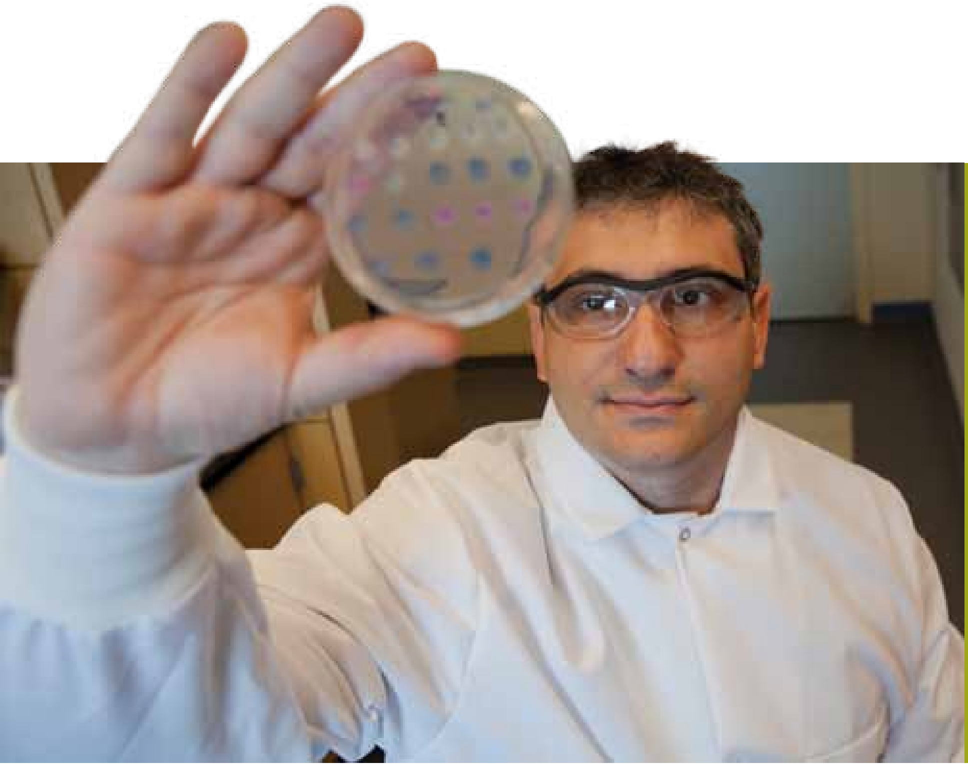
UC DAVIS COLLEGE OF ENGINEERING

ENGINEERING progress

Summer 2013



"WE TAKE BACTERIA — *E. COLI*, FOR EXAMPLE — AND EVOLVE IT FOR A THOUSAND GENERATIONS, IN ANY ENVIRONMENT YOU CAN IMAGINE."

◀ Ilias Tagkopoulos, assistant professor, Department of Computer Science

DESIGNING ORGANISMS
AND PREDICTING THEIR BEHAVIOR

By Derrick Bang

"...THE FUTURE, LIKELY WILL COME DOWN TO ENGINEERING ORGANS, AND EVEN LIFE."

IN AN ALTERNATE UNIVERSE, Ilias Tagkopoulos might not have joined the UC Davis College of Engineering faculty.

Tagkopoulos' parents are mathematicians, and he grew up fascinated by both problem-solving and biology. "I was amazed by the complexity of everything," he laughs, remembering his boyhood self. "There are so many fascinating things in the world."

He graduated with a diploma in electrical and computer engineering in 2001 from Greece's University of Patras. He then moved to the United States, and Columbia University, where he embraced "an amazing project" to build the first *in silico* simulation of gene regulatory networks.

"We designed and fabricated a mixed-signal integrated circuit, with roughly 200,000 transistors, that mimicked molecular and regulatory processes for 20 gene pathways. The analogies between electrical and biological circuits were exploited: For example, the diffusion of electrons within electrical wires, was used to simulate the diffusion of biomolecules within a cell.

"That's how I got hooked on biology."

After earning a master's in electrical engineering from Columbia in 2003, and wanting to continue applying engineering approaches to biology, Tagkopoulos focused on computational and synthetic biology during his doctorate work at Princeton University, where he also was affiliated with the Lewis-Sigler Institute for Integrative Genomics. He obtained his Ph.D. in July 2008, in electrical engineering, and immediately fielded an offer from UC Davis.

But he requested a one-year deferment, wanting to "try industry for a little bit."

Nothing particularly unusual in that, but at least a few eyebrows must have lifted when Tagkopoulos took a job as a quantitative associate with Credit Suisse, one of the world's leading financial services companies. He acted as a liaison between modeling, programming and business teams, and supervised the development of quantitative financial models and solutions.

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"MOST TRADITIONAL SENSORS RELY ON SOME ELECTRICAL INPUT... THAT'S A FUNDAMENTAL DISADVANTAGE... IF YOU'RE MONITORING A BUILDING AND THE POWER GOES OUT."

◀ Ken Loh (right), assistant professor, Department of Civil and Environmental Engineering

SAFER STRUCTURES THROUGH NANOTECHNOLOGY

By Derrick Bang

THE YEAR 2013 started with a celebratory roar for Ken Loh, an assistant professor in the Department of Civil and Environmental Engineering.

In February, he received a $400,000 National Science Foundation CAREER Award; in April, he was named a Fulbright Scholar by the U.S. Department of State's Bureau of Educational and Cultural Affairs.

Loh earned the CAREER Award for his project, "Integrated Research and Education on the Electro-Mechanical Behavior of Multifunctional Structural Coatings." The award validates research that dates back to his postgraduate work at the University of Michigan, where he obtained twin master's degrees — in civil engineering, and materials science and engineering — and a doctorate, while developing new thin-film technologies based on carbon nanotubes.

"I wanted to create very thin coatings that could be applied to various types of structures — buildings, bridges, aircraft, spacecraft — with the objective of monitoring how these structures perform, and pinpointing any types of damage that might occur over their operational lifetime," he explains. "The idea is to paint such materials onto the structures, and the materials would have various types of engineering functionalities: generating electricity; absorbing energy; and detecting or preventing damage, such as corrosion."

Loh hopes to improve upon existing structural analysis techniques that are cumbersome, impractical and often unreliable.

"A structure such as the Golden Gate Bridge is huge," he suggests. "How could you possibly crawl through the entire structure to identify a 2-inch crack, when that crack might be the only reason the bridge could collapse? Current methodology is based on labor-intensive visual inspection, which also is very costly in terms of time."

Loh's proposed solution: a sensor coating dubbed BISON, for Bio-Inspired Opto-Electronic Nano-Composite material. The coating begins in the liquid phase and therefore could be incorporated into paints and spray applicators. Additionally, Loh and his team are developing ways to free this coating from conventional power sources.

"Most traditional sensors rely on some electrical input — batteries, power supplies — for their continued operation. That's a fundamental disadvantage for even simple applications. If you're monitoring a building and the power goes out, what do you do?

"So we're developing a new structural coating that doesn't require any electrical power. You could paint this material onto, say, a spacecraft; if you have ambient light or sunlight, the material acts like a photo cell and generates electricity. And the amount of energy it generates correlates precisely to any amount of damage that has occurred.

"This same technology can be applied to any structure with the coating; once we can measure changes in this energy, we can use algorithms to back-calculate the coating's conductivity, which will give us a map that tells us where any damage is located, and its severity."

BISON was the first of several such projects to incorporate Loh's multifunctional coating materials. The CAREER Award will help Loh and his team focus on another project that involves wind turbines.

"My group essentially knows *what* these materials can do, but we want to understand *how* they behave in such a fashion, and *why*. The CAREER Award recognizes our goal to create a computational model, at very small length scales — from the micro-scale to the tangible-length scale — that will allow us to predict how the coating's spaghetti-like network of polymers and carbon nanotubes will behave mechanically, if we put it on a wind turbine blade. What strength will it have?

"We want to validate that with experiments, and the award lays down the foundational work, so we can better understand how these materials behave physically, mechanically and electrically. And why they deliver their sensing behavior."

But the coating is only half the equation. Such materials may delivers readings, but the information then must be read and interpreted.

"Data acquisition is a very challenging aspect of this project," Loh agrees. "We want to develop wireless systems: remote 'nodes' that would serve as mini-computers, responsible for the aggregation and processing of data, and of sending it upstream via a cellular or WIFI network."

Such nodes would be attached to the coating and then could be preprogrammed or commanded on the fly, via the Internet, and told when and how to collect data.

Still another goal involves the desire to remove the human element; the system isn't ideal if people are required to monitor the results 24/7.

"The whole point behind having new sensors isn't merely to collect information on how the structure performs. We want all this to occur autonomously. We're adding an active system of hardware connected to these coatings, and computers to acquire the data. Our role also is to design these technologies, and these algorithms, such that the data can be processed and boiled down to some type of engineering judgment. Yes, the structure is safe; no, it isn't."

Loh also recognizes a related goal that remains further in the future.

"The big unknown, moving forward, is to better *analyze* the data. If a bridge or wind turbine blade has a crack, what does that mean? Will the crack just stay there, and not get larger? If it does get larger, how fast will it grow? What does that mean, in terms of the service life of the structure? At what point do we intervene, and attempt to repair it?

"Prognosis is the biggest challenge in our field."

Depending on the degree to which a structure is compromised, and the nature of the event causing the damage, such information also might require a quick response.

"This approach is very computationally intensive; a computer must think a lot, and quickly, in order to provide a solution. One of my former students collaborated with a colleague in the Department of Mechanical and Aerospace Engineering, and came up with an updated algorithm that could perform this calculation in near-real time. That's critical, if you wish to visualize damage, and how the structure is performing."

An open-ended research project of this magnitude would be enough for most scientists, but in the near future — thanks to the Fulbright Scholarship — Loh will spend some time at National Taiwan University in Taipei City, Taiwan. The scholarship will support his collaboration with colleagues there, in a project designed to better understand "bridge scour" — the erosion of earth at bridge foundations, by flowing water — with the goal of preventing collapses.

Bridge scour is a leading cause of bridge failures worldwide. This study hopes to validate a new sensing system that can measure 3-D "scour hole evolution" in space and time. Data from large-scale testing performed during this project will be used to improve and update fluid-structure models for evaluating bridge foundation degradation. The model results and assessments of current design practices will be used to improve future design codes in the United States and Taiwan.

"I truly believe that this field is transformative, and will change the way the world does things ... whether or not we like it!"

ALUMNA SERVES AS JUDGE ON NEW DISCOVERY REALITY SHOW

Christine Gulbranson, who earned a bachelor's, master's and Ph.D. in materials science and engineering from UC Davis, served as one of two regular judges on the Discovery Channel reality TV series, *The Big Brain Theory: Pure Genius*, broadcast in May and June. This is quite a shift for a scientist cited as one of MIT's "Innovators for the 21st Century," and as one of the "Top 40 Under 40 Business Leaders in Silicon Valley," for her efforts as a nanotechnologist, renewable energy innovator and corporate strategist. But Gulbranson understands that her new media visibility has the potential to shape younger viewers who otherwise might not contemplate STEM careers.

"If we get kids to see that they can build something — that it is fun, sexy and attainable — then we can get them excited about it, and that's what we need for our economic engine." Gulbranson shares her experiences via Twitter at @cgulbranson.

— Derrick Bang

THROUGH THE GRID: IMPROVING SUSTAINABILITY OF POWER TRANSMISSION

By Derrick Bang

"IT'S NOT SUSTAINABLE TO SIMPLY GROW THE WAY WE CONSUME POWER TODAY. EFFICIENCY MUST IMPROVE…"

MANY FUTURE ENGINEERS have creative, gadget-laden childhoods; they're ham radio operators or science fair winners. Maybe they own model train layouts or they take cars apart.

"That wasn't me," Anna Scaglione laughs. "I played with dolls, like all the other girls I knew. And I come from a family of lawyers, not engineers."

Sometimes, though, late starters are the hardiest bloomers. Today, Scaglione is a professor in the Department of Electrical and Computer Engineering. Her research focuses on communication networks and information systems, with an emphasis on wireless networks and sensor networks. To use the buzz phrase *du jour*, she's fascinated by the potential that waits to be exploited by smart grids.

Her research acumen has been acknowledged on several occasions, most recently when the Institute of Electrical and Electronics Engineers selected her to receive the 2013 Donald G. Fink Award, which pays tribute to "researchers, inventors, innovators and practitioners whose exceptional achievements and outstanding contributions have made a lasting impact on technology, society and the engineering profession." She shares this honor with colleagues Stefano Galli and Zhifang Wang, for their paper *For the Grid and Through the Grid: The Role of Power Communications in the Smart Grid.*

Scaglione's goal: to help us utilize power more efficiently and sustainably.

She completed her doctorate in 1999, at the Sapienza University of Rome. During that time, she developed a research correspondence with Georgios B. Giannakis. He invited her to join him at the University of Minnesota, and subsequently became her post-doctoral adviser. (Giannakis now is the University of Minnesota's ADC Chair in Wireless Communication.) After a year with Giannakis at the University of Minnesota, she taught at the University of New Mexico and then Cornell University. In 2008, Scaglione joined UC Davis as an associate professor.

By this time, she also had solidified her interest in the growing need to improve her adoptive country's energy grid.

"Coal and natural gas are very cheap in the United States," she explains, "and they have a characteristic that we like a lot: They're reliably dispatchable. The power system is organized so that if I plug in an appliance, I draw power, as if this is a commodity that has to come to me, like water into a sink.

"What I actually want, though, is a certain service: certain work performed. And this service has a laxity that isn't exploited currently. If one wishes to use a dishwasher, for example, this doesn't necessarily need to happen when we hit the switch; the work need not be done until the next time we need clean dishes."

The concept of "scheduling" power tasks will become a much larger issue once electric vehicles become more common. Drivers will need their vehicles to be charged between trips, possibly at a competitive rate, and certainly at a convenient time.

"All sorts of applications could, by better sensing and describing the objective of the work the appliance will perform, incorporate an improved flexibility that would help utilize renewable 'green electrons' — from, say, solar panels or wind farms — instead of the electrons being dispatched by coal.

"This type of science already is utilized to manage computer servers, networks and memory storage via the Internet. It's just a matter of modeling the problem, for the energy grid, in a way that's different from what has been done so far, and to do it large-scale: not just the solar panel on your roof, but all the solar panels present in a community."

There is, however, an inherent problem: Clouds can unexpectedly obscure the sun; winds can suddenly diminish and stop.

"All power engineers recognize the control bottleneck. Their standard methods of dealing with system control, safety and reliability would be significantly compromised if we start adding wind and solar power, without compensating for the variability of that source."

Attention must be paid, as well, to the ideal medium in which to perform the necessary informational transactions. Scaglione points to a ubiquitous real-world example that could offer a solution. "We've become comfortable with smart phones that are charged via something with a USB port. My research proposes the same sort of power line for two-way communication. You'd therefore use the USB port to charge the device and communicate data about the type of work the appliance needs.

"Additionally, you want to monitor power consumption — describe it, for auditing purposes — in order to determine the desired injection of power, in order to charge a battery or run a dishwasher. Could some of these service tasks be described ahead of time, or parameterized, so that an intelligent infrastructure could react to them, and allocate resources optimally?"

This captivating line of research earned Scaglione, Galli and Wang their IEEE Fink Award. Scaglione describes their paper as a tutorial: "It reviews what we know about potentially using this medium to transmit such information, along with the challenges to organize this on a wide scale, as a network that would deliver such control.

"I already have some answers, such as how I would model the interactions between intelligent appliances and potential servers. I also have models on how to synchronize the activities of such networks. And I have some ideas on how to connect to the existing infrastructure of today's energy market.

"But it's a big puzzle, and many people need to contribute, in order to complete it."

A sidebar benefit likely would prevent the sort of chaos that erupted in September 2011, when an error by a single worker at Arizona's North Gila power substation led to a massive power outage that left millions of people without electricity in Arizona, Southern California and Mexico. "That sort of accident highlights the fact that the sensing infrastructure isn't always well-maintained ... or relied upon," Scaglione points out. "Also, a lot of dispatch decisions are made ahead of time; the use of real-time information is limited, and somewhat myopic. This sort of problem results from not relying more on sensing and real-time information, for the management of the commodity that the network delivers."

No matter how inspired some of Scaglione's suggestions, however, they'll be resisted by those with a significant financial investment in the existing infrastructure.

"Some power engineers have suggested that we should adopt guerilla warfare," Scaglione smiles, "in order to surround the entrenched 'core' of the grid with a much smarter periphery, and then conquer by edging inward. Eventually, we'll force the middle to better utilize resources."

The refrain is becoming more common: Moving forward, power allocation must be more efficient.

"I don't intend to paint a doomsday picture for existing power transmission. But it's not sustainable to simply grow the way we consume power today. Efficiency must improve, and we must stop thinking that we always can deliver power 'just in time,' and that the customer always will receive electron transfer as if it's available — and cheap — at all times.

"Sustainable development is the question that faces this generation. I want to help today's students experience what I felt, when I was graduating: I believed I was contributing to an infrastructure that would be great for humanity. I'm very idealistic; I still feel that way. One needs some sense of idealism, to contribute something exciting.

"And this discipline can be exciting."

"SUSTAINABLE DEVELOPMENT IS THE QUESTION THAT FACES THIS GENERATION. I WANT TO HELP TODAY'S STUDENTS EXPERIENCE WHAT I FELT, WHEN I WAS GRADUATING…"

Anna Scaglione, professor, Department of Electrical and Computer Engineering ▶

DEAN ENRIQUE LAVERNIA ELECTED TO THE NATIONAL ACADEMY OF ENGINEERING

ENRIQUE LAVERNIA, dean of the College of Engineering has been elected to the National Academy of Engineering, the highest professional distinction for an engineer. Lavernia was elected "for contributions to novel processing of metals and alloys, and for leadership in engineering education." Lavernia is the 17th current or retired member of the UC Davis faculty to be elected to the prestigious academy.

"I am truly honored by this recognition," Lavernia said. "This is a tremendous acknowledgement of the research achievement, teaching excellence, and public service accomplishments at UC Davis and our College of Engineering. I couldn't have accomplished so much without the tremendous efforts of my graduate students, research assistants and academic colleagues. I also have been very fortunate to have outstanding support from UC Davis leadership, which has been critical to the growth of our college."

Lavernia also holds the position of Distinguished Professor in the Department of Chemical Engineering and Materials Science. His research interests are principally in processes to make nanomaterials: materials made up of very small particles giving them unusual properties.

During Dean Lavernia's tenure, the College of Engineering has seen its research expenditures grow from $37.3 million (2001–02) to more than $87.1 million (2011–12). Undergraduate enrollment has increased from 3,317 (2001–02) to 3,852 (2011–12), while graduate enrollment has grown from 768 (2001–02) to 1,252 (2011–12). Dean Lavernia also has demonstrated a significant commitment to faculty, staff and student diversity, resulting in the College of Engineering ranking 6th (of 309) in the U.S. for percentage of female faculty.

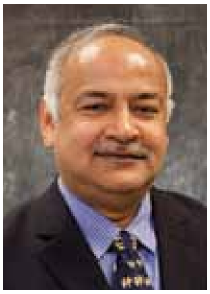
IMPROVING NATIONAL SECURITY

A UC Davis graduate student team, consisting of **YURIY ZRODNIKOV, KONSTANTIN ZAMURUYEV** and **JOACHIM PEDERSEN**, participated in the final judging of the annual National Security Innovation Competition in April. The competition, hosted by the National Homeland Defense Foundation (NHDF), challenges students to conduct research on concepts and technologies intended to improve our national security.

NSF AWARDS GRANT FOR TRANSPORTATION RESEARCH

The National Science Foundation (NSF) awarded a new grant titled "User-Centric Sensing And Distributed Control Of Corridor Transportation Networks" to UC Davis Professors **MICHAEL ZHANG, CHEN-NEE CHUAH** and **DIPAK GHOSAL**. The grant, effective July 2013, enables a truly interdisciplinary research effort, combining vehicular traffic engineering, wireless networks, mobile sensor networks, and distributed computing.

SECOND COMPANY "GRADUATES" FROM UC DAVIS TECH INCUBATOR



Biswanath Mukherjee

Ennetix, a startup firm based on research conducted at UC Davis, has graduated from the university's tech incubator, the Engineering Translational Technology Center (ETTC). Ennetix is the second firm to exit the ETTC, following the May 2012 launch of Dysonics, an audio technology company that received $750,000 in private investment after less than a year of ETTC residency.

Founded by UC Davis engineering distinguished professor **BISWANATH MUKHERJEE**, Ennetix commercializes university research on network topology optimization and adaptation. Ennetix, formerly named PutahGreen Systems, currently offers a software application called "EnergyPlus," which optimizes energy use in IT networks and connected systems.

The Engineering Translational Technology Center was established in 2010 to help technology startups, based on intellectual property developed at the UC Davis College of Engineering, attract support from external financial investors. ETTC assesses the commercial potential and developmental readiness of faculty research in determining admission into the incubator. There are currently 10 startup companies resident in ETTC.

ETTC is one of several initiatives at UC Davis designed to foster entrepreneurial activities and translational research on campus and facilitate effective technology transfer and new company creation as a means of achieving the university's mission of service to people and society. Since 2004, more than 40 new companies have been spun off from UC Davis research. The university held 375 active patents at the end of the 2011 fiscal year.

$120 MILLION GRANT FUNDS MATERIALS RESEARCH CENTER

Alexandra Navrotsky

The U.S. Department of Energy has awarded a five-year, $120 million grant to Ames National Laboratory to create a new research center, the Critical Materials Institute (CMI), which will bring together leading researchers from academia and four Department of Energy national laboratories, as well as the private sector. UC Davis professor **ALEXANDRA NAVROTSKY** will be among the contributors to this major research project.

UC DAVIS AND TEXAS A&M TEAM RECEIVE NSF GRANT

Valeria LaSaponara

UC Davis professor **VALERIA LASAPONARA** received an NSF grant for a joint effort with Dr. Anastasia Muliana from Texas A&M titled "Fatigue and Lifetime Performance of Polymer Sandwich Constructions: A Multi-Scale Experiment and Modeling Approach." LaSaponara directs the Advanced Composites Research, Engineering and Science (ACRES) lab with the goal of improving safety in fuel-efficient composite structures for aerospace, mechanical and civil engineering applications.

NAE GORDON PRIZE WINNER

Richard K. Miller

UC Davis College of Engineering alumnus **RICHARD K. MILLER** earned the National Academy of Engineering's Bernard M. Gordon Prize. The Gordon Prize, developed by NAE to recognize new modalities and experiments in education that develop effective engineering leaders, is shared by Miller and his colleagues David Kerns and Sherra Kerns for their teaching ingenuity.

BIOLOGICAL AND AGRICULTURAL ENGINEERING HONORS

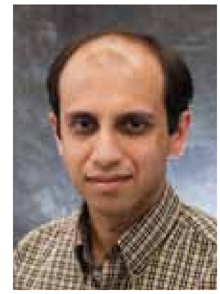
The American Society of Agricultural and Biological Engineers (ASABE) has bestowed three of its highest awards to three professors from the Department of Biological and Agricultural Engineering: **PAUL SINGH** (Massey-Ferguson Educational Gold Medal), **SHRINIVASA UPADHYAYA** (John Deere Gold Medal), and **WES WALLENDER** (Hancor Soil and Water Engineering Award).

OWENS TO LEAD DEVELOPMENT OF OPEN SOURCE GPU PLATFORM

The Defense Advanced Research Projects Agency (DARPA) pledged funding totaling $2M to SYSTAP LLC to develop an open source platform for accelerated and real-time analytics on GPU compute clusters. As part of this project, **JOHN OWENS**, an associate professor in the Department of Electrical and Computer Engineering, will lead the development of an open-source, scalable, multi-node, out-of-core graph library on graphics processing units (GPUs).

PROFESSOR HONORED WITH AWARD FOR RESEARCH IN FOOD SCIENCE

The Institute of Food Technologists (IFT) honored UC Davis professor **NITIN NITIN** with the Samuel Cate Prescott Award for his outstanding research within the field of food science and technology. An assistant professor in the Department of Biological and Agricultural Engineering, Nitin conducts research in the development and validation of nonthermal food processing operations for food safety and the engineering of food formulations to improve bioavailability.



Nitin Nitin

ZHENG RECEIVES BEST POSTER AWARD

The Minerals, Metals & Materials Society honored **BAOLONG ZHENG**, an assistant project scientist in the Department of Chemical Engineering and Materials Science, with an award for the TMS Light Metals Magnesium Best Poster Award. Zheng received this award for his work at the TMS 141st Annual Meeting and Exhibition in January 2013, where more than 3,500 materials scientists and engineers from more than 68 countries gather to exchange their knowledge and expertise in order to further advance the fields of metallurgy and materials science and engineering.

Baolong Zheng

WHITLOW RECEIVES MARTIN LUTHER KING, JR AWARD

The African-American Faculty and Staff Association at UC Davis presented the 2013 Martin Luther King, Jr. Social Justice Award to **TANYA WHITLOW**, a student affairs officer in the Dean's Office of the College of Engineering. The inaugural award was presented to Whitlow at the association's January luncheon, presented at the Student Community Center.

Tanya Whitlow

NSF GRANTS THREE-YEAR AWARD FOR PLANT SCIENCE RESEARCH

The National Science Foundation has granted a three-year, $185,000 award to **CRISTINA DAVIS**, a professor in the Department of Mechanical and Aerospace Engineering, for research to more accurately measure volatile organic compounds (VOCs) to further enable plant science research. Davis' project is titled "IDBR: Portable monitoring device for off-gassed volatile plant metabolites." All plants and trees produce VOCs as a normal byproduct of baseline physiological processes. These VOCs enable a unique, non-invasive route to assess plant health, infection, nutrient stresses, and many other important biological questions.

Cristina Davis

NEW LEADR STUDENT CENTER LAUNCHED

The College of Engineering opened the **LEADERSHIP IN ENGINEERING ADVANCEMENT DIVERSITY AND RETENTION (LEADR) STUDENT CENTER** with a special event on January 24. Located in Room 1050 of Kemper Hall on the university campus, the new LEADR Student Center is intended to improve retention of undergraduate engineering majors.

Created with leadership support from the Chevron Corp., and additional contributions from the Boeing Comp., Cisco Systems, Northrop Grumman Corp., and Union Pacific, the LEADR Student Center represents the first industry investment at UC Davis devoted to student retention.

The LEADR Student Center is open to any student who supports diversity and inclusion in the field of engineering, and who shares a willingness to create a welcoming environment for all students, including those historically under-represented in the engineering majors.

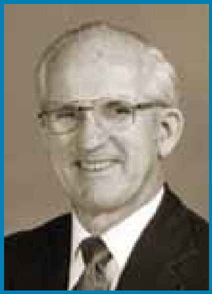
The LEADR Student Center features a student study center, and offers easy access to academic advising, tutoring, graduate school prep, club engagement, and more. The UC Davis College of Engineering has long been dedicated to the goal of fostering a vibrant community of learning and scholarship.

STUDENTS RECEIVE HYDROGEN RECOVERY SYSTEM AWARD

Undergraduate students from the Department of Chemical Engineering & Materials Science led by **IRENE (MENGJING) YU**, recently placed third in the US-wide student hydrogen recovery system design competition. The student team—**MENGJING YU, SUZANN MUY, FARAH QUADER, ABIGAIL BONIFACIO, ROSHNI VARGHESE, ELISHA CLERIGO, MAYA BIERY** and **MAGGIE MEI**—has had its report published in the *International Journal of Hydrogen Economy.*

REMEMBERING GERALD ORLOB

A devoted group of 50 friends, colleagues and family members shared memories about UC Davis Professor Emeritus **GERALD ORLOB**, during a "Celebration of Life" that took place April 14 at UC Davis' Ghausi Hall.



Gerald Orlob

Dr. Orlob died peacefully in his sleep in Poulsbo, Wash., on March 23. He was 88 years old. During a career rich with research success and professional acknowledgments, he was best remembered here as an instructor of graduate courses in the UC Davis Department of Civil Engineering, during a lengthy tenure that ran from 1968 until his retirement in 1991.

Speakers at the April 14 event included Professor Emeritus George Tchobanoglous, Professor Emeritus Len Herrmann and Professor Lev Kavvas, of the Department of Civil and Environmental Engineering, along with several of Dr. Orlob's former graduate students, each of whom has gone on to a prestigious career.

Recalling that Dr. Orlob and his wife, Lillian, always called his graduate students "Jerry's kids," Jamie Anderson — former student — concluded her short talk by saying, "I am a happier person and a much better engineer, and my life has been infinitely richer for having been one of Jerry's kids."

TAGKOPOULOS' INTEGRATIVE SYNTHETIC BIOLOGY LAB'S PRIMARY MISSION INVOLVES UNDERSTANDING AND ENGINEERING BIOLOGICAL ORGANISMS AT THE SYSTEMS LEVEL.

◀ Ilias Tagkopoulos, right

TAGKOPOULOS *continued from page 1*

In other words, his responsibilities were about as far removed from systems and synthetic biology as could be imagined. But it made perfect sense to Tagkopoulos.

"I've always been interested in creating predictive models for complex systems. The value of any prediction is how close it comes to reality. Predicting the fair value or price movement of financial instruments is a challenging problem with many unknowns and dependencies. In many ways, this is also what the case in biology, just instead of stocks and bonds, you have genes and proteins.

"It was an interesting experience, because of the system complexity, environment and way of thinking. In contrast with academia, the timescales for projects and actions are shorter and with palpable results. This creates excitement, additional pressure and less profound understanding of the system dynamics. In some cases, the models become very complex to fully comprehend and over-reliance in the suggestions that they offer can have devastating results, as it was the case in the recent financial melt-down driven by the mortage-backed securities."

Despite the challenges and rewards in Investment Banking, Tagkopoulos was looking forward to join the Department of Computer Science and UC Davis Genome Center, which he did in late 2009. While he misses the experiences, colleagues and rewards the fast-paced financial world has to offer, he finds the research atmosphere more comfortable and trying to extend human knowledge a more noble pursuit. The research "atmosphere" was more comfortable, and he happily returned to the challenging realm of bioengineering.

His Integrative Synthetic Biology Lab's primary mission involves understanding biological organisms at the systems level.

"It's more of a holistic perspective," he explains, "as opposed to looking at individual genes or components. We study how they interact with each other, and the resulting emerging properties.

"Our lab focuses on two areas. The first is adaptive laboratory evolution of bacteria, where we take bacteria and evolve it for a thousand generations in various complex environments. For example, we may add more salt, toxic compounds, or adjust temperature and pressure. We then study how bacteria adapt in stress combinations, what beneficial mutations arise and what the effect of those mutations is. In some cases, we are looking for hints of emergent mechanisms and behavior, such as associative memory or bet-hedging strategies, which are more difficult to find and provide a window to bacterial physiology.

"Our second focus involves developing the computational tools and infrastructure in order to enable synthetic biologists to build reliable circuits faster. We borrow ideas from electrical engineering and circuit design to create the computational and algorithmic framework for synthetic circuit design. We then use these tools to build gene circuits that we validate experimentally.

The best part, Tagkopoulos feels, is that he and his team are able to work both sides of a research problem.

▼ Concept of the mobile game app in development

"Our approach is behaviorally interdisciplinary: Half of my lab is computational, and the other half is experimental. So, for example, when doing synthetic biology — the bioengineering of genomes — we build computational tools that will predict the behavior of the organism, once we insert certain genes. Then we go to the experimental half and actually construct the circuit."

Tagkopoulos' work in synthetic biology came to the attention of the National Science Foundation, which in February honored him with an Early Career Development award in the amount of $600,000. The award recognizes Tagkopoulos' use of machine learning, graph theory, mathematical optimization, multiscale modeling and high-performance computing (HPC) simulation methods to address questions in evolutionary, synthetic and systems biology.

"It's quite a challenge," Tagkopoulos admits, eagerness evident in his eyes. "Can we build computational tools that use ideas and models from graph theory and mathematical optimization, in order to predict the behavior of biological systems? Even so, can we create tools to guide us towards the targeted bioengineering of organisms and systems with desired behaviors?"

NSF CAREER Awards come with outreach requirements, and Tagkopoulos does plenty of mentoring work. He belongs to the biophysics, microbiology, electrical engineering and biomedical engineering graduate groups, and he's working with other faculty members to enhance the campus' entry-level courses in computational and synthetic biology.

Tagkopoulos also is one of two faculty advisers — along with Marc Facciotti of the Department of Biomedical Engineering and the UC Davis Genome Center — for the UC Davis IGEM (International Genetically Engineering Machine) Synthetic Biology undergraduate team. Under Tagkopoulos and Facciotti's guidance, the team took gold medals in 2010 and '11, along with a Best Foundational Advance Award in 2011. The 2012 team, responding to the global impact of plastic pollution, explored methods of improving the biodegradation of PET (polyethylene terephthalate), in order to minimize its presence in landfills and oceans.

"We select an undergraduate team each May," Tagkopoulos explains, "and over the summer they work on some kind of experimental or hybrid computational/experimental project. The semi-finals competition is in November, and then MIT hosts the finals. It's a great experience for an undergraduate."

Tagkopoulos also is leading a team of undergraduate and high school students in a project that ccan potentially have a wide reach.

"We're developing an iPhone game app, which we hope will will introduce microbiology and synthetic biology concepts through gaming. The player becomes part of the microbial world, by selecting one of the three kingdoms — archea, bacteria, or fungi — and then growing three to five microbial species. Players must update their base stats, then arm their species with bioengineering plasmids that carry antibiotic resistance genes, toxins and so forth. The players then compete with each other, or the game's AI, in epic battles for world domination.

"The game's biological realism makes it unique among others in its genre. Additionally, players are encouraged to acquire knowledge about various molecules, species, environments and bioengineering techniques, in order to gain an advantage over the other competitors.

Tagkopoulos' biggest problem is finding enough time for all these activities, in addition to his teaching responsibilities and the research work that excites him so much.

"The whole field is in its infancy," Tagkopoulos observes, enthusiasm evident in his tone. "Computationally-driven and system-level methods in synthetic biology today are where VLSI (very large-scale integration) circuit design was in the 1950s and '60s: virtually nonexistent. There was no V, there was no L; at best, it was small-scale integration, with two or three transistors together on a table.

"Any bioengineering tools we construct today will need to be refined over and over again, as libraries of organisms grow, and we have new systems to incorporate. There is a lot of work to do and Davis with its expertise and leading faculty in biotechnology can play a key role towards this endeavor.

"It's very exciting, and it's the reason I'm here at UC Davis!"

Ilias Tagkopoulos, left

▲ Diane Bryant, center

ALUM ENDOWS SCHOLARSHIP FOR WOMEN IN ENGINEERING

DURING AN INTERVIEW given to CNN in February 2011, Diane Bryant cheerfully admitted that she hadn't planned to attend college.

Money also was tight, and Bryant was on her own at 18. She took a couple of waitressing jobs and, having been a good high school student, enrolled at Sacramento's American River College.

She began to focus on engineering only because a fellow student mentioned that job salaries were good. She transferred to UC Davis as a junior engineering undergrad — "I'd never met an engineer; there were no engineers in my family; and I had no clue what I was getting into" — and had her life-changing moment in a "Principles of Device Physics" class taught by Stephen Haley.

"He was the toughest professor I ever had; his tests were incredibly hard, but he was a generous grader. And I fell in love with device physics through his deep knowledge and understanding, and particularly his passion. You'd walk out the door thinking, Wow, this is really exciting."

Bryant graduated with a degree in electrical engineering in 1985. Scarcely an eyeblink later, she was recruited by Intel where today, she's senior vice president and general manager of the company's Datacenter and Connected Systems Group, a recent transition after her stint as the company's corporate vice president and CIO.

She holds four U.S. patents, all received while part of Intel's mobile group.

Bryant is equally devoted to outreach, and particularly concerned by the underrepresentation of women in STEM fields: Only 18 percent of today's computer science and engineering degrees nationally are going to women.

Intel recently surveyed 1,000 students across the United States, ages 13–18 and evenly divided between girls and boys in varying economic situations. Roughly 63 percent had never even considered a career in engineering.

"The problem is awareness," Bryant insists. "The earlier we make kids aware that this is a valuable occupation, the more likely they'll pursue it. We need to tell them, hey, you know the people who saved those Chileans, in the 2010 mining disaster? Those were engineers! Do you know who developed that Facebook app you love so much? Engineers! Do you know who brings clean water to remote parts of Africa? Also engineers!"

She also knows that actions speak louder than words, and has endowed a scholarship, with matching support from the UC Davis Foundation. The Diane Bryant Endowed Scholarship for Women in Engineering is designed to assist, in her words, "a small handful of excited and motivated young women each year" who pursue engineering at the UC Davis College of Engineering.

"I always discuss the exciting things I do as an engineer, when I talk to young students. I tell them to stick with school, because there is value and benefit beyond just getting that A and moving into the next math class."

THE CAMPAIGN FOR UC DAVIS

JOIN DIANE in encouraging women students to pursue engineering at UC Davis. For more information on making gifts that open educational pathways, please contact Oliver Ramsey at 530-752-7412 or owramsey@ucdavis.edu.