes clinical prototype devices, design verification and validation activities, and preclinical safety and efficacy studies. Projects should pursue systems integration of multiple neural prosthetic devices, particularly the combination of volitional control, actuation and/or sensory feedback. Partnerships between engineers, scientists and clinicians will be required; these partnerships may span academia and the private sector. The project period may be up to five years; award sizes may vary but the direct costs may not exceed $1 million per year.

Johns Hopkins University Applied Physics Laboratory

Computer and Network Systems Core Programs

National Science Foundation 08-576
Deadline dates in 2009 are by size category: Aug. 30 (medium); Nov. 28 (large); Dec. 17 (small)

This broad solicitation seeks research proposals on the problems and opportunities posed by parallel, distributed and/or mobile computing.

Research is also sought on the scalability, robustness and extensibility of networks. Investigators are encouraged to focus on innovative holistic approaches to address the end-to-end requirements of different applications in large-scale, heterogeneous networks. $60 million is available for 80 to 120 awards.

UC Discovery Grants

University of California Office of the President
Proposals are due in fall 2009, date to be announced

These grants provide support for research projects in collaboration with industry. UCOP provides funding to a UC researcher, and one or more firms in California provide matching support. Projects are supported in the fields of biotechnology, communications and networking, digital media, electronics manufacturing and new materials, and the use of IT for life sciences. Funding levels vary from $50,000 to more than $2 million.

[Bits and Bytes]

by Shellie Nazarenus

Sampling the Research

UCI's Chancellor and new engineering dean paid separate visits to the Calit2 Wireless Sensor Technologies lab to try out some of the latest prototypes under development. Among the many research projects demonstrated, Chancellor Drake seemed particularly interested in the XSense technology embedded into head coverings such as the current baseball-cap model. The technology enables wearers to experience a sixth sense – the ability to perceive objects that cannot be detected using their own senses. Dean Rafael Bras also viewed numerous activities and sampled a floor-sensor mat system that researchers hope will provide intelligent feedback for people undergoing mobility rehabilitation.

A Digital Way of Life

In February, Calit2 hosted the MacArthur Foundation Portfolio Conference on Digital Media and Learning. Attendees from across the country spent two days discussing how digital technologies are changing the way people, especially young people, learn, play, socialize and participate in civic life. They also had an opportunity to visit some of the labs in the building and see research projects that are developing creative digital learning technologies and approaches. Lab stops included the eMedia Studio, Interactive Animation, Visualization and Game Development.

A Step in the Right Direction

Best practices for minimizing the human carbon footprint will be explored at a May 22 program at the Beckman Center for the National Academies of Science and Engineering in Irvine. "Green Development" is a solutions-oriented conference sponsored by the Newkirk Center for Science and Society at UCI, and Chapman University. "This program will examine case studies of successful initiatives in the business sector and in the university, pointing to concepts and principles that explain winning results," says Joseph DiMento, the center's director and conference co-organizer. The program is free and open to the public, but space is limited and reservations are recommended: *newkirk@uci.edu*.

SURFing into Summer with a Splash

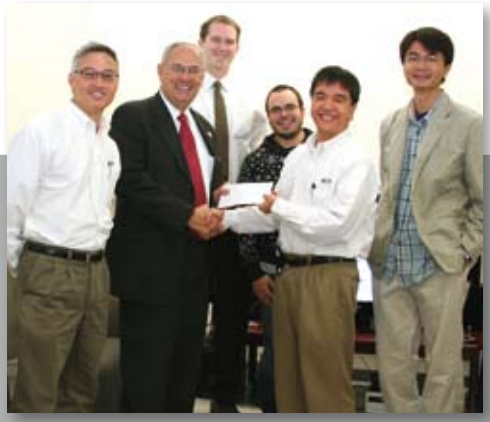
The fifth consecutive summer of undergraduate research at Calit2 is getting underway with 15 projects earmarked for UCI students to explore. The Summer Undergraduate Research Fellowship in Information Technology (SURF-IT) provides a unique 10-week experience for talented participants to become immersed in IT-related research and applications. Selected Fellows work under the guidance of a faculty mentor and research team. To date, 47 undergraduates from various disciplines have developed the knowledge and skills that can propel them into graduate studies or careers in the technology sector. 2009 SURF-IT Fellow Lauren Lewis recently was first author of an article about her "Fanfiction University" research that was published in the inaugural issue of the International Journal of Learning and Media. The computer science major was mentored by education assistant professor Rebecca Black.

Picture Perfect Projection

Equipment donations from two global companies have contributed to significant research advances for Professor Aditi Majumder's group in the Calit2 Visualization Lab. Late last fall, Epson's R&D arm donated 10 new projectors, while Canon Development Americas division contributed state-of-the-art cameras. The research team is developing camera-based calibration techniques and custom algorithms to produce realistic, high-resolution, seamless displays using multiple projectors. In the initial phase, the project utilized a rear-projection system. With the new equipment, the group is developing a front-projection configuration that produces seamless images on cylindrical screens, including wavy surfaces. "We've really reached some milestones in terms of seamless displays," says Majumder.

Focus on Orange County

Leadership Southern California 2009 Fellows spent a day in late January exploring science and technology sites and trends in Orange County. Their excursion included Calit2, where they saw first-hand how industry and university researchers interact to stimulate innovation. The group made several stops, including the Visualization lab, where lab manager Steve Jenks demonstrated the capabilities of HIPerWall and explained the project's path to recent commercialization. Each year the Leadership Southern California program selects approximately 40 mid-career participants from a six-county region for their leadership development program. The diverse group learns more about the business and education climate, public policy and regional stewardship efforts.



Funding Enables Prototype Deployment

Calit2's telemedicine initiative got a shot in the arm this winter when the Verizon Foundation delivered its funding gift in support of the Telios project. Gary George, Verizon's director for government and external affairs, presented the check to Calit2 Irvine director G.P. Li and the research team after seeing a demonstration of the working prototype. Telios makes telemedicine options available to average individuals by employing a software package that brings healthcare providers into patients' homes via the Internet. The system also enables doctors to receive continuous updates from selected medical devices linked to it. The Verizon funding is being used to install and test a Telios prototype in Orange County's Share Our Selves medical clinic for underserved and uninsured patients.

Picture Perfect Pyramid

Next year, 12 miles of murals will be displayed electronically on an enormous pyramid constructed in Egypt. Last fall, a smaller replica of the international Art Miles Mural Project was erected in the Calit2 Building atrium. The project, founded by former U.N. executive Joanne Tawfilis, is meant to erase boundaries between countries, and encourage a mutual respect for the Earth and its many cultures. More than 5,000 murals have been created by more than 500,000 people of all ages and backgrounds from 125 countries. The murals fall into one of a dozen themes, including the environment. It was this subject in particular that landed the four-sided, nine-foot tall portable pyramid at Calit2 as part of the institute's water and technology conference. "The Art Miles Mural Project links art, technology, children and the world to provide a path through international cooperation for sustainability," said conference speaker Bill Cooper, who directs UCI's Urban Water Research Center.

Startup Success Stories

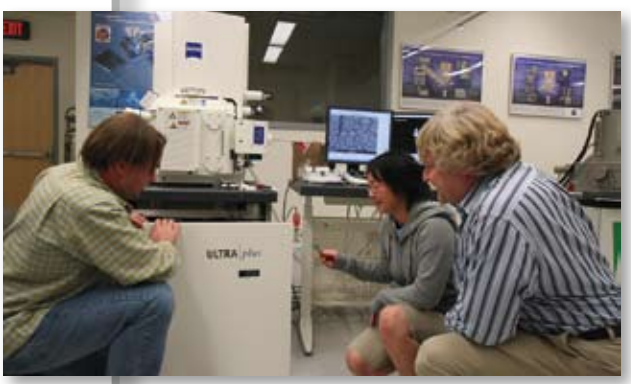
As a guest entrepreneur, G.P. Li enlightened an audience of researchers with lessons learned on the road to starting up companies. Li, who directs the Calit2 Irvine division, has been involved in several business opportunities during his 20-plus years in academic research. He told the crowd that he considers only one of those a success story but never regrets having given them all a try. "You have to go with your gut feeling. If it is something you are passionate about, and there is a good business model, then go for it," he told listeners. "If I hadn't tried all of those times I wouldn't have these good lessons to share with you today." Li was interviewed by OCTANe's Luis Vasquez as part of the ongoing Entrepreneurs Forum@UCI, which is held two Fridays a month in the Calit2 building.

Tapping into Technology

Most of the 125 people who attended H2Ology, the Igniting Technology event held in November at Calit2, were probably aware that a serious global water crisis is afoot. After watching the 15-minute film "Running Dry: A Call to Action" that opened the event, they knew it for certain. What they might not have realized, though, is the role information technology is playing in the race to solve the problem and avert an all-out disaster. Four researchers discussed their various efforts, including tracking and providing ready access to previously inaccessible data, translating scientific information for policymakers, monitoring quality and educating consumers – all enabled by the unlimited potential of information technology. A Washington, D.C.-based venture capitalist rounded out the presentations by acquainting the audience with new international partnerships and business models that are forming as water becomes the new gold. Igniting Technology is a semi-annual program sponsored by Knobbe Martens Olson & Bear LLP.

Zeiss Center Welcomes Upgrade

The Carl Zeiss Center of Excellence received a new Ultra Plus field-emission scanning electron microscope in February, replacing an earlier model. The upgrade, one of the benefits of the Calit2 partnership with Zeiss, dramatically improves the imaging quality of insulating materials, such as polymers and ceramics, which are intrinsically challenging to image. Instruments are upgraded regularly, enabling company representatives to use the lab as a demonstration facility, while researchers have access to the newest equipment. Lab manager John Porter and graduate student assistant Mai Ng got a closer look at the new microscope while it was being installed by John Laughlin, a Zeiss field service engineer. The Zeiss Center opened in the Calit2 Building in the spring of 2006.



Participants Enjoy Lifelong Learning

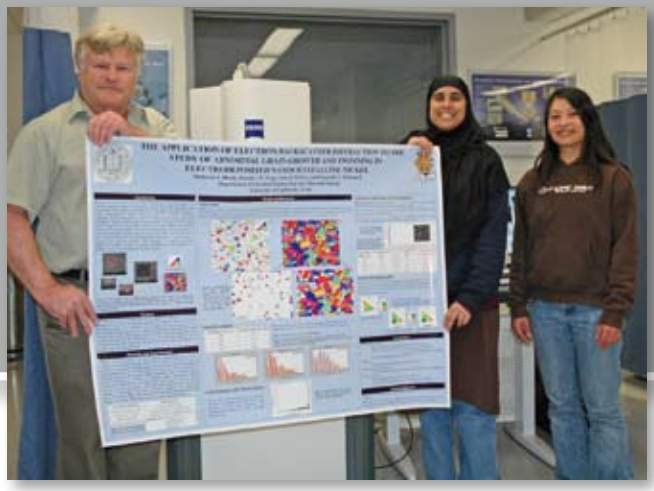
For the third consecutive year, members of the Osher Lifelong Learning Institute participated in a series of Calit2 presentations. The November program featured three primary research initiatives: green-IT, eHealth and digital learning. Each topic was presented by several researchers working on various aspects, such as Department of Education professor Rebecca Black's "Fanfiction University" project. After the series was complete, attendees indicated they had learned about useful IT applications and creative, multidisciplinary research approaches. Organizer George Hume said "brief survey results are proof that again the classes were an excellent, very worthwhile experience." OLLI, which offers programs and classes for seniors, is managed by UCI Extension. Calit2 plans to partner with the group for another round of learning next fall.

Noted Scientist Shares Expertise

On a visit sponsored by the British Consulate, materials scientist Valerie Randle spent three days at Calit2 working with graduate students to enhance their understanding of electron backscatter diffraction (EBSD). She concluded the visit by giving a public seminar on the latest developments in EBSD based on advances in technologies. Randle has been eminent in her field for more than 20 years and is the recipient of the Institute of Materials' Rosenhain Medal. She currently directs the Materials Research Centre at Swansea University in Wales, UK. Her visit to UCI in November was part of an initiative to promote British and Southern California university collaborations. It followed an earlier visit by a research delegation from the University of Warwick, UK, to learn more about Calit2's Zeiss Center of Excellence.

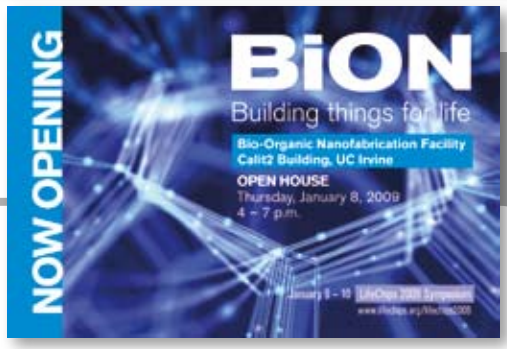
Students Win Microscopy Awards

Two UCI students who work in Calit2's Carl Zeiss Center of Excellence won awards at this year's Southern California Society for Microscopy and Microanalysis Symposium held in March at UCLA. The awards were given for the best student platform presentation and the best student poster. Anh Duong (far right) received a $500 check for her presentation "3D Reconstruction of Solid Oxide Fuel Cell Cathodes using FIB/SEM." Shehreen Dheda received $300 for her poster "The Application of Electron Backscatter Diffraction to Study Abnormal Grain Growth and Twinning in Nanocrystalline Nickel." The awards will support travel to Richmond, Va. for the Microscopy Society of America's annual meeting in July.



Calit2 Irvine Launches Division Site

In an effort to better inform its local audience, Calit2@UCI announced the launch of its Irvine-specific Web site, *www.calit2.uci.edu*. The site focuses on the division's research activities, current projects and campus participation, and provides numerous ways for the campus and surrounding business community to get involved. Calit2 Building-specific information is also featured on the new site. An online reservation system allows users to check meeting room availability, including the atrium and auditorium, before making a request. Detailed information about the facility's labs and project rooms includes manager contact information and a system for reserving time on equipment in the first-floor clean rooms and microscopy center. The site also features the division's upcoming events and an easy link for requesting inclusion on Calit2@UCI mail lists. In addition, a newsroom contains news and feature stories, as well as current and back issues of *Interface* magazine.



Building Things for Life

The new year ushered in the opening of Calit2's Bio-Organic Nanofabrication (BiON) facility. The series of clean-room labs located on the building's first floor offers unique prototyping capabilities for building next-generation microdevices for the biomedical and biotech industries. BiON specializes in using organic and natural materials such as polymers, hydrogels, proteins and tissue. The new facility will serve as Southern California's innovation incubator for the development of advanced healthcare technologies. Potential users got a first look at BiON during the Calit2 Building Open House, which also featured lab tours, project demonstrations, shared-use equipment resources and opportunities for future collaboration.

You Make Me Feel Like Dancing

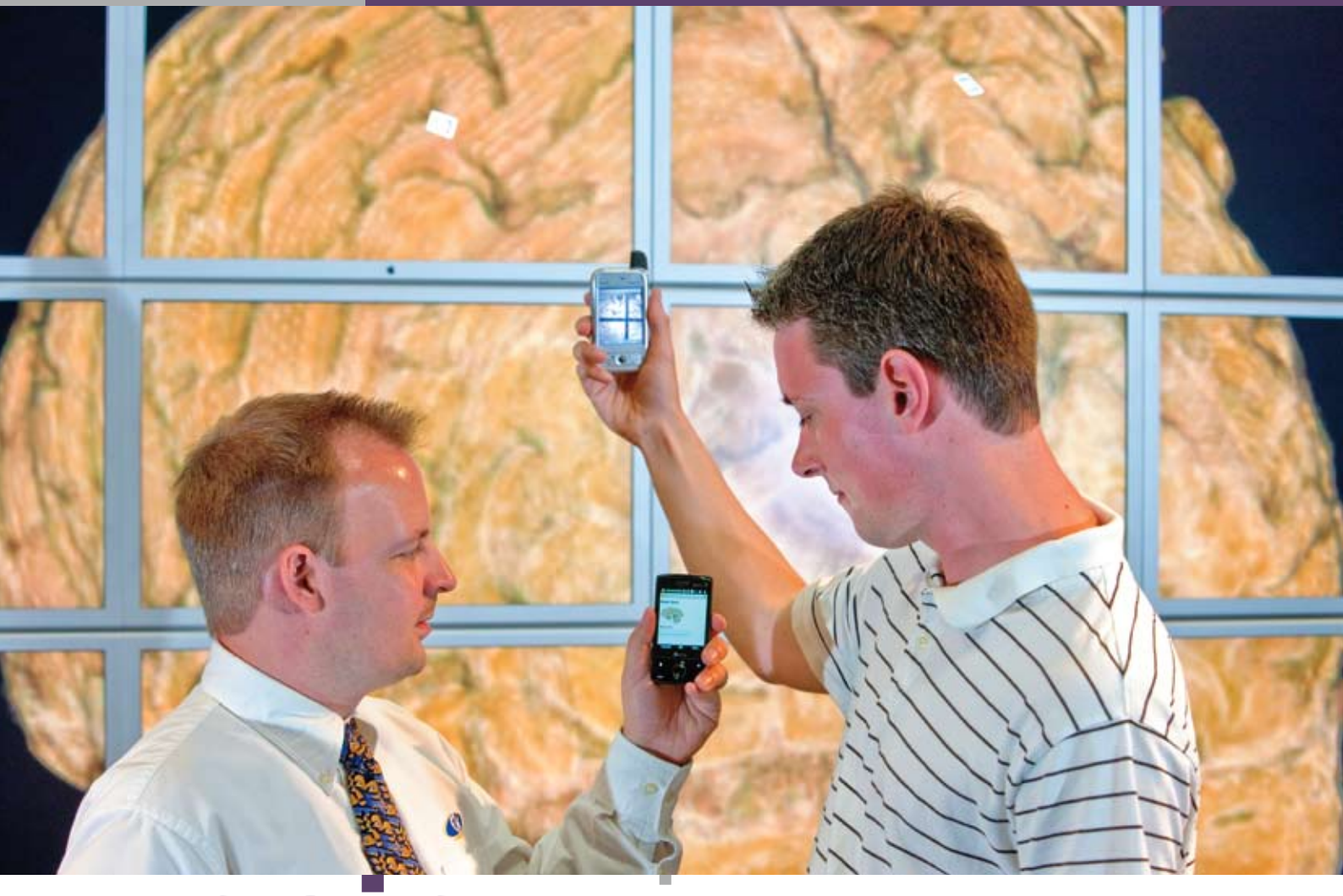
There were no judges, but those passing through the Calit2 atrium in early November had a chance to do some dancing with the stars, albeit virtually. Participants twirled with talented instructors in the Dance-IT kiosk via pre-recorded lessons. The interactive exhibit teaches dance styles from around the world, enabling individuals to select a style on a screen menu, and then watch, learn and dance along. Dance-IT is the creation of Calit2 eMedia Studio director John Crawford, who says "the goal of the project is to explore a new way of experiencing dance using digital media." Technology embedded in the kiosk records and alters the perspectives of visitors' dances and then replays a montage on screens for passers-by to enjoy. Crawford is working on plans to have a series of kiosks installed in various locations around the world and connected over a high-speed network, allowing participants to collectively share their experiences.

The California Institute for Telecommunications and Information Technology is a two-campus multidisciplinary research institute. In collaboration with its sister institute at UC San Diego, Calit2@UCI develops innovative projects that integrate university expertise with industry experience. The result: IT-based solutions that benefit society and ignite economic development.

University of California, Irvine
California Institute for
Telecommunications and
Information Technology
4100 Calit2 Building
Irvine, CA 92697-2800

NONPROFIT ORG.
U.S. POSTAGE
PAID
Santa Ana, CA
Permit No. 1106

Calit2



brainquiz

Think you're a real brainiac? An interactive quiz developed by two Calit2 researchers based on an anatomical map of the human brain may prove otherwise. The software, developed by assistant professor Joerg Meyer (left) and researcher Sebastian Thelen, lets users scan small tags on the surface of a large 3D brain image with a cell phone camera. The user enters the name of the tagged region; the answer is transmitted over a wireless network and a Web page displays on the cell phone instantly indicating the accuracy of the choice.

"The system makes use of the 800 megavoxel 3D rendering capabilities of HIPerWall and uses a cell phone as a universal input and display device," says Meyer, "making a seamless, interactive application."

(Brain data set provided by Arthur L. Toga, UCLA)