UCLA INVENTS

OFFICE OF INTELLECTUAL PROPERTY

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Driving Innovation to Market

CONTENTS

Cover art by Roger Lee

As a public land-grant institution, UCLA has a three-part mission: education, research and service. The three parts are integrated and complement one another.

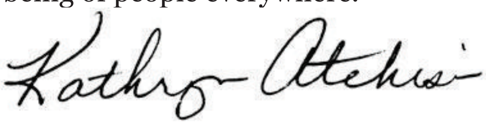
UCLA strives to address its service mission in ways that return benefits to California.

Our technology incubator program, launched last year in the California NanoSystems Institute (CNSI), exemplifies the novel approaches that UCLA uses to address these expectations. The incubator nurtures translational and applied research and speeds the transfer of technology from lab to market, where it can make a real difference in people's lives. As a result, new businesses arise, creating new jobs. Already, UCLA's teaching incubator program has accepted 11 startup companies, seven of which have already moved in.

This issue of *UCLAInvents* highlights several of the incubated companies, along with other UCLA technologies. The products they seek to develop hold astounding promise in such areas as optical biopsy, antibiotic resistance, reconstructive dentistry, heart surgery, imaging, noninvasive medicine, and detection and treatment of cancer. Others could revolutionize wireless communication and early childhood education.

Students play a critical role in the technology transfer process. For example, through the Price Center for Entrepreneurial Studies in the UCLA Anderson School of Management, MBA students help the startups prepare to meet with potential investors, providing market analysis and developing business plans. In the process, the students hone their own entrepreneurial skills, preparing to become the business leaders of the future.

Through all of these efforts, the entrepreneurial spirit continues to spread across our campus, enabling UCLA to be an even stronger economic engine for California and an even greater contributor to the well-being of people everywhere.



Kathryn Atchison, *D.D.S., M.P.H.*

Monitor on the Move

DEBORAH ESTRIN is a professor of computer science and electrical engineering at UCLA and founding director of the NSF-funded Center for Embedded Networked Sensing. Her current work focuses on participatory sensing systems, leveraging location, image and user-contributed data streams available globally from mobile smart phones. Projects include participatory sensing campaigns for civic engagement and privacy-aware self-monitoring applications for health and wellness. Her recognitions include the Anita Borg Institute's Women of Vision Award for Innovation and election to the American Academy of Arts and Sciences and the National Academy of Engineering.

When most of us look at a cell phone, we see a handy tool for keeping in touch with family and friends. But when Deborah Estrin looks at a cell phone, she sees something more. She sees a device that can radically enhance the way scientists gather and analyze data about our world.

Estrin, a professor of computer science with a joint appointment in electrical engineering, is founding director of the NSF-funded Center for Embedded Networked Sensing (CENS). "When we began the center over eight years ago," she explains, "it was about placing sensors in an environment, up close to the action. And analyzing this data with computers, we could then measure the results."

This approach only made sense, however,

when attempting to measure something with fixed boundaries. You could embed sensors in a bridge or a building or an airplane, for example, to monitor its structural integrity. But Estrin and her colleagues found that in order to observe and measure changes in a larger swath of the environment — a forest, a neighborhood or a village — mobility is essential. Fortunately, this realization coincided with a revolution in communication technology.

"My research now," she says, "is almost entirely based on leveraging the worldwide network of mobile phones and engaging the people who choose to carry these devices around with them."

A typical mobile phone equipped with a camera and GPS has proven to be a remarkably robust tool for both scientific research and consumer applications. Current projects range from helping the National Park Service monitor invasive weed species that threaten local ecosystems, to using smart phone applications to collect data relating to health and safety in the Boyle Heights section of Los Angeles. In addition, a recently funded NIH activity will support new mothers at risk of cardiovascular disease, allowing them to monitor diet, exercise and stress factors.

"Whether you're interested in chronic disease management or prevention, for conditions ranging from diabetes to depression, you're using the same mobile phones," explains Estrin. "It's just different software that you download and different data that you're looking for."

That, says Estrin, is what makes her work so rewarding. The software she develops is copyrighted by UCLA and is available to other researchers through free open-source licensing. These researchers are then free to adapt it as they see fit to meet a variety of individual needs.

"We see our role as trying to help create innovations that have impact," Estrin says. "These are systems that people can go out and adapt for their own use. So the best measure of success is when people are, in some sense, taking the ideas and running with them."

On-Time Delivery

When Hsian-Rong Tseng talks about his work, he often turns to analogies. His conversation fairly bristles with allusions to things like Velcro and cocktails and even cruise missiles. This is, perhaps, an occupational hazard when you work day in and day out with arcane concepts like microfluidics and supramolecular nanoparticles.

An associate professor in molecular and medical pharmacology, Tseng began his career as a chemist, and did postdoctoral work in molecular electronics before entering medical school in 2003. It is not surprising then that his lab on the UCLA campus is known for its wide-ranging research interests. The common theme, however, is innovation with an eye toward using new technologies to advance the cause of patient care.

"We want to make our technologies useful," says Tseng. "The ultimate purpose is to translate this knowledge to the clinical side. If my research cannot be used in a clinical setting, we will refuse to do it."

Tseng is currently focused on two technologies that could revolutionize the detection and treatment of cancer. The first, licensed to NanoPacific Holdings, uses a supramolecular synthetic approach to produce large mixes of nanoparticles. These nanoparticles can be used to destroy cancer cells with targeted therapeutic payloads, thereby avoiding damage to surrounding tissues. The selectivity of these nanoparticles also gives clinicians an unprecedented ability to time the delivery of therapeutics.

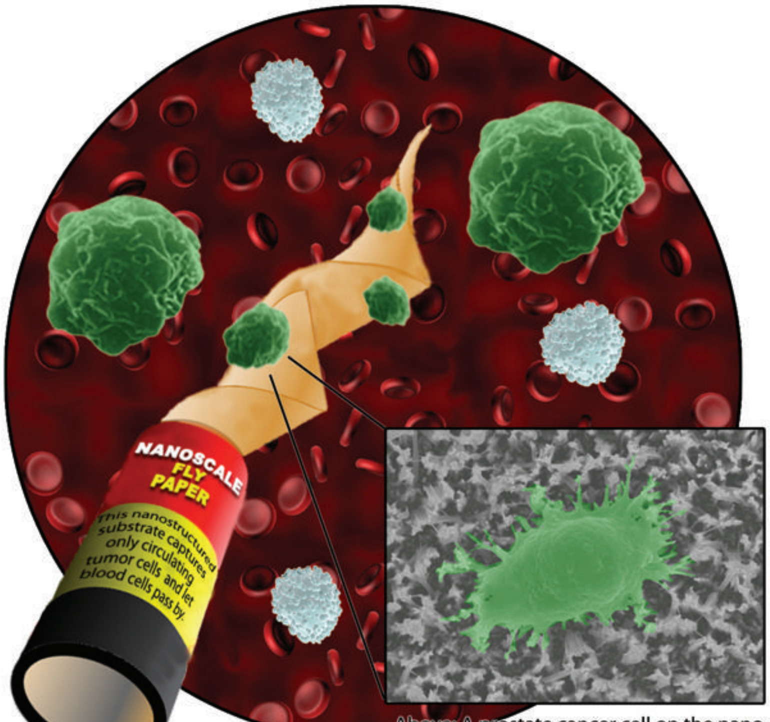
"With conventional 'cocktail therapy,'" explains Tseng, "the two treatments you give the patient may have different functions or different kinetics. One may arrive first, and when the second arrives the first has already been cleared. With our approach, we now have a 'cruise missile' that carries therapeutics with synergistic effects to the cells, delivering and releasing them at the same time."

Tseng's second area of interest is a diagnostic tool designed to detect circulating tumor cells in the blood of cancer patients. He likens the technology to a Velcro pad covered with nanostructures. These structures attach themselves to the hairlike structures typically found on the surfaces of cancer cells, making it possible to detect the presence of a tumor through a simple blood test.

"When cancer cells start the process of metastasizing, they break away from the primary tumor and enter the bloodstream," he notes. "So the presence of tumor cells in the blood is a very important marker for monitoring cancer progression. This is a powerful diagnostic technology. We just need to draw 1 to 5 mL of patients' blood to see if it contains circulating tumor cells."

Tseng's team has produced a prototype device based on the concept. Its effectiveness will be evaluated at two primary testing sites in the Los Angeles area: City of Hope and Cedars-Sinai Medical Center. UCLA is seeking to license this technology through a startup, CytoScale Diagnostics.

HSIAN-RONG TSENG'S research interests are in the development of nanostructured materials and microfluidic platforms as enabling technologies for facilitating the advancement of molecular diagnostics (imaging) and therapeutics, as well as in vitro diagnostic devices for cancer. He envisions that a systems-oriented integration of new-generation in vivo molecular diagnostics/therapeutics and in vitro diagnostic devices might lead to a paradigm shift in cancer diagnosis and treatment. Tseng was trained as a synthetic organic chemist and is currently on the faculty of the David Geffen School of Medicine at UCLA.



Above: A prostate cancer cell on the nano-structured cell capture substrate.

Ending Electronic Gridlock

FRANK CHANG is the Wintek Endowed Chair and a distinguished professor of electrical engineering at UCLA, where he also serves as director of the High Speed Electronics Laboratory. He was elected to the National Academy of Engineering in 2008 for the development and commercialization of GaAs power amplifiers and integrated circuits. He was elected a fellow of the IEEE (Institute of Electrical and Electronics Engineers) in 1996 and received the IEEE David Sarnoff Award in 2006 for developing and commercializing HBT power amplifiers for modern wireless communication systems. He also received the 2008 Pan Wen Yuan Foundation Award and 2009 CESASC Career Achievement Award for his fundamental contributions in developing AlGaAs/GaAs heterojunction bipolar transistors.

Think of it as a lazy day's drive on the boulevard. Traffic is heavy, but you're moving along at a good clip, making all the lights. Life is good. But then you realize that you have to make a left turn, and suddenly you're in the left turn lane, inching forward slowly, two cars at a time through every green light.

As Frank Chang explains it, this is not unlike the challenge faced by electrons as they course through your smart phone or iPod. Signals in electronic devices travel along physical circuits. And where these circuits intersect, there are going to be "bottlenecks."

"Modern systems like the iPhone continue to evolve in terms of thinness," says Chang, the Wintek chair professor in the electrical engineering department at the UCLA Henry Samueli School of Engineering and Applied Science, and the director of UCLA's High Speed Electronics Laboratory. "But a physical connector is now needed for passing high-speed signals between the board and between the chips. And given the space constraints in these devices, the connections become a bottleneck."

In light of the public's insatiable demand for smaller and ever more functional mobile devices, Chang believes it is time to eliminate physical connections altogether. To that end, he has developed a technology that moves signals across these intersections wirelessly, like radio waves. The technology exploits the special properties of high-frequency electromagnetic radiation. At extremely high frequencies, it is possible to produce signals with wavelengths of a few millimeters. At sizes like these, the signals can be generated on a piece of silicon that is roughly the size of a small fraction of a grain of rice.

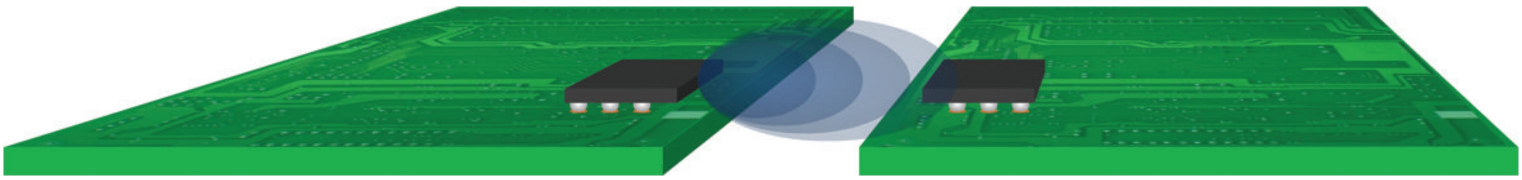
"This technology reduces the complication of building these devices," says Ira Deyhimy, CEO of WaveConnex Inc., the company founded to develop and market Chang's technology. "If you go online and look at an exploded view of an iPhone, say, it's very complicated, with many, many internal connections. Our technology makes it simpler to connect the various functions at a reduced size and a reduced cost."

Deyhimy became familiar with Chang's work in millimeter-wave technology while participating in the school of engineering's Institute for Technology Advancement (ITA). The goal of the program is to bring private-sector entrepreneurs and faculty members together to facilitate the commercialization of research underway within the school. Vijay K. Dhir, advisory board chair of ITA and dean of UCLA engineering, notes that "successful partnerships like this are integral to our goal of being a presence at UCLA to aid novel inventions that have positive outcomes for both the economy and society as a whole."

In Chang's research, Deyhimy found a technology that he felt was "ready for prime time."

Chang, who spent part of his career at Rockwell International, was happy to discuss the commercial potential of his research with the entrepreneur. "My industrial experience has taught me so much in terms of where I should focus my research at the school," he says. "And I think that is a key factor in my work. I have always been alert and been interested in pushing the technology for commercialization."

Incorporated in August 2009, WaveConnex is now headquartered in the on-campus incubator at the California NanoSystems Institute.



The WaveConnex product concept uses 60GHz EHF energy to transmit Gbps signals across short-reach gaps between printed circuit boards.

Seeing for Themselves

Once the toothpaste has been squeezed out of the tube, it is virtually impossible to put it back in. "Once you say something and your words come out, it's really hard to take them back," says Jan Cohn, a teacher at UCLA Lab School, the laboratory elementary school of the Graduate School of Education and Information Studies. "So maybe it's a good idea to think beforehand about the words you're going to say."

Adults understand this warning intuitively. But for the average 5-year-old, it isn't always easy to wrap one's mind around such abstract notions. So when Cohn and her colleagues need to illustrate the point to children, they reach instinctively for their box of Cool Tools. This set of lesson plans, teaching guidelines and physical props was developed by Ava de la Sota and several colleagues at the Lab School. After a brief session of trying to put real toothpaste back in the tube with toothpicks, the students usually get the point.

Taking advantage of these "teachable moments," as Cohn describes them, is the driving idea behind Cool Tools. Although de la Sota has left the lab school, her colleagues there have implemented the Cool Tools approach, and Cohn believes this approach has made a big difference in her students' behavior.

"I have seen that the tenor of the whole school is very different," she says. "It used to be that kids would get very physical or put other kids down. That has changed. They know that that's not acceptable. We're very clear that there are ways to deal with it. In most elementary schools, if kids do something wrong they get in trouble. But getting in trouble doesn't teach you anything. So we treat these as learning opportunities, and that's a big shift."

It is such a change, in fact, that Pam Harper, a physical therapist from Woodinville, Washington, is licensing Cool Tools. She hopes to demonstrate their effectiveness in the Seattle area's Northshore School District. If successful, she hopes to distribute them nationwide through her company, Children's Integrated Movement Therapy. From her perspective as a counselor and physical therapist, Harper views Cool Tools as an approach that could significantly reduce student behavior problems, especially when implemented schoolwide.

"When you use these tools and props, rather than just discussing complex ideas with young kids, they can see it literally first," she explains. "And then through time they can start to grasp concepts at a more complex level. I like that. And I like the idea of the toolbox with all of the examples and familiar objects, so kids can have pictures in their heads and start to form those ideas gradually."

With growing concerns about the effects of anti-social behavior and bullying in the nation's schools, Cohn and Harper believe that Cool Tools represents an important alternative to traditional approaches to enforcing discipline.

A Leg Up

Every day, researchers at UCLA make discoveries and perfect technologies that even a decade ago would have been considered the stuff of science fiction. But sometimes, doing the impossible is the easy part. Turning these discoveries into viable products and services can be an even greater challenge. In an effort to ease the transition from laboratory to marketplace, the California NanoSystems Institute (CNSI) and the Office of Intellectual Property created UCLA's first on-campus incubator. Launched in 2009, the incubator offers faculty researchers part of a modern 2,000-square-foot laboratory where they can develop their ideas and form startups that can become self-sustaining, stand-alone companies in just a few years.

"Serving as an engine for the Los Angeles economy is one of UCLA's most critical obligations as a great public research university," says UCLA Chancellor Gene Block. "Creating sustainable private businesses is one of the important ways we fulfill that responsibility. The incubator at CNSI will go a long way toward ensuring that promising new firms stay here, in Los Angeles, instead of leaving the region and state."

At the time of this writing, 11 promising startups had received approval to share space in the technology incubator. Two of these — WaveConnex Inc. and Holocope LLC — are featured elsewhere in this year's edition of *UCLA Invents*. Three more — Aneeve Nanotechnologies, Matrix Sensors Inc. and Librede Inc. — are profiled below.

Aneeve Nanotechnologies

Exploiting the unique properties of carbon nanotubes, Kang Wang and his team at the UCLA Department of Electrical Engineering have developed a new generation of ultrasensitive biosensors based on semiconductor technology. Wang hopes to commercialize this revolutionary carbon nanotube technology in the form of a low-cost, consumer-based meter that can be used to instantly measure levels of the hormones estrogen and progesterone.

"When a woman is going through menopause, say, she could track her hormone levels and use this information to mitigate the symptoms," explains Wang. "And another potential application is assisting couples who are having a hard time getting pregnant. Using this meter to measure the woman's hormone levels, they could accurately track their peaks and thereby increase the chances of fertilization."

Working with Kosmas Galatsis, Wang founded the company Aneeve Nanotechnologies, which is now headquartered in the technology incubator.

"From the company point of view, the important aspect of being in the incubator is that we do not have to spend huge amounts of money purchasing equipment and setting up labs," says Galatsis. "That's already done."

Wang adds that the incubator's support for business development is just as valuable as the laboratory facilities. "The companies in the incubator are linked to the Anderson School of Management," he notes, "and they have a program — the Technology Innovation Program — that links us to a group of very talented students who are interested in marketing and other specialties. This is an integral part of the incubator, and it has been very helpful."

Librede

Jacob Schmidt, an associate professor in the Department of Bioengineering and co-founder of Librede, believes that one of the incubator's biggest draws is the fact that it is on campus.

"It is really great," he says, "because it's about 300 feet away from my lab. It's so easy to walk back and forth that we can communicate and meet on the spur of the moment."

Schmidt also likes the fact that the incubator

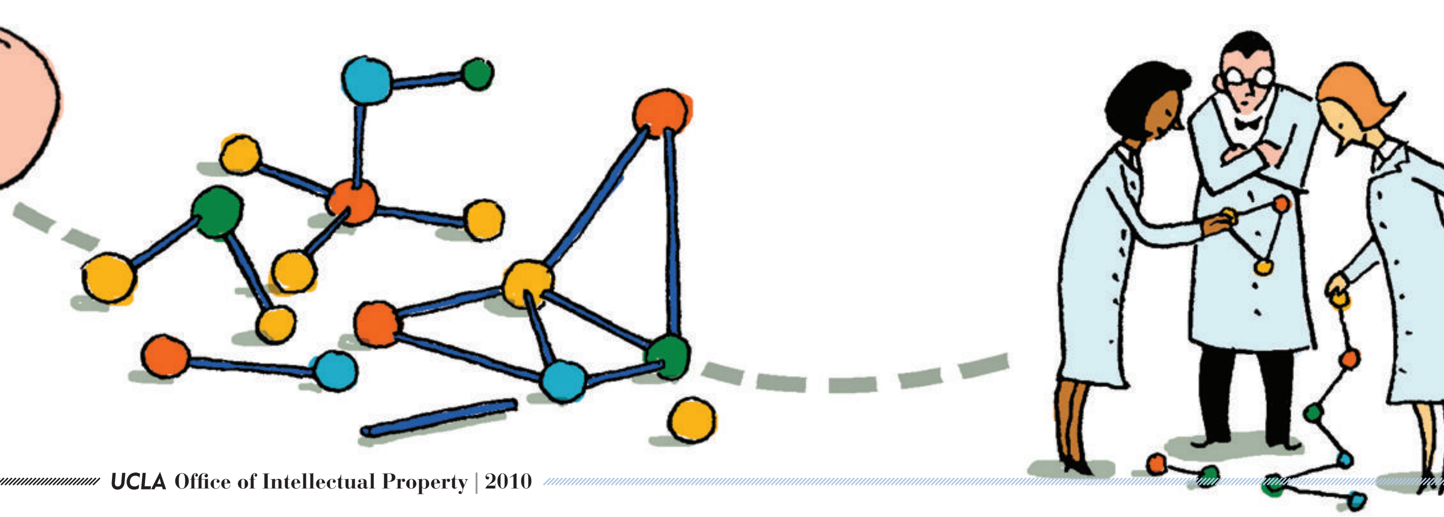


Illustration by Marc Rosenthal

provides a place to meet regularly with entrepreneurs who don't necessarily share his research interests, but face common challenges in getting their businesses off the ground.

"We have chatted," he says, "with some people in the incubator who are in different stages of corporate development. So it's been good to get their feedback on the kinds of things we're going through now that they have already gone through. That's pretty useful."

Librede is currently developing disposable biochips that can be used to measure ion channel activity. Because ion channels regulate the flow of ions through cellular membranes and thereby regulate electrical activity within the cell, they are of vital interest to researchers who study everything from cardiac function to electrical behavior within the brain. Traditional methods for studying ion channels, however, are cumbersome and require equipment that is both expensive and difficult to use.

The biochips that Schmidt and his colleagues have developed overcome this difficulty by dispensing with cells altogether. Employing inexpensive artificial membranes, they measure ion channel activity at a fraction of the cost associated with older technologies. The implications for basic research are enormous, but Schmidt believes the simplicity of this technology also will attract a lot of attention in the pharmaceutical industry.

"The biggest impact of our artificial membrane platform may be in drug discovery and drug safety screening," he explains. "There is a really big, unmet need for higher throughput and lower-cost ion channel screening technologies in the pharmaceutical industry. There are a number of diseases attributed to ion channel defects that may be improved by drugs. Conversely, if a drug unintentionally interacts with ion channels in your heart or your brain, that's going to be a big problem necessitating withdrawal of the drug."

With Librede, Schmidt believes he and his team could address these areas to speed development of new drugs at lower costs.

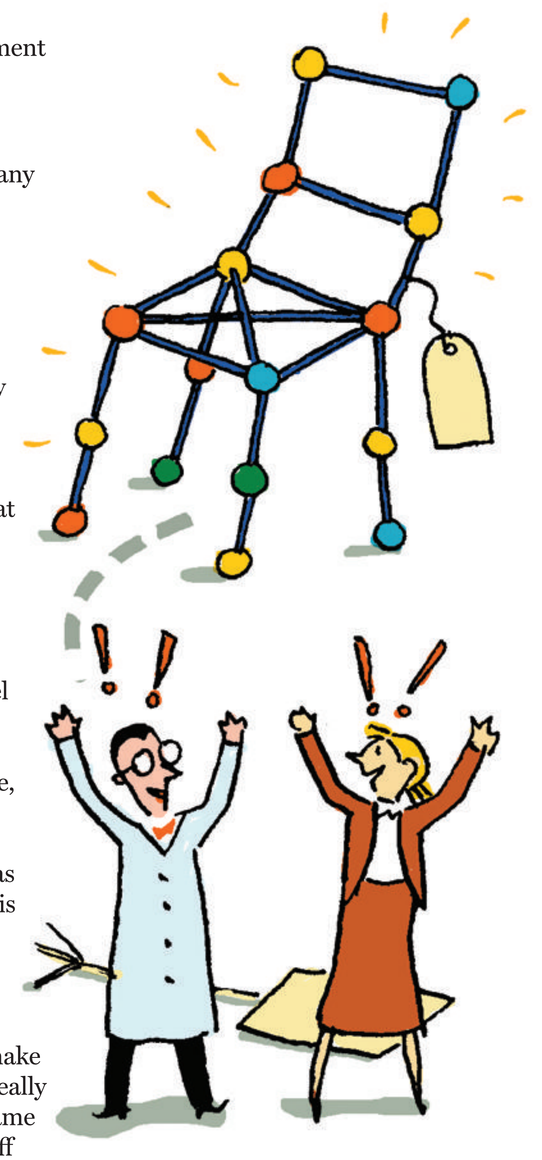
Matrix Sensors

Matrix Sensors is another incubator-based company that is attempting to leverage UCLA's expertise in chemistry and nanosystems into a successful product line. Using technology developed jointly by researchers at Stanford University and at UCLA by Distinguished Professor of Chemistry Jim Gimzewski, Matrix is currently developing microchips that carry an array of small, extremely sensitive mass detectors. These detectors are made chemically or biologically sensitive by the application of a special nanoscale chemical layer to the detector areas. When molecules bind to that material, the increase in mass can be measured, making it possible to detect molecules of specific bacteria as well as proteins and DNA, and thus diagnose early stages of illness.

"Given that the sensor chip can hold a lot of different sensors, it can be used for multiple panel type assays," explains Matrix CEO Mike Cable. "You can put different materials on each one and do fairly sophisticated assays in a relatively simple, inexpensive format."

Like Wang, Galatsis and Schmidt, Cable believes the existence of the incubator at CNSI has significantly reduced the challenge of bringing this technology to market.

"Access to their facilities has been absolutely key to the progress that we're making," he says. "This incubator program has not only allowed us the use of the CNSI equipment, it's designed to make us part of the UCLA community. That has been really helpful for a startup. A startup is just what the name says. You don't have anything. Having all that stuff immediately available has been great."



Unmistaken Identity

DAVID HAAKE is a professor of medicine in the division of infectious diseases at the David Geffen School of Medicine at UCLA and a leader in the fields of polypeptide synthesis, self-assembly of block copolypeptides, and biological activity of polypeptides. He has been recognized by the National Science Foundation, the Office of Naval Research, the Arnold and Mabel Beckman Foundation, the Alfred P. Sloan Foundation, the Camille and Henry Dreyfus Foundation, the Materials Research Society and the IUPAC Macromolecular Division. In addition, he was recently named a fellow of the American Institute of Medical and Biological Engineering.

One of the most persistent fears in modern medicine is the prospect that a drug-resistant organism — the so-called superbug — will make its way into the general population, rendering penicillin and other common antibiotics ineffective and, ultimately, useless.

Illustration by Richard Mia

Physicians agree that the best way to prevent this is to become ever more discriminating in our use of antibiotics. Instead of reaching immediately for the most powerful drug in the pharmacy, doctors should select the antibiotic that best targets the infection they are attempting to treat. Unfortunately, traditional tests for bacterial infections take two to three days to produce results. So when a patient is suffering, the physician's natural impulse is to reach for the most powerful antibiotic available.

David Haake, professor of medicine at UCLA's David Geffen School of Medicine, likens this approach to a gambling habit. "It's like going to Las Vegas," he says, "and needing to win every time you place a bet. The consequences of using the wrong antibiotic are so great that doctors end up covering their bases by treating patients for all possible infections. So why not find out in advance what's really causing the infection and use a simpler antibiotic like penicillin whenever possible? Save the more advanced antibiotics for the patients who really need them."

Haake believes the answer lies in cutting down the time required to make a diagnosis. And using technology that he and his colleagues at the UCLA Bioengineering Research Partnership have developed, it is now possible to make these diagnoses in minutes instead of hours or days. The research, sponsored by the National Institute of Allergy and Infectious Diseases, currently focuses on urinary tract infections and employs a system of DNA probes that bind to species-specific regions of ribosomal RNA. The probes work like supermarket barcode scanners to quickly identify bacteria in clinical specimens. These probes, in turn, are linked to signal-generating enzymes that can be read by either electrochemical or optical sensors. This approach is not only faster, it is more sensitive as well.

"Currently, even the very best laboratories only report bacteria down to ten to the fourth, or 10,000 bacteria per milliliter of urine," says Haake. "Our detection system is now sensitive to something like 500 bacteria per milliliter. And we're trying to get it down to the 100-per-mil level. If we can get this information to a doctor and his or her patient in a rapid way, they can use antibiotics more judiciously. Rather than treating everybody the same, the patient gets the best antibiotic for their infection right from the start."

UCLA has licensed the team's DNA probe technology to Qvella, a Toronto-based startup. According to Qvella CEO Tino Alavie, the company will use the probes in combination with an optical sensor system. And while Haake and his associates have thus far focused their attention on infections of the urinary tract, Alavie hopes to adapt the technology for use in the diagnosis of a variety of infectious diseases.

Straight to the Heart

Performing modern heart surgery is a lot like threading a needle. Cardiologists enter the heart through the body's circulatory system and, using precisely engineered catheters, can perform a variety of delicate, lifesaving procedures. They can replace leaky valves. They can correct abnormal rhythms. And they can do it all using minimal and microinvasive approaches, without the trauma and expense of major surgery.

However, the very procedures that can save a patient's life carry their own risks. Perhaps the most significant is the possibility of accidentally introducing air bubbles into the patient's bloodstream.

"These minimally invasive surgical procedures are now very common," says Kalyanam Shivkumar, director of the UCLA Cardiac Arrhythmia Center at the David Geffen School of Medicine. "But when you go inside the heart, there is always the risk that air can get sucked into it, and that is very dangerous. If a lot of air gets in, the heart just stops. And if bubbles of air get into the blood, they can go to the brain and cause a stroke. This is particularly a serious risk in children undergoing heart procedures. It's a well-recognized problem, but to date there has been no active solution to prevent it."

Shivkumar and his UCLA colleagues believe they have found that solution. Their technology, which Shivkumar describes as a breakthrough, effectively prevents air bubbles from entering the bloodstream during cardiac procedures.

"When you watch science fiction movies and people get into a space capsule," he explains, "they don't just open a door and go out into outer space. They go into an intermediate chamber and then into outer space. In other words, it's sequential. Essentially, we have created sequential valves so that anything that enters the heart has to go through a sequence like an air lock. Or in this case, an 'air bloc.' This has wide implications for any procedure involving the cardiovascular system."

Shivkumar and his team intend to bring this technology to market through the startup company EP Dynamics, which he and several associates founded in 2009. The company has attracted financial backing from a number of private investors and has negotiated a licensing agreement that will allow it to commercialize the intellectual property patented by UCLA. The FDA has already approved the sale of the company's Air Bloc™ transseptal sheath system in the United States.

"This is an area of major importance," Shivkumar explains, "because more and more cardiovascular procedures are going to be done by catheters and not by surgery."

He believes that once this technology is widely adopted it could have a significant impact on the overall safety of these procedures, improving the quality of care available to all cardiac patients.

KALYANAM SHIVKUMAR specializes in interventional cardiac electrophysiology. He heads a UCLA research group that is developing innovative techniques for the nonpharmacological management of cardiac arrhythmias. He also serves as director of the UCLA Cardiac Arrhythmia Center at the David Geffen School of Medicine at UCLA and as academic director of cardiac electrophysiology at the VA West Los Angeles Healthcare Center. He received his medical degree from the University of Madras, India, and is certified by the American Board of Internal Medicine in the subspecialties of cardiovascular disease and clinical cardiac electrophysiology. He is a fellow of the Heart Rhythm Society and the American College of Cardiology.

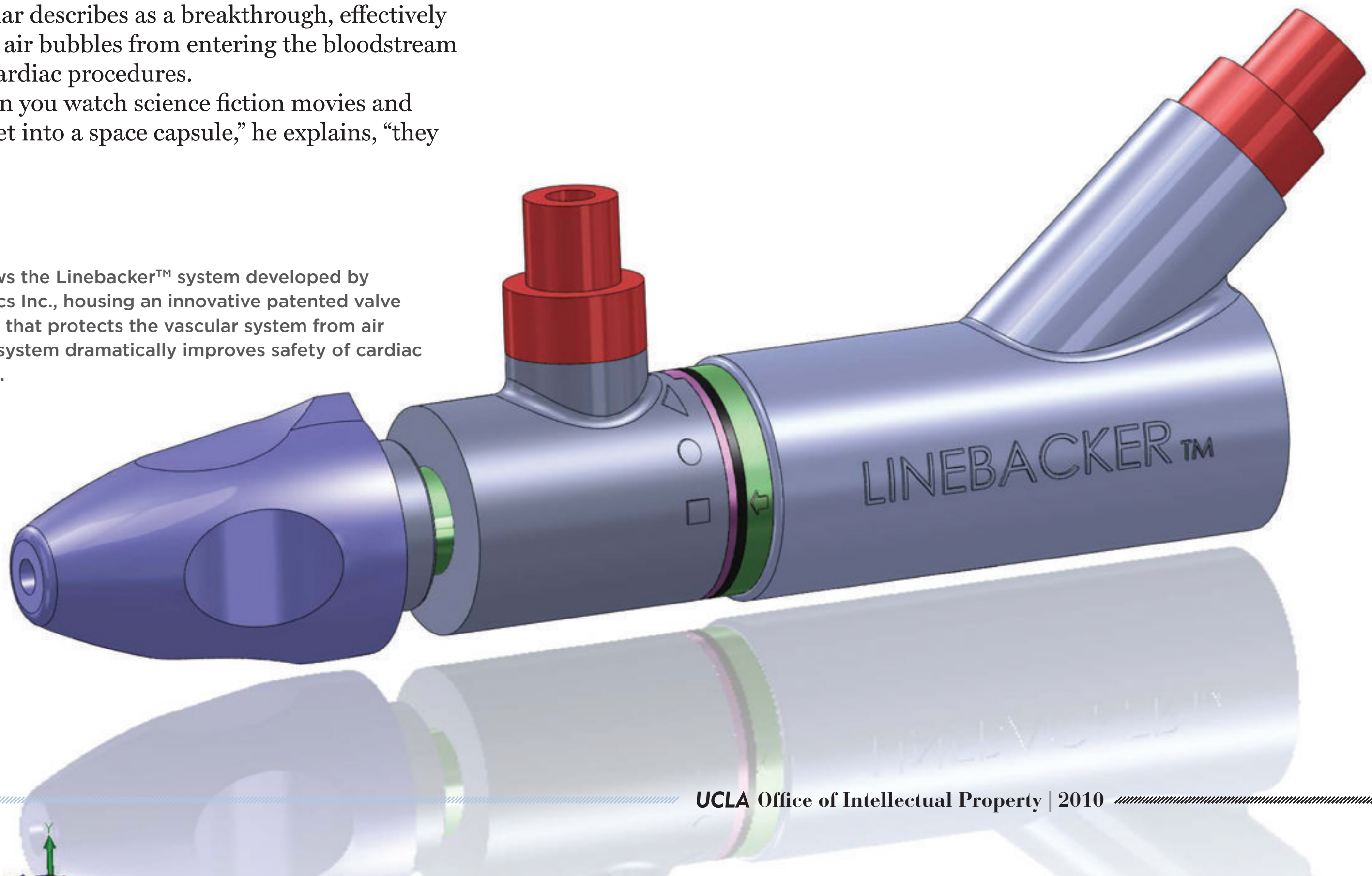


Image shows the Linebacker™ system developed by EP Dynamics Inc., housing an innovative patented valve mechanism that protects the vascular system from air entry. This system dramatically improves safety of cardiac procedures.

Synthetic Solutions

TIMOTHY DEMING chairs the bioengineering department at UCLA, where he is a professor of bioengineering, chemistry and biochemistry. He is a leader in the fields of polypeptide synthesis, self-assembly of block copolypeptides and biological activity of polypeptides. He has been recognized by the National Science Foundation, the Office of Naval Research, the Arnold and Mabel Beckman Foundation, the Alfred P. Sloan Foundation, the Camille and Henry Dreyfus Foundation, the Materials Research Society and the IUPAC Macromolecular Division. He was recently named a fellow of the American Institute of Medical and Biological Engineering.

It is altogether too easy for most of us to take things for granted. If we see a spider web in a corner of the basement, for example, we see something that needs to be swept away. But when Tim Deming looks at that same spider web, Deming — a chemist who currently chairs the UCLA bioengineering department — sees something more.

"There are a lot of biological polymers out there," he explains. "Things like proteins, carbohydrates, DNA. And many of these have interesting properties that we don't usually find in most synthetic polymers or conventional plastics. A good example is something like spider silk. It's one of the strongest fibers known. It's better than anything man can make."

Which doesn't mean a man can't try, however. Hence, Deming and his colleagues are working to bridge the gap between biological and man-made polymers, hoping to synthesize in their lab materials that actually mimic the properties of naturally occurring substances.

Deming's interests are wide ranging. But he notes that his current research has a number of potential commercial applications and NanoPacific Holdings, a high-tech startup, is actively exploring ways to license these technologies and bring them to market.

Perhaps the most promising technology is an antimicrobial based on chemical substances known as peptides. These compounds, which bind to the cell membranes of microbes and punch holes in them, could represent an important response to the growing problem of antibiotic resistance. "The advantage here," explains Deming, "is that these substances don't follow very specific pathways into the cell. The old antibiotics get into the microorganisms and interrupt them through very specific biochemical pathways that are crucial to the organisms' survival. Normally, the microbes figure out a way around this, or they synthesize a molecule that inhibits the antibiotic, thereby creating a drug-resistant strain of bacteria."

Deming hopes to create libraries of synthetic peptide molecules that can destroy an array of microbes. These could then be incorporated into antimicrobial lotions or sprays, providing a potentially low-tech solution to a high-profile problem.

Deming says that he is motivated in large part by the thrill of discovery. But the potential for translating his research into commercially viable products is always on his mind.

"I've been working in the polypeptide materials area for about 15 years now, and the idea all along has been trying to make something useful," he says. "We try to do things that have some potential for commercialization rather than being so expensive or complicated they could never be used for anything."

Photo by Joe Gough

A Better Way

It has long been recognized that iron is essential to maintaining human health and vitality. But iron is beneficial only as long as the body maintains proper levels of this mineral. Too little iron can result in a variety of debilitating anemic conditions. Too much can lead to potentially fatal oxidative damage in the heart and liver.

In 2001, UCLA researcher Tomas Ganz reported the discovery of hepcidin, a hormone that regulates iron uptake and distribution in the body in much the same way that insulin regulates glucose. He and fellow researcher Elizabeta Nemeth went on to develop the first test for measuring levels of hepcidin in humans. The test, however, was based on an analysis of urine samples, and this, says Ganz, was a less-than-optimal approach to the problem.

"We were assuming that the amount of hepcidin in urine reflects the amount in blood," he explains. "The amount in blood, however, is the essential quantity, because the blood hepcidin initiates the biological activity, and hepcidin in urine is only an estimate of the blood hepcidin. We assumed that the two track together. But in fact there may be situations where the two do not track together, and the blood value is the correct one and the urinary value is in some ways false."

"So," says Nemeth, "it is more accurate to measure hepcidin levels in the blood itself."

The solution to this problem came from an unlikely source — Mark Westerman's private-sector research on the striped bass. Westerman and his colleagues had discovered a fish "homologue" of the human hepcidin molecule and developed a sensitive assay to measure hepcidin in the fish's bodily fluids.

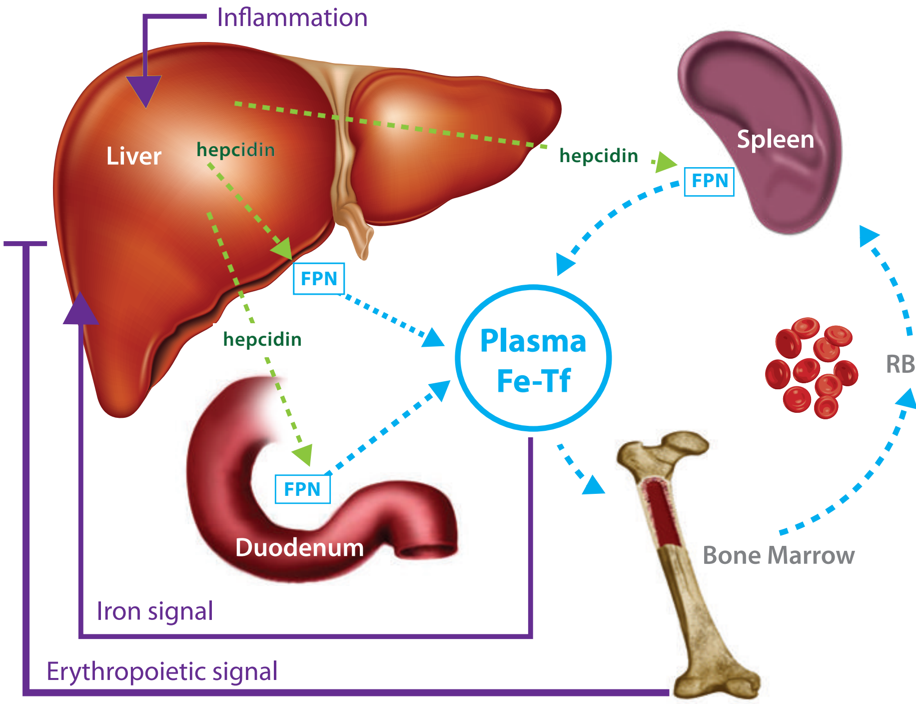
After Westerman explained his discovery to Ganz and Nemeth, the three agreed that combining Westerman's proprietary technology with the UCLA antibody used for the urine assay would enable them to produce a more sensitive method for measuring hepcidin in humans. Taking this approach, they developed a test that measures hepcidin levels directly in samples of human blood. The blood test is not only more accurate, it also eliminates the difficulties associated with collecting and handling urine samples. And in situations where a rapid, noninvasive test is needed — in pediatric offices, for example, or resource-poor developing countries — it also enables faster and easier measurement of urinary hepcidin.

The three researchers decided to bring this groundbreaking diagnostic test to market through the creation of a startup venture, Intrinsic LifeSciences. A transfer agreement negotiated with UCLA gives Intrinsic access to antibodies that Ganz and Nemeth have produced in their lab. These antibodies are currently being used in tests that measure hepcidin levels in clinical samples from drug trials.

Ganz and Nemeth continue their research at UCLA while serving as advisors for Intrinsic. "We have our own research agenda," Ganz explains. "We would like to move on and discover other things."

While applied research is vital, the two researchers agree that without private-sector involvement, it could be something of a futile exercise. "The only way that we can make something happen," says Ganz, "is if we convince private enterprise entities to take advantage of what we have learned. Otherwise, no practical results will flow from what we do."

TOMAS GANZ is a co-founder of Intrinsic LifeSciences, a UCLA professor of medicine and pathology, as well as a UCLA faculty member in pulmonary and critical care, hematology, and oncology. Since 1983, he has studied the biology of host defense peptides. He has also contributed to the revolution in iron biology and the understanding of iron-related disease. He helped found Intrabiotics and has consulted for major biotechnology and pharmaceutical companies. He holds a Ph.D. in applied physics from the California Institute of Technology and an M.D. from UCLA. He trained in internal medicine and pulmonary critical care at UCLA and has served on the UCLA faculty since 1983.



Hepcidin (shown in green) is produced in the liver. By causing degradation of the iron exporter Fpn, hepcidin blocks the flow of iron into plasma from the duodenum, spleen and liver (blue). Hepcidin production is regulated by erythropoiesis, iron loading and inflammation (purple).

A Longer Reach

WARREN GRUNDFEST, a leader in image-guided therapies and medical device design and development, holds 15 patents, with five more pending. His research interests include minimally invasive surgery, optical diagnostics, medical robotics and advanced medical imaging technologies, and he has participated in a number of corporate and venture technology development programs.

At UCLA, Grundfest holds faculty appointments in bioengineering, electrical engineering and surgery, and he serves on the executive board of the Center for Advanced Surgical and Interventional Technologies, where he is also principal investigator. A fellow of the American College of Surgeons, he has published more than 225 papers and 46 book chapters.

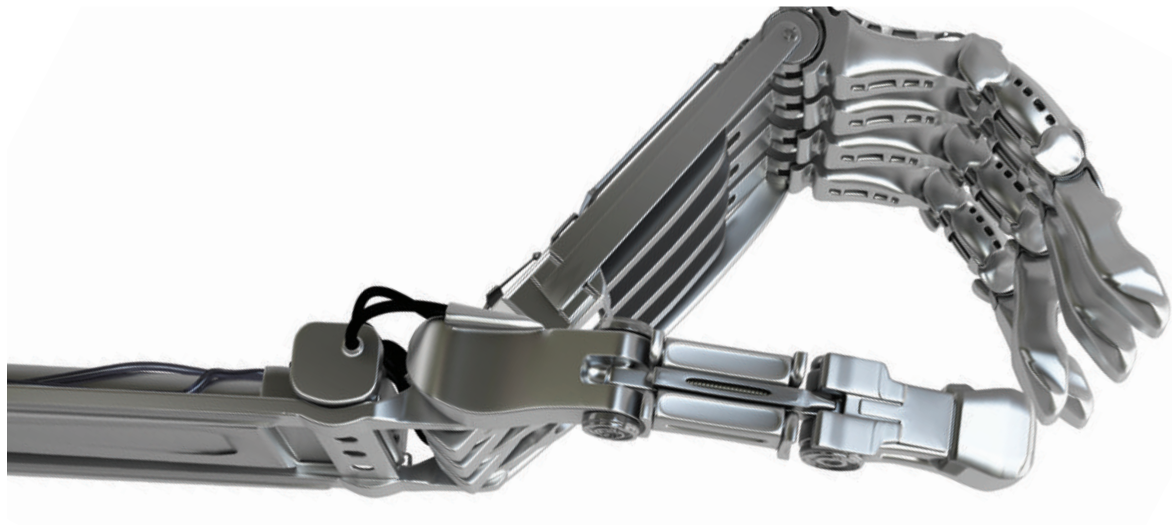


Photo by Tomasz Kaczmarczyk

At first, it might be easy to mistake Warren Grundfest for an ambitious entrepreneur or businessman. The companies he has helped found include Advanced Interventional Systems, Intramed Laboratories and Cogent Light Technologies. He has also served as a limited partner at Sequoia Capital Technology Partners and has worked as a consultant to General Electric, Pfizer and United States Surgical Corporation.

Grundfest, however, is a medical man by trade. He began his career as a general surgeon and currently serves as a professor of bioengineering and electrical engineering at UCLA, while also sitting on the board of directors at CASIT, UCLA's Center for Advanced Surgical and Interventional Technology. He believes that it is only natural that his work has led him so often to the point where science and commerce intersect.

It's fine to make discoveries in the laboratory," he explains, "but if you really want to help people, you have to translate this technology into productive capacity."

Grundfest parlayed an early interest in lasers and optics into the successful development of tools for exploring the body through angioscopy and microendoscopy. This, in turn, led to the development of tools not only for cardiac and vascular procedures, but also for laproscopy, arthroscopy, gynecology and neurosurgery.

Today, Grundfest focuses on two primary fields of interest: optical biopsy techniques and prosthetics. Both, he notes, are natural extensions of his long-standing interest in minimally invasive technologies that extend the reach of physicians, surgeons and researchers alike.

The ability to perform an optical biopsy, he explains, eliminates a big step in the treatment of many diseases. "If you can make the diagnosis at the time you do the biopsy, you can then decide to treat it. This furthers the goal of converting open surgeries to minimally invasive procedures."

Grundfest's growing interest in creating better prosthetic devices can be traced back to this research.

"When you use robots for surgery," he explains, "one of the problems is that you have no idea how hard you're pressing on the tissue or pulling on the suture. So in an attempt to restore feeling, we put sensors on the tips of surgical instruments and relay that information back to the thumb and the forefinger using tiny balloons that inflate and deflate, depending on the pressure that you're applying. So we said, 'Well, if we can do it for a surgical tool we can do it for a prosthetic limb.'"

Such an undertaking requires expertise that inevitably crosses traditional academic boundaries, and Grundfest believes this is part of what makes CASIT unique.

"It is very important to understand that the current state of medicine requires interdisciplinary solutions," he says. "You can't just be a biologist or a physicist anymore. The junction of these two is where progress is made."

Not-So-Strange Bedfellows

Dentistry might well be considered the Rodney Dangerfield of medical specialties. It is an essential practice, yes. And most of us visit our dentists dutifully twice a year. But compared to brain surgeons, say, or cardiologists, dentists don't always get the respect they deserve.

Unless, of course, the dentist happens to be Ben Wu.

Wu, who currently serves as vice chair of UCLA's Department of Bioengineering and holds academic appointments in dentistry, materials science and orthopaedic surgery, began his career as a general dentist in the San Francisco Bay area. He shared an office with a prosthodontist — a specialist who treats severe conditions that require the reconstruction of the mouth and jaw. "Prosthodontists are considered the super dentists," Wu recalls. "They are referred the most difficult cases, in both technical complexity and case management. It made what I did seem pretty ordinary. I knew I wanted to be a prosthodontist."

As Wu familiarized himself with the programs available around the country, he sought after those that offered strong research opportunities as well as specialty training. This led him to enroll in a Harvard/MIT program that combined a prosthodontics residency with Ph.D. training in materials engineering.

Engineering and dentistry seem at first glance to be odd bedfellows. But Wu notes that modern dentistry relies heavily on the development of advanced materials and predicts that reconstructive surgeries will also be transformed by new materials.

At UCLA Bioengineering, Wu focuses on a "biomimetic" strategy to regenerate a wide variety of tissues by building the proper environment for the cell.

"We want to know, of all the millions of factors that could normally induce tissue to develop in the first place in embryos — and later as a person develops — what are the two or three key factors that we could control and engineer to induce the damaged tissues to repair properly and reliably."

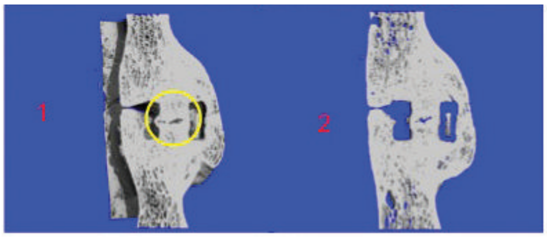
Wu explains that control is a crucial variable in this work. A growth factor that is not sufficiently specific — one that could cause bone or cancer to grow in nerve tissue, for instance — would do more harm than good. His team is creating materials and growth factors that stimulate tissue growth under only specific conditions. "It will only form bone where we put it, but not if it leaks away somewhere else. We just need to engineer the right environment for each application."

Several of these technologies have been licensed for commercialization from UCLA. Pending FDA approval, the company Bone Biologics, Inc. — which Wu co-founded and where he currently serves as a board member — will conduct clinical trials and commercialize the technology for human use.

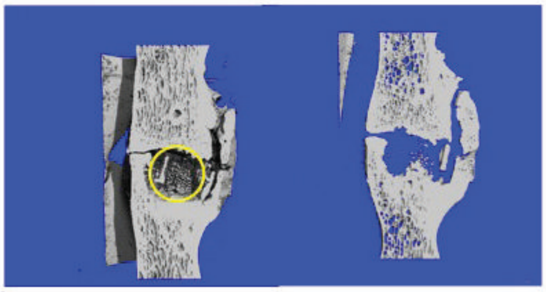
His work in the lab and the boardroom notwithstanding, Wu has not given up on his dream of joining the ranks of so-called "super dentists." In addition to his academic and administrative duties, Wu is a prosthodontist in the UCLA Faculty Group Dental Practice, where he specializes in full-mouth reconstruction.

BEN WU is vice chair of the UCLA Department of Bioengineering, with a joint appointment in the School of Dentistry and the Departments of Materials Science and Engineering and Orthopaedic Surgery. A fellow of the Academy of Prosthodontics, he practices in the Faculty Group Dental Practice at the UCLA Medical Plaza. He also directs an active research group and collaborates with clinical specialists to develop novel approaches for restoring lost function and replacing damaged tissues. His lab studies how nature heals wounds and tissue defects; seeks to emulate nature and engineer biomimetic microenvironments to promote repair; and investigates the molecular mechanisms by which progenitor cells interact with the engineered microenvironments.

Good Fusion (growth factor)



No Fusion (control)



Good Fusion (growth factor) :

1. MicroCT showing new bone formation in between spine vertebral bones (see new bone inside the circled region) by the growth factor.
2. MicroCT from another slice, showing good bone formation with growth factor.

No Fusion (control) :
No bone formation without growth factor.

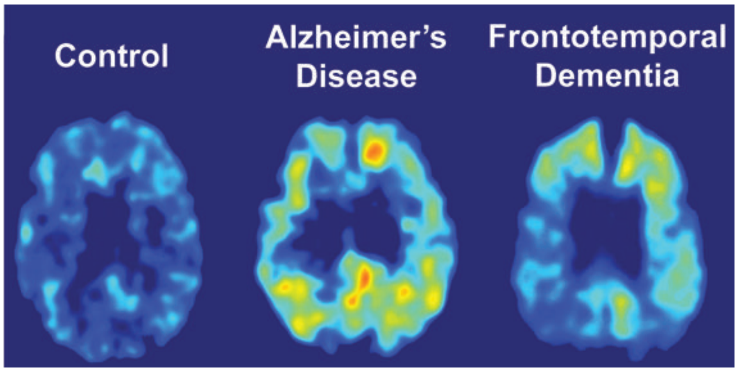
An Improved Image

Until the latter part of the 20th century, there were essentially two ways for physicians to find out what was going on inside the human body. One was to take an X-ray. The other was to cut the body open and look. Considering the technical limitations of the first technique and the risks associated with the second, neither was an ideal option. But in the last quarter of the century, an array of new imaging technologies emerged — positron emission tomography (PET), computerized axial tomography (CAT) and magnetic resonance imaging (MRI), to name just a few. Using them, physicians could observe physiological processes — often, as they happened — without disturbing the body. A new era in medicine and medical research had dawned.

At UCLA, researchers are at the cutting edge of efforts to develop new and novel approaches to imaging technology. And as these discoveries make their way into the marketplace, medical professionals around the world gain access to ever more effective tools for combating disease and improving public health.

Positron Probes

Jorge Barrio, UCLA professor of molecular and medical pharmacology, believes that the key to understanding, and eventually treating, Alzheimer's disease is to identify Alzheimer's patients before they present symptoms of the disease. "There are an estimated 100 billion neurons in the human brain," he explains. "But when Alzheimer's disease is going full steam, we have probably lost 30 billion neurons already. There is little chance to recover the number of neurons lost. So the basis of any successful therapy has to be to stop the deterioration at the earliest possible stage, when most brain functions are maintained."



In vivo imaging of neurodegeneration.

This belief has led Barrio and his colleagues to develop biochemical markers that can be used to detect a predisposition for Alzheimer's long before the disease manifests itself in memory loss and dementia. These so-called probes, having been tagged with positron-emitting molecules, migrate to specific parts of the brain where researchers can measure the biochemical activity using positron emission tomography (PET). "It's like a spy that we are sending in," says Barrio. "And it is giving us information in the form of an image of what is going on in that tissue."

One particular marker, FDDNP, has in fact been used to successfully detect brain lesions associated with Alzheimer's in a living patient. Barrio believes the importance of this achievement — the first of its kind — cannot be underestimated, especially if successful treatments for the disease are ever going to be discovered.

"We need to understand the disease process if we are to achieve a cure," he says. "That's one of the values of research based on imaging technology. You can have several levels of use. First, there's early detection. Secondly, it aids in the selection of patients for clinical trials. And third, it enables you to monitor the specific intervention you are making. Does it, for example, reduce or eliminate brain pathology?"

Developing molecules that can be used as probes is complex and painstaking work. But, Barrio notes, it is well worth the effort. "We are all patients," he says. "I never forget that. It doesn't matter what our age is, we all know people who have or have had Alzheimer's disease. It affects all of us."

X-ray Specs

Despite the rise of many new and novel imaging techniques, X-ray imaging remains an essential tool for evaluating injuries and other medical conditions. As anyone who visits the dentist regularly can tell you, X-ray technology has improved steadily over the years. Despite these improvements, however, the equipment used to produce X-ray images is still large, expensive and power-hungry.

Mark Evans and Gil Travish are hoping to change that. Their company, Radius Health, is currently developing a revolutionary flat-screen technology that they believe will change the nature of X-ray imaging. Evans, who serves as Radius Health's CEO, likens this change to the transition from CRT technology to the flat-screen technology that now dominates our computer and home entertainment systems.

"We think it's going to be quite revolutionary," he says. "In the same way that you'd laugh if someone came in with a laptop with a cathode ray tube, we're hoping the same thing is going to happen in a few years with X-rays."

This revolution is powered by Travish's work in the field of advanced particle accelerators and high-brightness electron beams. Travish, a research scientist in UCLA's Department of Physics and Astronomy, explains that he and his team were searching for a way to create a particle accelerator that would fit on a microchip. In the course of their work, they found that the beams they were producing could also generate X-rays.

"Then," he recalls, "the question was, what can you do with that? I started hunting around for applications. Just through serendipity I was introduced to Mark, who had been looking for

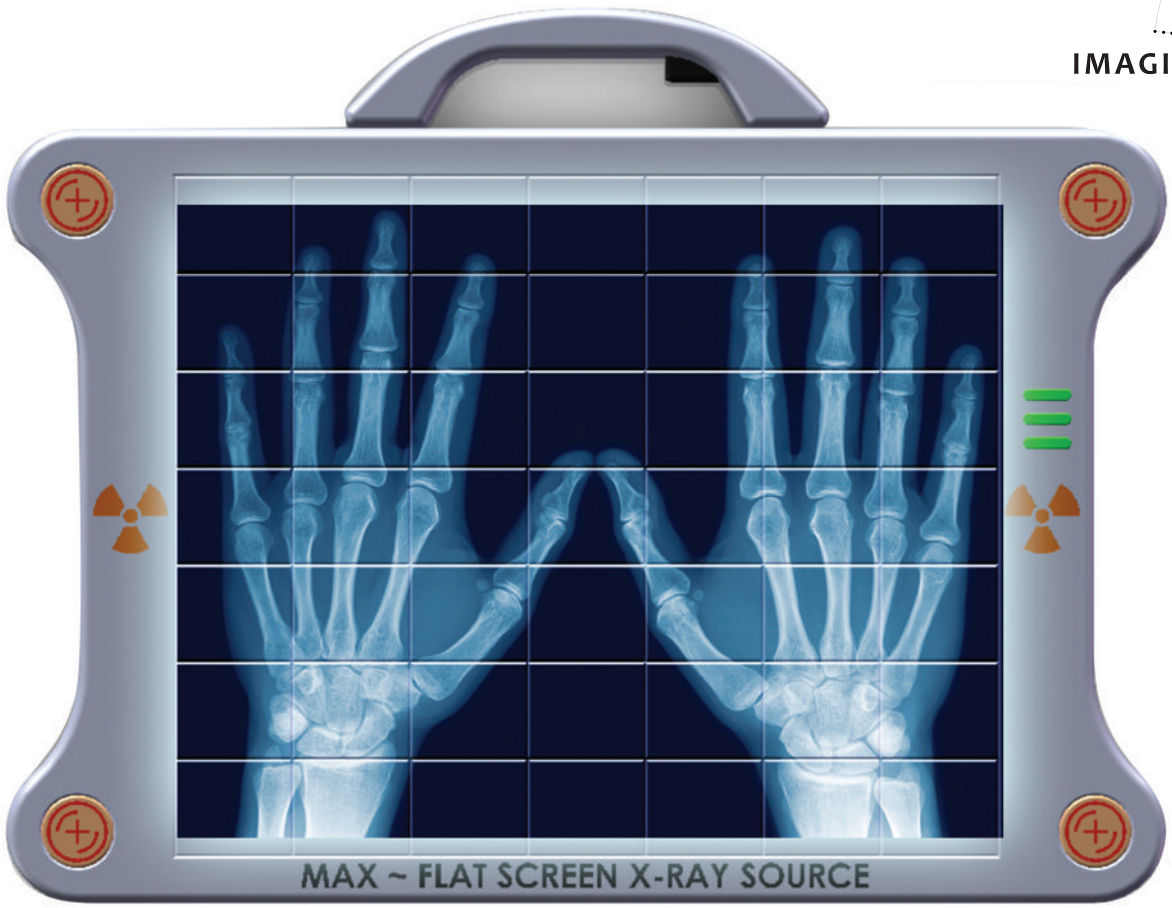


Illustration by Roger Lee

a technology that could do this mobile X-ray generation. We very quickly realized the potential of my work and started exploring how one goes about making these larger flat-panel arrays. That's what put us on the path to what we're doing now."

Now headquartered in UCLA's California NanoSystems Institute technology incubator, the Radius team is working to commercialize Travish's discoveries in a line of X-ray applications that are affordable and more mobile than current tube-based devices.

"It's really hard to give birth to a technology," says Travish. "It is a daunting challenge on the one hand. On the other, it has surely been refreshing to have a great team of people to work with and have access to the wider skill set that a great university like UCLA offers."

Hooked on Photonics

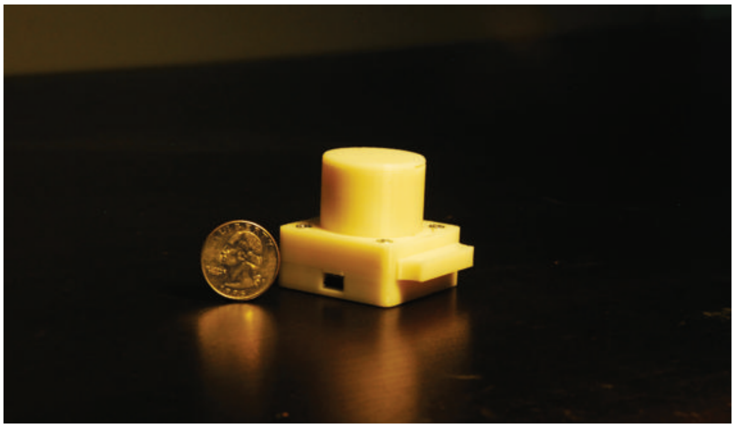
In a modern, well-equipped medical laboratory, it is relatively simple to test blood or other specimens for bacteria and other contaminants that could pose a health hazard. But in remote parts of the world, it is quite another matter.

"Out in the field, it's pretty difficult to find an advanced microscope or a blood analyzer that you'd normally find in a hospital," says Aydogan Ozcan, assistant professor of electrical engineering at UCLA. "It's especially difficult when dealing with global health-related problems like malaria, HIV, TB and water screening. You cannot rely on having access to an adequate medical infrastructure."

Ozcan proposes to use the increasingly ubiquitous cellular networks to compensate for the absence of this infrastructure. Drawing on his expertise in photonics, Ozcan and his research group have developed a software-based technology that simulates the lenses found in microscopes and other sophisticated diagnostic devices. Cells suspended in a specimen of blood or water, for example, cast shadows. These shadows, in turn, can be detected by sensors embedded on a cell-phone-like device.

"Quite importantly, we can process these shadows to do blood analysis and to do microscopic imaging entirely in the digital domain," says Ozcan. "The hardware, which fits into the pocket of the user, is very lightweight and cost-effective. Everything else is done in the computational domain using a computer to create microscopic images based on the cell shadows."

Ozcan licensed the technology from UCLA and, working with business partner Neven Karlovac, formed a company called Holocope to develop a commercial version of the device.



Prototype for Ozcan's lensless microscope.

A Big Payoff

Photo by John Yip

"There are two types of people," says Arya Ahmadi-Ardakani. "One type has the greatest ideas, and they don't do anything about it. The second type has the good idea, but they do something about it."

Until 2009, Ahmadi-Ardakani would have put himself and his longtime friend Omid Sabeti in the first category. But that year he received an email from his advisor in the UCLA Electrical Engineering Department, alerting him to an opportunity to participate in a competition sponsored by the Mail Room Fund. The fund — a joint venture sponsored by the William Morris Agency, venture capital firms Accel Partners and Venrock, and AT&T — was created in 2008 as an investment vehicle to help launch Internet-based businesses. The following year, the fund partnered with UCLA's Schools of Engineering and Theater, Film and Television to stage a competition. First prize was a $10,000 reward to the students with the best idea for an Internet-based business.

With $10,000 at stake, Ahmadi-Ardakani and Sabeti decided it was finally time to act. "We had a great idea all along," he says, "and this actually motivated us to something about the idea. This is the spark we needed."

Their idea, an eBay-like service in which products can be exchanged for online gaming points, is called Trap Zoo, and in October 2009, a panel of judges declared it the best of the six ideas evaluated in the final round of the competition. And the victory is paying off in more ways than the award money. Ahmadi-Ardakani, who is in the second year of his doctoral studies, and Sabeti, who is an undergraduate majoring in business and marketing, are negotiating with several venture capitalists to turn their winning idea into a viable business.

That Ahmadi-Ardakani and Sabeti represent two different disciplines is significant, says Jeff Burke, director of Technology Research Initiatives at the UCLA School of Theater, Film and Television (TFT). "Collaboration across disciplines is a long-standing interest of ours."

Burke credits the Mail Room Fund's manager Richard Wolpert with the idea of taking the educational experience to the next level by adding entrepreneurship to the mix.

"The connection to entrepreneurship and venture capital," he says, "is something that we hadn't explored in this particular way before. Our research has been supported by venture capitalists in the past, but creating an opportunity for students to connect directly with potential sources of funding for their innovative ideas was a new and exciting thing."

Burke also applauds TFT and the Mail Room Fund's joint decision to pair student teams with mentors from industry. He believes that this aspect of the competition created an important bridge between the classroom and the private sector.

Teri Schwartz, dean of the School of Theater, Film and Television, agrees. "Putting students together with successful mentors who can both teach and serve as role models is a wonderful idea," says Schwartz. "One of our goals at TFT is encouraging students to believe that they can not only achieve success in their respective fields of study, but that they can use their personal vision to create works that enlighten, engage and inspire change for a better world. The entrepreneurial spirit of these industry leaders can energize young talent to ground their work in these ideals, which is increasingly necessary in a highly competitive professional environment."

Success Stories

From UCLA's Intellectual Property Portfolio

Licensed Products

PomElla PomElla is a blend of pomegranate polyphenols for use in capsules or liquids, so that the heart-healthy benefits of pomegranate can be incorporated into more food and beverage products. Licensed by Blaze.

GDC and Matrix Coils Both coils are used in the treatment of brain aneurysms: GDC is a bare-platinum coil while Matrix2 coils are covered with a biopolymer. Licensed by Boston Scientific.

Introduction to Algebra Introduction to Algebra is a full-year course aimed at preparing California's low-achieving 8th grade students for algebra. Licensed by CMAT, the Center for Mathematics and Teaching.

MERCI Embolism Retriever Device MERCI stands for Mechanical Embolus Removal in Cerebral Ischemia. In lay terms, it's a device used to remove blockages from the arteries that supply the brain. Licensed by Concentric Medical.

Metamaterial Antennas (for handsets, wireless routers and laptop computers) Metamaterials are engineered structures made of common materials — such as copper or silver — that are designed in such a way that tiny antennas can still do a good job of gathering up radio signals. Licensed by Rayspan.

Nicotine Patch Because a nicotine patch releases nicotine into the body through the skin, smokers can use it to gradually reduce the amount of nicotine they receive instead of trying to quit "cold turkey." Licensed by Novartis.

Copyright Technologies

Calibrated Peer Review (CPR) Peer review plays a prominent role in the progress of science: proposals, research and manuscripts are all peer reviewed. The web-based CPR program teaches students how to review discipline-based writing.

Cool Tools Lesson plans and physical props in Cool Tools are designed for teachers to help young children understand complex ideas about behavior.

Digital Models of Rome 400 A.D. Digital models allow scholars and visitors to visualize ancient Rome as seen at a particular moment in time.

UCLA's three-part mission is research, teaching and service. OIP strives to support UCLA professors and researchers by helping them connect with industry and investors. In FY2009, UCLA investors earned $10,440,000 from their successful technologies. Overall IP revenues for UCLA during that year totaled $28,866,000.

IP Protection, Technology Transfer and Research Activities for FY2009

333	Invention disclosures
179	New U.S. patent filings
136	Secondary filings
60	Issued U.S. patents
76	First foreign filings
37	License and option agreements
19	Amendments with new IP matter
317	Confidentiality agreements
45	Letter agreements
25	Interinstitutional agreements
52	Material transfer agreements (case related)
964	Material transfer agreements (non-case-related)
430	Number of inventions optioned or licensed

TOTAL INVENTION PORTFOLIO	1700
TOTAL ACTIVE U.S. PATENTS	581
TOTAL ACTIVE FOREIGN PATENTS	584
TOTAL ACTIVE LICENSE AGREEMENTS	277

WRITER, DAYTON FANDRAY. COPYEDITING, KEASHA DUMAS.

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Companies in California with licensed technologies developed at UCLA

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